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COLOR AND FOOD: From the Farm to the Table

Interim Meeting of the International Color Association

12-15 October 2010

PROCEEDINGS

José Luis Caivano and Mabel Amanda López
editors

Grupo Argentino del Color

Universidad Nacional de Mar del Plata

International Color Association

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From the Farm to the Table

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José Luis Caivano and Mabel Amanda López

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Preface

Dear friends,

On behalf of the International Color Association (AIC) and the Argentine Color Group (GAC), we are delighted to welcome you at the AIC Interim Meeting 2010, in Mar del Plata city, Argentina, from October 12 to 15, on the theme “Color and Food: From the Farm to the Table”.

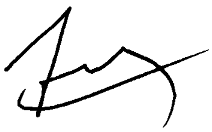
The meeting includes keynote lectures by specialists, oral papers and posters on different aspects of color related to food, as well as a commercial market and an artistic exhibition. The theme of the meeting is approached from different perspectives, including not only food technology and colorimetry, color chemistry and physics, but also commercial architecture and design, lighting, packaging, advertising and color communication, color psychology related to some aspects of food, consumer expectations, color preferences, the representation of color and food in the arts, and various other aspects of the interdisciplinary net that these two essential aspects of life interweave. We cannot live without food, and certainly life would be extremely ominous and difficult without color.

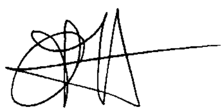
This is the second time that an AIC meeting or congress is held in Argentina. Various participants may still have fresh memories of the 6th AIC quadrennial Congress held in Buenos Aires in 1989.

You will experience the friendly and open character of the Argentine people, who will warmly receive you in a country with plenty of natural beauties and appealing cultural features.

Welcome to AIC 2010!





José Luis Caivano
Chairman, AIC 2010

Roberto Daniel Lozano
Committee member

Omar E. Burgos
GAC president

Program outline

47 oral papers (20 minutes); 4 keynote lectures (40 minutes)

TUESDAY, October 12

10:00 to 16:00	AIC executive committee meeting (at ADUM)	pre-congress seminars / tutorials: (at ADUM) 10:00-16:00 D. Bardier: ¿Qué nos da hoy el color? De la física a la sociedad (in Spanish) 15:30-18:00 L.MacDonald: Introduction to colour measurement (in English)
16:00 to 18:00	registration & posters hanging (at Hotel Provincial)	
18:00 to 20:00	opening of the meeting artistic exhibition reception cocktail (at Auditorium)	

WEDNESDAY, October 13

	Opening session	
8:40	opening ceremony	
9:00	**OPENING LECTURE: John Hutchings** (40')	
9:40	DaPos-Rao	
10:00	Jung et al.	
10:20	coffee break, posters (30')	
	Psychological aspects	
10:50	Conceição	
11:10	Ortiz	
11:30	Frontera et al.	
11:50	Cox-Domper	
12:10	Kuo et al.	
12:30	lunch (1 h.)	
13:30	commercial exhib. (1 h.)	
	Packaging	
14:30	Castillo-Becerra	
14:50	Musso	
15:10	Csillag	
15:30	Prause-Cariola	
15:50	Rojas-Fossati	
16:10	coffee break, posters (30')	
	Architecture	
16:40	Hidalgo et al.	
17:00	Incatasciato et al.	
17:20	Suarez-Avila-Domijan	
17:40	Koblanck-Ejhed-Moro	
18:00	Noury	
18:20 to 19:00	posters session	study group meeting: CE

THURSDAY, October 14

	Chemistry & colorimetry	
8:40	Akhtar et al.	
9:00	Hirschler	
9:20	Harkness et al.	
9:40	Kim-Golding-Archer	
10:00	Melgosa et al.	
10:20	coffee, posters (30')	
	Colorimetry	
10:50	Ferraris et al.	
11:10	RodríguezPulido et al.	
11:30	Lucassen et al.	
11:50	**KEYNOTE LECTURE: Angel Negueruela** (40')	
12:30	lunch (1 h.)	
13:30	commercial exhib. (1 h.) lecture L.Schmid, Osram	
	Arts & culture	
14:30	Echagüe	
14:50	Burgos	
15:10	Gündes-Özden	
15:30	Silveira	
15:50	Tassara	
16:10	coffee, posters (30')	
	Properties & preferences	
16:40	PeacockSmith	
17:00	Sueeprasan-Traisiwaku	
17:20	Agudelo et al.	
17:40	Gallo-Buera-Petriella	
18:00	Sandoval et al.	
18:20 to 19:00	posters session	study group meeting: ECD

FRIDAY, October 15

	Environmental design
9:00	Avila
9:20	Cordero-Poblete-Egert
9:40	Serra et al.
10:00	Lee-Sun
10:20	coffee, posters (30')
	Culture & language
10:50	Barrios
11:10	Gündes-Yildiran
11:30	MacDonald-Mylonas
11:50	**KEYNOTE LECTURE: V. M. Schindler** (40')
12:30	lunch (1 h.)
13:30	commercial exhib. (1 h.)
	Lighting and imaging
14:30	Villar
14:50	Okuda et al.
15:10	Funt-Mosny
15:30	Lin-Lo
15:50	Farroni-Buera
16:10	coffee, posters (30')
	Closing session
16:40	**CLOSING LECTURE: Daniel Lozano** (40')
17:20	closing reports: study groups reports final open discussion presentation of next meetings
19:00	city tour / dinner / party (included in full registration)

SAT, Oct. 16

excursion to the hills (included in full registration)
lunch (optional)
other optional tours or excursions

99 posters exhibited all 3 days: October 13-15
Commercial exhibition open all 3 days: October 13-15
Optional tours or excursions after the meeting: Saturday, October 16 in the afternoon

pre-congress seminars / cursos pre-congreso:
Dardo Bardier: ¿Qué nos da hoy el color? Desde la física a la sociedad
Lindsay MacDonald: Introduction to colour measurement

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Oral session: **Color and Food in Culture and Language**

Oral session: **Food Lighting, Color Imaging and Appearance**

Posters

Posters: **Color in Food Packaging and Identification**

Posters: **Color in Food Design, Architecture and Built Environment**

Posters: **Food Color and Lighting**

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Posters: **Food Color and Appearance**

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Posters: **Food Color Vision and Imaging**

Oral Papers and Invited Lectures

Food, expectations, colour and appearance

John HUTCHINGS
Department of Colour Science, The University of Leeds, UK

ABSTRACT

Expectations drive our decisions, lives and actions. Interpretation of the scene governs whether or not we eat the food front of us, or whether or not we patronize a particular store or restaurant. Throughout the food supply chain expectations (derived from the total appearance of the food) are at the heart of quality and price judgements. On entering a restaurant or pub we may subconsciously judge expectation qualities such as cleanliness, comfort, privacy and quality. Such judgements are direct responses to the visual properties of the space. A holistic approach is taken because total appearance images and expectations are critical in separate and interlinking ways to all aspects of food research, development, production, marketing, sales and preparation, as well as consumption. Above all, they are critical to each individual producer or customer whether they are in the field, kitchen, store, restaurant or pub. They are also critical to those contributing to the visual stimulus experienced by the customer. These include architects, store designers, and food producers, whether they are chef or manufacturer, as well as those in advertising and packaging or those responsible for training customer contact staff.

1. INTRODUCTION

The early history of life on earth involved co-evolution of insect and animal visual characteristics with vegetation and fruit to produce food appearance based on sensitivity to wavelength and angle, on surface texture, on ultraviolet signals and on polarisation. Specific food properties evolving were related to the particular visual sensitivities of the creature. Human beings see that world using a restricted wavelength sensitivity, zero detection of the ultraviolet and zero detection of polarisation. Cones in the retina of the human eye gave us the ability to detect the yellows, oranges and reds of fruit and reddish coloured succulent edible leaves from their respective green and brown backgrounds.

Our early evolutionary link with fruit and vegetable colour is so profound that we need to eat generous portions of pigment containing fruit and vegetables to live a healthy life today. Colour is not the whole story of our visual link with food because we have evolved to respond to appearance. This comprises visual structure, each element of which possesses colour, translucency, gloss, surface texture (roughness) properties. Each of these attributes behaves characteristically with time and processing, all contributing to our overall expectations of the food in front of us.

Study of the appearance of food is totally different from the study of other mass marketed materials such as paints and plastics. There is considerable interaction of appearance properties of foods in the formation of expectations, whereas it is normally easy to treat appearance attributes of other materials as independent variables.

This paper contains an outline of food appearance properties, expectations that arise for food and the food environment, and gives examples of commercial exploitation and the halo effects that result. It will conclude with a brief consideration of specification and measurement of appearance attributes as well as of the expectations themselves.

2. FOOD COLOUR AND APPEARANCE

One of the ways that study of how foods look differs from that of all other mass marketed materials is that foods have a natural variation in appearance properties. Normally, solid foods are non uniform in colour, they are translucent and vary, often irregularly, in surface texture (i.e. roughness) and gloss. It is the complete package of these properties that leads to identification and preference for a particular food.

Many products, for example meats, have a visual structure revealing different elements within the total product. We immediately receive information as to the number of muscles present, the degree of lean and fat contents.

Translucency, caused by occurrence of both light transmission and reflection, is visually perceived as a colour contrast. Ancient Egyptians clarified drinks by filtration and today a reduction in clarity leads to rejection of alcoholic drinks. Turbidity in fruit juices, such as apple, can be a positive or a negative attribute depending on the expectation of the consumer. Processing affects colour as well as translucency. Fish and red meats depend for their perceived quality on the balance between colour and translucency.

Gloss, also perceived as a colour contrast, is of concern to the food industry. Specific gloss characteristics are associated with different fruits and vegetables. High-quality chocolate normally has a high gloss and light scattered from the surface is near mirror-like specular reflection. When chocolate blooms it loses gloss, the specular reflection changes to diffuse scatter and the surface becomes dull. In the store glossiness of moist surfaces such as fish reinforce perceptions of freshness, but only if there is sufficient directional light. Glossy surfaces look attractive and are perceived as clean. Hence, for the store apples may be coated with wax designed to reduce gas exchange, weight loss, and fungal growth but are also designed to be glossy. Gloss or glaze is achieved in the kitchen by finishing vegetables glacé or coating products with a jam or fruit puree, or with a sweet or savoury aspic glaze.

Surface texture is also a characteristic of foods. Meat cut along the grain reveals its fibrous structure, breakfast cereals have differing degrees and types of roughness, some varieties of apple are rough skinned some smooth. We perceive this roughness as colour contrast but a study of colour alone will not reveal the story behind the product.

In summary, there is a number of attributes of appearance that affect the look of the product. Hence, when we study effects of processing, cooking and consumer preference it is essential to consider appearance as a whole. This consists of *visual structure*, variations of *colour*, *translucency*, *gloss* and *surface texture*, and *temporal properties*, this is, how these individual attributes change with time or processing. All these attributes combine to result in what we expect of the food in front of us.

3. EXPECTATIONS

There are two main types of expectations that condition our subsequent responses and experiences. The first are those generated by what we believe, perhaps from a religious knowledge. The second are the five general categories of expectations generated from our perceptions of a scene. This applies to everything we view, whether that is a landscape, store front, the waiter, a plate of food or its packaging (Hutchings 2003).

Visually assessed safety involves safety of body and safety of mind. Perhaps the cutlery appears dirty, or that this television programme will corrupt the mind of my child.

Visual identification, for example, this building is a restaurant, that person is the store manager, this food will taste sweet.

Visually assessed usefulness, for example, will the waiter know how the meal is prepared, is this food what I need at this time, will it contain the vitamins I need?

Visually assessed pleasantness, this is a comfortable looking restaurant, will this waiter be friendly, how tasty will this plate of food be?

Visually assessed satisfaction, for example, when I have finished eating a meal in this restaurant, will I have enjoyed it; will it have been value for money?

Expectations are fundamental to food marketing and when a food pack, advertisement, dining room, or a particular food dish is being designed it is helpful to consider the five types. An important consequence of expectations are the halo effects they generate, these have profound implications for the sensory testing of foods. Expectations can also be commercially exploited, sometimes to an unethical extent.

3.1 Halo effects

Colour and appearance are powerful indicators of object quality. Human beings have different sensitivities to flavour and it is relatively easy to confuse tasters by giving them inappropriately coloured foods. Raspberry flavoured drinks may be identified as orange juice, sweets presented in differently coloured wraps taste differently. Food folklore has it that diners eating in the dark can be made physiologically sick by switching on the lights, revealing that they are eating inappropriately coloured food. Divisions occur within populations; in the UK there are different preferences for tomato soup colour. Dark, deep red is the preferred colour for those used to tomato puree/powder based soup but orange red is preferred by those raised on tins of Heinz cream of tomato soup (Hutchings 1999).

3.2 Implications for sensory testing

Halo effects have severe implications for the food sensory panel. Panel in-mouth scores can be influenced by sample appearance, the environment, panel organisation and panel organiser attitude. During optimisation of product flavour or texture, low illumination levels or coloured lighting is used in the tasting area. However, although the actual colour of the product may be completely lost, conclusions may still be drawn about the sample from the light reflected. For example, the extent of baking of bread products can be detected even under low illumination levels. The halo effect is so powerful that variations in appearance should be entirely eliminated while judgments of flavour and texture are made. There are however two groups of subjects, field-independent, who attend to their taste and smell perceptions even in the presence of an inconsistent visual stimulus, and the field-dependent, who make more mistakes when trying to identify flavours in the absence of visual cues as to their origin. The traditional R and D function of the manufacturer may concentrate too much on the product. The marketing end of the business may focus too much on concepts, and the lifestyle and attitudes of potential customers. Often little account is taken of the extreme influence of the brand.

Preconditioning influences eaters' beliefs. For example, knowledge of the fat content may affect consumer responses to the product but this may not occur with trained panellists. Preferences of young children are easily changed by identification of the product with hero figures. Product advertising affects panel members. For example, the British have been subjected to the persistent advertising claims that "smaller peas are sweeter" and that "larger peas are tougher peas". An unwary approach to the panelling of peas results in erroneous findings founded upon knowledge of this claim.

Halo effects can be positive or negative. The colour of an orange tells us that it contains a natural mix of healthy antioxidants which are good for us. But the colour uniformity may tell us that it is sprayed with fungicide and herbicide, and the gloss reveals that it has been waxed. We may therefore conclude that oranges are poisonous and are bad for us.

3.3 Commercial exploitation

Although colour might be basic to judgements of identification and quality it is by total appearance that we come to understand the product. High expectations about the healthiness of oranges may lead us to have similar beliefs about orange juice. This is itself an example of the halo effect. A commercial exploitation of this is the extension to some commercially produced 'orange' drinks. Not only is this orange liquid in a white translucent plastic bottle having an orange label, it is marketed in exactly the same way as real orange juice in a chill cabinet. But when it was launched this product contained a mere 5% orange juice with lots of sugar, water and colorant. The success was great, the parent thinking that it is healthy for the child but the child liking it because it contains lots of sugar. The marketing was brilliant, unethical, but brilliant.

Lighting is a factor in environmental design and no single lighting regime is optimal for all foods. Red biased light is used to conceal the brown specks in fresh beef that indicate pigment oxidation. The customer normally regards such meat containing metmyoglobin, although probably edible, as undesirable. Some regard this use of store lighting as bordering on fraud, but is it unethical to display foods to their best possible advantage?

4. ETHICAL CONSIDERATIONS

We expect natural foods that we eat to have a colour and appearance appropriate to the dish. Similarly we feel better if a synthetic dish, such as ice cream, also has a colour appropriate to the flavour. For 4,000 years colorants have been added, perhaps to restore damage caused by processing, or to make products more uniform or attractive, or later to protect flavour- and light-sensitive vitamins during storage. Colour helps us identify flavour and estimate its strength and quality. How far is it ethical to colour foods?

In the USA non-natural colours are being used to tempt children to overeat foods that contribute to obesity when eaten to excess. Examples include: high fat margarine products that are purple and bubblegum flavoured, or hot pink, or bright blue; high fat, high sugar ketchups that include bubblegum flavoured blue mayonnaise and 'Blastin' Green' and 'Funky Purple' versions of the normal yellow ketchup; high fat, high salt snacks that include some that are neon orange; and high sugar drinks that are marketed in colourful branded cans. Is manufacture of these products and such presentations ethical?

Rules of colour in food marketing were very simple. Dark colours with sophisticated textures and design for adults; bright high contrast saturated colours and horror figures as well as free toys for children. However, changes to this controlled order have taken place and marketing for adults has to a large extent become an extension of marketing for children. High contrast colours are increasingly used to attract everyone and are a feature of even dairy, bakery and alcoholic drinks sections of the store. Colourful cereal packs featuring cuddly animals or icons of respectability tempt children and adults to eat products that are high in sugar and salt. The binge drinking among teens and twenties in the UK have, some have argued, resulted from the open marketing of alcoholic lemonades or alcopops sold in brightly coloured cartoon covered bottles. Bright high contrast colours are used to market to all ages and younger buyers are attracted by products specifically meant for adults (Hutchings 2006).

5. MEASUREMENTS

Visual appearance is comprised of those properties we perceive as *visual structure*, the value, uniformity and pattern of *surface texture* (i.e. unevenness of surface), *colour*, *translucency* and *gloss*, plus changes of these properties with time or with response to, say, pressure or temperature. All these attributes we can scale visually with precision and accuracy and instrumentally specify using digital camera technology (Hutchings et al. 2002). The term total appearance, meaning a combination of assessable and measurable product attributes as well as our feelings about them, was first used 30 years ago with reference mainly to foods. Since then the approach has been extended and refined (Hutchings 1999). The CIE has a Technical Committee TC 1.65 coordinating progress in this area (Pointer 2006).

When we think of objects as having derived attributes, such as *acceptability* of appearance of foods, the *ripeness* of tomatoes, the appearance *warmth* of a room, the *elegance* of a building, then we are thinking in terms of appearance and impact. Such attributes are related specifically to our recognition and psychological sensory, emotional and intellectual images and estimates of quality. As such they are scalable and understandable in terms of visual appearance attributes and their interactions.

Understanding of any food product (e.g. a plate of food), internal space (e.g. dining room or store) or external space (e.g. a store façade or landscape) can be achieved using the following six elements. The details obviously change with situation, but there are six elements to the understanding of a space and its effect on the viewer. The approach can be applied to the analysis and possibly to the prediction of the effects of the space on the human being. These six elements of a scene fall into three groups, they are:

1. The physical *environment* consisting of the static environment itself (e.g. the furniture in the room or food on the plate, and *additions to the static environment*, for example, the temperature, illumination and human beings within the space or the temperature of the food.

2. The *psychophysical* impressions, that is, the *impact* properties in terms of warm/cool, hard/soft and clear/greyed (suggested for colours by Kobayashi 1998), i.e. design elements (e.g. curves and angles, irregularity, furniture style, small/large spaces), materials of construction, illumination (colour, artificial/daylight, rendering intensity, uniformity), colours (also in terms of Green-Armytage 2002); the *primary expectations*, that is, safety, identification, pleasantness, utility, satisfaction (see above); and *secondary expectations*, that is specific psychophysical experiences of the appearance of the space, in terms of, for example, homeliness, intimacy, elegance, and privacy (Hutchings 2003).

3. The *psychological effects* of the environment, such as the sadness, fear, vulnerability, motivation, calmness, self esteem, or tranquillity generated by the space or the product.

Elements of a space as well as the space itself can be quantitatively scaled (Hutchings et al. forthcoming). We now have an in-depth understanding of the colour and appearance of food and the food environment as well as detailed methods for their quantification. Assessment and measurement can be linked with the emotional responses to what we see.

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Colours seen through transparent objects

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ABSTRACT

Perceiving transparency involves the perception of a transparent object, may it be real like a drink or simulated like in virtual reality, distinct and in front of an organized background visible behind and through it. Here we study how the colours in the background are modified by a coloured filter which completely covers them. Four observers had to reproduce in a uncovered part of the background the nine colours of a simulated mondrian stereoscopically observed through a coloured veil. The filters could have one of the four unique hues, at two levels of chromaticness (NCS), and at two levels of transmittance. A control mondrian without filters had also to be matched. The obtained matching colours show rather relevant deviations as respect to the 'real' colours of the covered mondrian, that is little colour constancy occurred. No constancy difference has been found as a function of the chromaticness and of the transmittance of the filters, while colour constancy seems to depend on both the colours of the filter and of the background.

1. INTRODUCTION

Both foods and drinks can be transparent or translucent (from now on we do not differentiate the two terms), but not always they appear as such. The reason is that the definition of transparency is almost always framed in physical terms (transmittance or density). We need a psychological/perceptual definition which describes the visual appearance, for instance: "transparency is the property of an object through which we can see more or less distinctly what is behind". The degree of distinctness of the shape, colour, texture, glossiness and other features of the objects perceived in the background through a transparent object determines different kinds of transparency. Research about transparency in the field of foods and drinks can be concentrated on two main characteristics, either on the transparent object or on the background seen behind and through it. Therefore we distinguish two main aspects: first the determination of the chromatic characteristics of the colour of the object (its colour and its visual density), and secondly how the colours of things seen through it are modified by the transparent object. The present research deals with this latter aspect, and our hypothesis can be formulated in term of colour constancy: "how much a surface colour appears constant despite the modifications introduced by a coloured filter in front of it" (Foster and Nascimento 1994, Ripamonti et al. 2004). We expect that, contrary to what found by D'Zmura et al. (2000), and on the basis of previous works (Masin 1998) colour constancy of surfaces completely covered by transparent objects is quite low.

2. THE EXPERIMENT

2.1 Material

To study this effect we simulated in a calibrated 21" Quato monitor a coloured transparent veil completely covering a chromatic mondrian (about 5 × 5 cm, about 10° at 30 cm of viewing distance, and protruding from it over a white background (120 cd/m^2). The veil was perceived at a certain distance in front of the mondrian (about 6 cm) by means of a simulated stereoscopic vision (two prismatic lenses were placed at 30 cm from the screen). The mondrian consisted of nine nearly square regions of chromatic (B, G, Y, O, R, P) and achromatic colours (W, S, and A-grey), always presented in random order (Table 1, Figure 1, left). It appeared behind and covered by the filter as a result of the stratification in depth; the reduction colours (Katz 1935) were computed according to one of the most widely accepted models of phenomenal transparency (partitive mixtures: Metelli 1974, Da Pos 1989, D'Zmura et al. 2000). The filter could have one of the four unique hues (Y, R, B, G), at high or low saturation (20 and 60 NCS chromaticness), and at high or low density (0.10 and 0.5 achromatic transmittance) (Table 1, Figure 1, right).

Table 1. CIELAB specifications of the colours of the mondrian at left, and of the filters at right. In brackets colour labels at left and the approximate NCS chromaticness at right.

SF	L*	a*	b*
Red (R)	53.40	84.59	63.86
Yellow (Y)	94.00	-10.27	90.98
Blue (B)	46.85	-13.72	-37.46
Purple (P)	37.32	41.83	-43.39
Green (G)	56.00	-51.69	25.64
Orange (O)	63.06	61.40	69.62
White (W)	100.00	0.00	0.00
Gray (A)	53.98	0.00	0.00
Black (S)	0.00	0.00	0.00

F	L*	a*	b*
Y (60)	86.49	-1	66.86
R (60)	64.03	44.28	16.44
B (60)	63.68	-17.38	-34.67
G (60)	68.85	-48.69	16.65
Y (20)	92.29	-3.8	28.34
R (20)	85.43	15.35	7.04
B (20)	87.07	-8.29	-9.6
G (20)	90.18	-16.31	7.63

Figure 1. The colours of the mondrian at left, and of the filter at right.

2.2 Method

The task of four female observers was to reproduce the mondrian seen through the filter with its original colours (as if it were observed without the filter) the assumption being that they could perceived the original colours through the filter. The modifiable mondrian was perceived in front of a local background of the same colour of the filter so to keep the same contrast relationships with the background as the covered mondrian, but seen in plain air. A series of many small buttons displayed in the screen allowed easy changes in hue, lightness, chroma, and whiteness/blackness of each small square forming the mondrian. Observations were made in a dark room after a suitable adaptation time. At the beginning the observers had to get accustomed with the stereoscopic device, and were asked where they perceived the veil to be sure that the depth perception was adequate to visually separate the veil from the mondrian. Some training time was also assigned to the matching procedure. The modifiable mondrian appeared with achromatic squares of different lightness, which had to be changed by the observers. Before closing each session observers were invited to give an overall look both at the filtered and at the reproduced mondrian to verify their global colour correspondence, and to adjust again the matches if necessary. There was no time limit to perform the task and it could be interrupted as many times as the observers liked. To check the ability of the observers in matching colours a number of further sessions were performed in which both mondrians were uncovered while all other factors remained unchanged.

2.3 Results

All colours were transformed in the CAM02-UCS appearance colour space to better deal with measures of colour constancy (inconstancy index: Luo et al. 2006, Kim and Park 2010). First of all the performance of the four observers showed rather interesting differences. The observer 2 resulted significantly, and also largely different from the other three (her median deviation ΔE' = 31.99 compared with 16.68, 21.42, 13.14 of the other three observers, two tails Wilcoxon Z test = ~ 8.2 for the three comparisons, p = 0.0000) in that it reproduced with admirable care the 'reduction' instead of the mondrian colours (see an example in Figure 2).

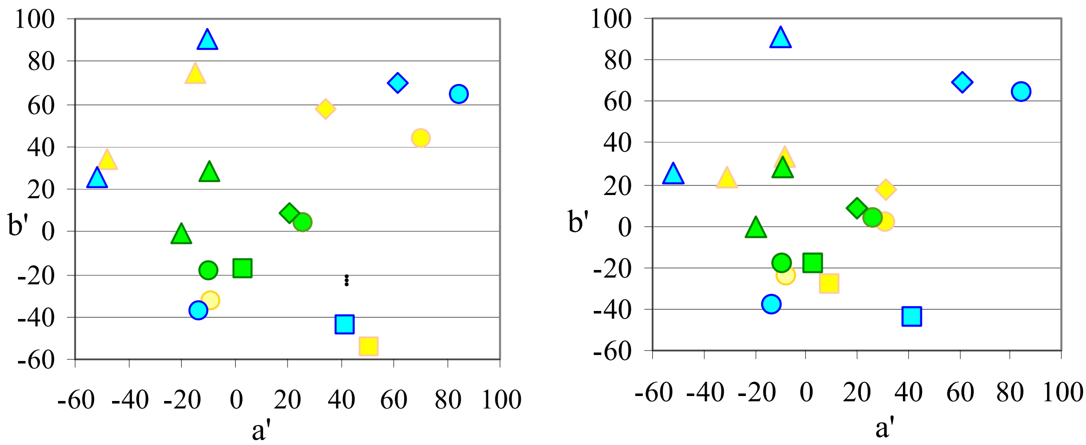

Figure 2. At left the results plotted in a CAM02-UCS diagram of three observers when the filter was blue, little chromatic and highly transparent. In green the chromatic colours, derived by calculations according to Metelli model (1974), and presented in the screen; in blue are the colours of the mondrian if seen in plain air. In yelloware the colours reproduced by the three observers (1, 3, 4). At right the results of observer 2 in the same conditions. Perfect constancy is obtained if the reproduced colours are the same of the uncovered mondrian. While rather good constancy is achieved by the three subjects at left, observer 2 carefully reproduces the reduction colours, failing to see the colours of the mondrian.

This difference seems to depend either on the very poor stereoscopic vision of observer 2, not emerged in the initial training, or on her very strong selective attention which prevents spatial interactions between colours (Masin and Quarta 1984) and consequently the appearance of complex phenomena like transparency, in which two colours are perceived at the same time in the same area, one in front and one on the back, along the same line of sight. All further statistical analysis have been therefore made on the data provided by three observers only.

On the basis of previous experiences we expected that highly transparent filters would affect colour constancy less than the more opaque ones. On the contrary we found no significant difference between conditions in which transmittance was high (50%) and low (10%). Moreover we also expected that more chromatic filters would distort more the back colours than little chromatic filters: results on the contrary indicate that slightly less deviations are derived when more chromatic filters are covering the mondrians (median =

14.76 vs 15.16). Although the difference is very small, it is significant (two tails Wilcoxon Z test = -8.07, p = 6.85E-16). Interesting results were obtained relative to the filter colours: increasing deviations from colour constancy are produced by Red, Green, Blue and Yellow filters in the order (median-R = 17.9, median-G = 18.7, median-B = 20, median-Y = 21.4; yellow is more deviating than the others, two tails Wilcoxon Z test = -2.8, p = 0.005 in comparison with the blue filter; Z test = -2.9, p = 0.003 in comparison with the green filter; Z test = -2.6, p = 0.008 in comparison with the red filter). Also the colours of the background are more or less susceptible of being modified by the filter. Warm colours (Y, O, R) seem to be more constant than cold ones (B, G, P), irrespective of the kind of filters which cover them (median-Y = 21.9, median-O = 27.3, median-R = 32.3, median-B = 40.0, median-G = 40.1, median-P =49.7). In the control trials deviations were rather small: red, yellow, and blue colours are reproduced with small deviations (CAM02_UCS $\Delta E'$ = 3.1, $\Delta E'$ = 3.5, $\Delta E'$ = 3.8 respectively) while slightly higher deviations are found in the case of orange, purple, and green (CAM02_UCS $\Delta E'$=7.1, $\Delta E'$ = 8.1, $\Delta E'$ = 10.3 respectively). Lastly lightness matching has been always very accurate.

3. CONCLUSIONS

The perception of transparent objects can be studied as a case of colour constancy: the variable which interfere with colour constancy are many, and on the one side we found that constancy of the background colours depends on the colour of the filters, while on the other side warm colours in the background are more constant than cold colours.

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What is the color of a glass of wine?

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ABSTRACT

In this multidisciplinary pilot study, the overall research question is how the color of transparent materials is perceived and if it can be matched with opaque samples in visual color system. The focus is on the Natural Color System (NCS) and its potential to represent color in glass artifacts. The perceived color of seven glass objects was determined using NCS notation, i.e. hue (Φ) and nuance (s, c, w). A total of 420 color observations were conducted by 20 trained observers, using three different techniques. Two of them utilized the NCS atlas and the third one used virtual screen images of the NCS colors. The differences in hue and nuance were calculated for the three techniques. The main conclusion is that it seems to be possible to use NCS representation also for transparent materials but the standard viewing conditions must be modified to take account of the light that is transmitted through the object. It is also indicated that the virtual images match the nuance values of reference method quite well, but further studies are needed to enhance the color appearance of virtual hue values.

1. INTRODUCTION

The area of color research is characterized by its multidisciplinary approach, including phenomenological, psychological and physiological aspects of color perception (Billger 2000, Fridell Anter 2000, Hård and Sivik 2001), physical measurements of light spectra and, most recently, also the color appearance in virtual reality (Stahre 2009). The main focus in perceptual color research has been on the surface colors and the existing colour systems, such as Natural Color System (NCS) and Munsell, are established using opaque colors (Hård et al 1996a, 1996b, Kuehni 2000, Nayatani 2004). When it comes to transparent materials e.g. glass, plastics and liquids, there is no available color system based on perception (Gladushko and Chesnokov 2007). Pantone has a set of transparent three-step plastic samples with progressively increasing thickness and specified color codes designated to these samples, but they are not organized systematically in a color-space like NCS.

In this pilot study, the authors investigate the overall research question how the color of transparent materials is perceived and matched with samples in visual color systems; the main focus is on the NCS and its potential to represent color in glass artifacts. The research group is multidisciplinary and it comprises areas such as Design, Interaction design and Computer science as well as experts in the glass production processes. One of the partners in the research project is Glass Research Institute, Glafo (Växjö, Sweden), and this partner has a unique collection of several hundreds of colored glass samples, which have been gathered during 60 years. The collection is frequently used by glass designers but it does not cover the entire color range that can be produced in glass. In general, the industrial color generation process in glass artifacts is based on trial-and-error, which makes the procedure tedious and costly (Bamford 1997, Gladushko and Chesnokov 2007).

2. RESEARCH PROBLEMS ADDRESSED

The overall research question is as follows: Is it possible to use the same perceptual representations (especially NCS) for transparent materials that are used for surface colors and if this is possible, in which way should the existing color space be modified or extended to be able to incorporate transparent colors. Another research perspective is to study how the color appearance of transparent objects can be modeled in the virtual reality and how virtual models can be used to facilitate the communication in industrial color generation processes.

In the current study, the perceived color of glass objects is determined by trained observers in a standardized setting. The perceived color is expressed using NCS notation: hue (Φ) and nuance, i.e. the relationship between blackness (s), chromaticness (c) and whiteness (w). Similar method has been used by Fridell Anter (2000) in order to study the perceived color of painted house facades in different viewing situations. However, it is important to keep in mind that it is impossible to visually determine the “true” color of a transparent sample as the human color perception is always subjective. What is more, the perception also depends on external viewing conditions such as the type and position of the light source, viewing distance and angle, the thickness and shape of the sample as well as surrounding colors.

3. PILOT STUDY

In the pilot study, a total of 420 color observations were conducted by 20 different observers. The observers were 18 students and lecturers from the School of Design (Linnaeus University, Sweden) and two glass experts from Glafo. All the observers had prior experience of color matching using NCS atlas. The studied samples were seven glass sheets with the same dimensions (5*10*4 mm) and different colors, these samples will be referred to as sample A to G. The glass samples were matched with the NCS colors in three different ways:

- The sample was placed on a metal frame 5 cm above the white paper and the color was matched with the color samples in the NCS atlas.
- The sample was placed directly on the computer screen and the color was matched with screen images of the NCS colors.
- The sample was placed on a white paper and the color was matched with the color samples in the NCS atlas.

During all the observations, the light source, viewing distance and angle as well as other significant conditions were according to Swedish Standard, SS 019104, color specifications with NCS.

The observers conducted the three different matching procedures for each glass sample, and indicated in a questionnaire sheet which NCS color was the best match in each case. It was possible to choose two alternative colors, if the observer did not find the perfect match in the NCS atlas or screen image. For each sample and for each observation technique, an arithmetic mean of hue (Φ) and nuance (s, c and w) were calculated using the results from all 20 observes. If the observer indicated alternative colors, all the values were included in the mean value. The first matching technique is used as the reference value and the results are reported as the differences (ΔΦ, Δs, Δc and Δw) between the mean values of the reference color and the two other perception methods, respectively. As discussed above, there is no “true” perception of the color, therefore, the reference color is chosen in order to illustrate the differences between the three observation techniques, but the choice *per se* is an arbitrary one.

4. RESULTS AND DISCUSSION

The differences in nuance and hue between the mean values of the reference color and the two other perception methods are summarized in Table 1 and 2. In these tables, 1 denotes the values when the sample is observed 5 cm above the white paper, 2 is the value when the sample is placed directly on the computer screen and 3 is the value when the sample is placed directly on the white paper. The differences in nuance are calculated as follows: $\Delta s2 = s2 - s1$ and $\Delta s3 = s3 - s1$; $\Delta c2 = c2 - c1$ and $\Delta c3 = c3 - c1$; $\Delta w2 = w2 - w1$ and $\Delta w3 = w3 - w1$.

Table 1. Summary of differences in nuance between the three observations techniques.

	Δs2	Δs3	Δc2	Δc3	Δw2	Δw3
A	-9.10	17.9	-3.50	4.55	12.6	-22.5
B	14.6	4.90	-14.0	3.80	-0,90	-8.75
C	-5.05	5.70	-0.95	4.50	5.65	-10.4
D	2.00	0.40	-5.95	11.2	4.20	-11.5
E	-2.95	-0.15	-1.15	4.30	3.90	-4.35
F	0.45	0.05	-2.20	26.6	1.75	-26.6
G	-0.70	0.70	-1.10	8.60	2.00	-9.15

The differences in hue are calculated in the same manner: $\Delta\Phi 2 = \Phi 2 - \Phi 1$ and $\Delta\Phi 3 = \Phi 3 - \Phi 1$. The other way to estimate the difference in hue values also includes the chromaticness (the reference value) as follows: $\Delta\Phi c2 = (\Phi 2 - \Phi 1)*c1/100$ and $\Delta\Phi c3 = (\Phi 3 - \Phi 1)* c1/100$. The differences and the position of samples in the NCS circle are shown in Table 2:

Table 2. Summary of differences in hue between the three observations techniques.

	Quadrant	ΔΦ2	ΔΦ3	ΔΦc2	ΔΦc3
A	yellow-red	-7.58	2.67	-0.88	0.31
B	red-blue	-1.25	0.08	-0.75	0.05
C	blue-green	-0.58	3.33	-0.32	1.85
D	blue-green	7.25	3.75	1.98	1.02
E	blue-green	-20.9	14.1	-1.56	1.05
F	green-yellow	-7.5	2.00	-3.29	0.88
G	green-yellow	-16.5	1.75	-2.82	0.30

For all the samples A to G, the variation in nuance follows a similar pattern: samples observed 5 cm above the paper and on the computer screen are relatively similar and they both show lower chromaticness as well as higher whiteness compared to the observation made directly on a white paper. Sample A and F have the largest overall variations, whereas E has the smallest variation. Comparing the observations made when sample was placed directly on a white paper with the reference technique, following pattern can be used to describe variation in nuance:

- Samples D, F and G, which all have low blackness values, show greater whiteness and lower chromaticness for the reference method. E, which has the highest whiteness value, varies only slightly but could be classified in this pattern.
- Samples A and C, which have higher blackness values, show greater whiteness and lower blackness for the reference method.

Generally, the difference in hue values is greater when virtual images are matched with glass samples than when the NCS atlas is used. However, there are no obvious similarities with the variation in hues and nuances. It is interesting to note that when ΔΦ-values are weighed against chromaticness, the obtained values show much less variation as the colors with the lower chromaticness are allowed to vary more in hue values.

The main conclusion from the pilot study is that it seems to be possible to use NCS representation also for transparent materials. However, the standard viewing conditions must be adapted to take account of the light that is transmitted through the object, which is illustrated by the difference in whiteness between the reference color and the color observed when the sample lies directly on a white paper. What is more, for transparent materials the lightness value depends on the thickness of the sample. It is also indicated that the virtual images match the nuance values of reference method quite well, but further studies are needed to enhance the color appearance of virtual hue values.

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The control of animal stress and welfare with measurements of skin color variation: A new field of applications of colorimetry in applied psychology

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ABSTRACT

The main objective of the present study is to bring new perspectives on the application of reflectance spectrophotometry to control stress through the analysis of skin color changes in threatening situations, which has common implications in human and animal health. The control of animals stress is challenging, as the biochemical diagnosis and control involve the determination of stress biomarkers levels, e.g. hydrocortisone, and it is even more problematic outside the laboratory setting. The management of skin color oscillations due to stress and environmental conditions is presented through a new chromatic approach to the control of animal welfare, and to the quality of animal food products –from the farm to the table. Stress has adverse consequences on the quality of meat, affecting its color, pH and tenderness. The influences of stress on the oscillations of skin color in humans and animals are the consequences of reciprocal regulatory mechanisms between sensory perception, psychological reaction, neurohumoral mechanisms and physiological responses, which are determiners of the vasoconstriction of blood flow in responses to stress symptoms such as fear and fright. The harmful effects of stress in animals could be minimized by the control of skin color alterations during handling and transportation.

1. INTRODUCTION – STRESS AND ANIMAL EMOTIONS: FROM THE FARM TO THE TABLE

The color of the skin may change and become yellowish; a condition generated by psychological reactions, neurohumoral mechanisms and physiological responses to symptoms of stress such as fear and fright – these mechanisms have common aspects in humans and animals, Conceição (2008). Fear responses in animals are difficult to predict because they depend on how the animal perceives the handling and transport experience. Fear is a universal emotion in the animal kingdom that motivates animals to avoid predators, Grandin (1997).[1]

Grandin explains that both genetic factors and experience are determiners of how an animal will behave in a fear-provoking situation, animals with high-strung temperament are more fearful and form stronger fear memories than those with placid temperament. Two types of animals may have different physiological and behavioral reactions to the same procedure: the one with calm temperament may adapt more easily and become less stressed with repeated handling. The way an animal is handled early in life will have effects on its physiological response to stressors later – memories of stress can't be easily erased, Grandin (1997), Sacks (2006).

[1] Grandin is a designer of livestock handling facilities and a Professor of Animal Science at Colorado State University. She has a singular character and sensibility for the perception of animal emotion as explained by the neurologist Oliver Sacks.

Mounier et al. (2006), Buckham et al. (2008), and Gruber et al. (2010) make clear that stress has adverse consequences on animal welfare and health, and also on the quality of the meat, affecting its tenderness, color, pH, taste and hormonal vestiges. Buckham et al. (2008) observe that the transportation of young beef bulls causes stress and thus alters physiological variables, with negative impact on animal production. One possible consequence of transportation stress is severe respiratory diseases, to which animals often succumb.

Buckham collected various samples (10 ml each, at -24, 0, 4.5, 9.75, 14.25, 24, and 48 h, relative to the indication of transportation) and found that after nine hours of truck transportation by road there was drastic increase in cortisol levels, significant decrease in protein metabolism, and reduction in testosterone. The study concluded that researches of physiological response to stress may aid future detection of disease-susceptible cattle after transportation and suggest the necessity of further researches to validate the potential of blood plasma biological biomarkers.

The control of the levels of animal stress is already challenging, as the biochemical control and diagnosis of stress involve the classical determination of cortical levels, in invasive procedures which needs a series of variants control outside the laboratory setting.

Studies to determine the amount of stress in farm animals during handling and transportation have highly variable results and are difficult to interpret from the animal's stand point, since stress in farm animal routines depends on how different individuals perceive potential stressor agents according to genetic variability (temperament and hereditary dispositions); physiological stressors (hunger, thirst, fatigue, injury or exposure to thermal extremes), and psychological factors (handling, and reaction to novelty).

2. THE ORIGINS OF THE PARADIGMATIC VIEW ON STRESS STUDIES

Cannon, cited by Nitsch et al. (1981) devised a series of studies and experiments exposing animals to stressor agents at the beginning of the systematic research of stress with two focuses: revealing the somatic basis of symptoms (stress was seen as a clinical / popular parameter); and the differentiation of the concept of biological balance in the notion of homeostasis, a term of Greek etymology –from homo (same) and stasis (state)– that means "constant condition". The mechanism that regulates the vital conditions tends to maintain a stable equilibrium regulated by mechanisms of feedback on (internal/external) essential conditions - the metabolism of nutrients (proteins, vitamins, water, among others) produces energy (internal), and the amount of the nutrients in the ambient (external), as well as the threats and opportunities to obtain this resources - operating as an open/closed system.

Cannon proposes the concept of psychosomatic stress in relation to the environment and social conditions, a process that results from the organism reactions to non-specific stressors.

Selye, cited by Nitsch et al. (1981) carried out experiments extracting and injecting hormones in animals while simultaneously exposing them to a range of stressful situations. In his experiments with rats, Selye discovered a hormone (epinephrine) which, in elevated levels, causes several injuries, and he explained the "triad of stress" characterized by the morphological degeneration of the thymus;[2] growth of the cortex of adrenal gland due to excessive production of epinephrine;[3] ulcers and bleedings in the stomach and duodenum, as the result of a prolonged activation of the hormonal pituitary adrenal axis. Subsequently inferring the General Adaptation Syndrome (GAS), explained in three stages:

[2] Thymus is the gland whose function is to produce lymphocytes, largely responsible for the organic immune response.

[3] Epinephrine is the hormone responsible for rapid physiological responses of the organism to external stimuli.

1) Alarm reaction: (stressor identification) - something is perceived or realized as threatening and activates the pituitary adrenal axis to stimulate the production of energy for defense. It's the condition necessary to fight-or-flight response, characterized by an increase in respiratory frequency; increase in cardiac frequency, increase in arterial pressure, sweating, pupil dilation, anxiety, agitation, contraction of sphincters and the vasoconstriction.[4]

2) Resistance: (stressor agent persists) - the organism starts to operate at a higher energy level, characterized by the continuous activation of the sympathetic nervous system. Neither people nor machines can, however, operate indefinitely at a higher energy level or far from regular parameters. It becomes necessary to attempt to develop coping strategies to neutralize or reduce the harmful effects of the stressors on the organism, if there is a lack of coping strategies, this stage results in the increase of the adrenal cortex, ulcerations in the digestive system, irritability; and reduction of sexual hormones.

3) Exhaustion: (the final stage) - the stressor agent still persists and there is an eventual return to the stress initial stages of alarm reaction as an attempt to produce more energy (major increase of epinephrine, cortisol and other stress biomarkers), which results in the classical symptoms of stress: inhibition of the immune system, emergence of inflammations, ulcers, exhaustion and even death.

Selye, cited by Nitsch et al. (1981) understood the pituitary / adrenal axis as the decisive basis of endocrine response to stress. In this sense, the vast majority of researches on animal stress are currently focused on the control of physiological parameters: heart rate, blood pressure, rectal temperature, weight control, control of hormone levels and the search for new biomarkers that may help to better characterize stress.

The use of colorimetry for the control of skin color oscillations to stress management in the context of animal psychology implies a change in the paradigm of stress researches from the control of hormone levels to the prevention of stress and the promotion of animal welfare.

3. THE SKIN COLOR MEASUREMENT

The skin is the largest and most visible organ of vertebrates, a barrier between the internal and external environment. The functions of the skin are: to protect the body from injury, invasion of pathogens, and harmful substances; and to provide thermal isolation and energy storage. The epithelial tissue, the nervous system and the sense organs have the same genetic origin in the primordial layers of the gastrula ectoderm, U. S. National Institute of Health and National Cancer Institute (2008).

Bindon (2009) explains that the color of the skin is due to three pigments: melanin, the primary determinant of skin color variability, deposited in the upper layers of the epithelial tissue; hemoglobin, a complex molecule responsible for the red color of the blood; and carotene, the least common skin pigment, which gives the skin its yellowish aspect.

The perception of the skin color depends on the incident light on epithelial tissue and the mechanism of absorption and reflection of the light by the skin pigments received by the eyes. Sharpe et al. (2002), explain the physiological process of the color vision as trichromatic, but mediated by the interactions among fourth types of photoreceptors cell in the retina, the rods which contain the photopigment rhodopsin - constituting more than 95% of all photoreceptors cells do not contribute to the color vision, except under twilight circumstance. They clarify that color vision is mediated by three specialized photoreceptors, the cone cells, which

[4] Vasoconstriction: this mechanism confers the (human or animal) skin color the yellowing tone in frightening situations. It is a very intense reaction - there are records of people who suffer injuries in combats, but do not bleed. The internalization of the blood stream and the muscle contraction may be the mechanism which confers cattle beefs its darker tone.

represent only 7% of the remaining photoreceptors, have pigments (opsin) that respond to electromagnetic spectrum short-wave (S-cones) sensitive to a wavelength around 420 nm (blue); medium-wave (M-cones) whose pigment is sensitive to medium wavelengths, around 530 nm (green); and long-wave (L-cones), sensitive to wavelengths around 560 nm (red).

The perception of skin yellowing is difficult to the human vision because it may result from the activation of the cones bistratifield cells or small field – tritanopia or loss of S-cones functions by light-sensitive opsin to wavelength around 420 nm (blue-yellow), in the process of the additive light syntheses blue-ON/yellow-OF, which is assumed to polarize the yellow-blue color system. The neural locus of the cone antagonism is critical to the establishment of the color opponent channels in the stimulus of presynaptic circuit, Calkins (2002).

CIE TC1-63 (2009) sees the reasons for some of the problems with the perception of yellowish tones as the effect of small-field: since the (blue) S cones are rare in the retina, the spatial discrimination in the yellow-blue direction is limited.

4. THE METHOD - SKIN COLOR MEASUREMENT

Serup et al. (2006) suggests the Chromameter CR-200 of Minolta for skin color measurements, as it was used in many studies on skin cancer in the United State of America.

Conceição (2008) measured the athletes' skin color alterations with the Minolta Chromameter CR 410, a portable piece of equipment that measures the intensity of the light emitted by a xenon lamp and reflected from the surfaces, which is captured by R (red), G (green) and B (blue-violet) color filters, which simulate the trichromatic perception of the color by human eye (S, M, L).

Serup et al. (2006), in researches of skin diseases, argues that the CIELAB system, established by the Commission Internationale de l `Eclairage, is recommended for skin color measurements; nevertheless, he calls attention to measurement errors and malformation of skin, the variation of dermis and epidermis thickness and skin folds. He claims that oiliness and moisture affect the skin brightness. Hair, blood vessels, moles and scars can be decisive in the value of the measure.

5. RESULTS - SKIN COLOR OSCILLATION AND SYMPTOMS OF STRESS

Conceição (2008), made skin color measurements with the Minolta Chromameter CR 410 with aperture 8mm; mean of three consecutive valid measures of the skin color in the inner upper arm of Olympics Athletes (n = 32), before (standard measure) and after low-intensity training sessions only to elevate the activation of the organism, in situations of characteristic sport stress.

The deltas of the oscillations in the differences in skin color were calculated by the difference between the values obtained in pre- and post-training measurements. Statistical relation between variables was investigated and analyzed by SPSS version 10.0 with nonparametric tests (Spearman coefficient).

There was significant association between the color direction Db* (mean –0.24; min. –1.51; max. 1.14) and the frequency of the feeling of fear[5] ($p = 0.000$) and fright[6] ($p = 0.001$) evaluated with List of Symptoms of Stress LSS-VAS, Vasconcellos (1985).

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[5] The original item-question of the List of Symptoms of Stress LSS-VAS is: *tenho medo (I'm scared).*

[6] The original item-question of the List of Symptoms of Stress LSS-VAS is: *Qualquer coisa me apavora (I'm frightened of any sort of thing).*

There was no statistical association between the color direction Da* (red-green) in measurement in the inner upper arm and the frequency of the feeling fear and fright.

There was no significant statistical association with total color differences expressed in the CIELAB equations DEab* (mean 1.46; min. 0.53; max. 3.42), and the equation CIEDE2000 (mean 1.26; min. 0.45; max. 3.16), may because the principle stated in this equations fail to describe small yellow color differences to encompass the human eye deficit acuity to perceive variations in the direction of yellow-blue field.

5. PERSPECTIVES ON THE CONCLUSION OF ANIMAL STUDIES

The results of the preliminary studies with athletes point to new directions in the studies of stress management and applications of colorimetry, Conceição (2008).

Reflectance spectrophotometry analyses of the skin color are suggested as new chromatic approach to the study and control of stress in humans and animals, since the reactions of fear and fright are generalized and may have the same phylogenetic origins in the vertebrates' evolution.

The management of skin color oscillations may be a new non-invasive procedure to the control of stress in animals, possibly enabling the prevention of the harmful effects stress has on health, as well as on the quality of meat - from the farm to the table.

The harmful effects of stress in animals could be minimized by the control of skin color alterations during breeding, which is also associated with the reduction of diseases and reproductive problems, Mounier et al. (2006), Buckham et al. (2008), and Gruber et al. (2010).

Controlling skin color oscillations during handling, transportation and slaughtering would be less complicated and less invasive than controlling blood and biomarkers stress parameters, it would also help to understand the results of researches in the hormonal field.

The yellowness of the skin reveals symptoms of psychological and physiological responses to stress, which has common implications in human and animal health –the same stressor stimulus may affect one individual but not the other.

Studies based on the eye physiology may better explain the difficulty in perceiving small differences in shades of yellow. It's necessary to study new colorimetric equations to encompass/distinguish subtle color differences which are useful in many areas of science and its applications.

The measurement of subtle color differences may require the development of new equation to encompass the total color space which may have applications in other fields such marine navigation.

The improvement of the animal stress management may help bridge non-tariff barriers in international trade of food and meat products.

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Colors, flavors and emotions

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ABSTRACT

This paper has as an objective to seek if a relation between colors, flavors and emotions exists in a group of 100 Mexican students. With this purpose, we carried out an exploratory, cross-sectional and comparative study. We found that there are mainly given relations in which colors are primarily related with emotions through their meanings: flavors with colors, and just in the case of the sweet flavor they related colors with flavors and emotions.

1. INTRODUCTION

Food has the objective to satisfy a requirement: eat. We consider hunger a physiological normal and healthy reaction to the physical urgency of eat something due to an immediate food deficiency. This process of satisfaction has two important aspects: the physical and the emotional, both of them operating independently of the nutritional value of what we eat.

However, in this selection, the emotional factor plays a very important role. We can define the emotions as a mechanism that allows the mind to describe our world and that enable us to interact with people and things in our environment through a variety of subjective, physiological and behavioral components (Davidoff 1980), and that involves the learning of describe, understand and modify that environment using languages, symbols and behaviors.

On the other hand we have color, which has been studied since many years ago, as a communication element that then become signs with a specific and recognizable content that individuals handle as symbols (Ortiz 2004: 247). That's why many symbols of colors are ruled by principles based in their meanings that then become universal and timeless. We use these meanings in a familiar way to evaluate objects, situations, people, and in this case, food.

Food, color and emotion

If we remember that colors are linked to the emotional aspect it is not difficult to accept that when we select the food and their colors, we are influenced by emotions so we can't detach them from the activity of eating and so on to the selection and / or approval of some food. This is the case of desserts (a fact that has not been ignored by food traders), that in addition of the great amount of sugar they have they are usually pink because people relate this color with positive affections (Ortiz 2000, 2004) so we can say that the psychological aspect together with the colors becomes evident.

In the color-food relation field exists a series of ideas with no scientific basis that have been transmitted generation by generation, ideas which nobody know where they were born, and to which people have added their individual ideas trough years. These things transform the original idea in an affirmative and collective knowledge, which is taken for true. For all the above, we have the interest in give an answer to the question:

Is there a relation between food, color and emotion in a group of Mexican students?

2. METHOD

Objective: To know the relation food / colors / emotions.

Type of investigation: Exploratory, cross-sectional, descriptive and comparative study, with a non-probabilistic sample, only the people which wanted to answer the quiz was selected. The sample was formed by 100 college students: 58 women and 42 men, all of them were single.

Colors, flavors and emotions

As we can appreciate in Table 1, green was the most mentioned color in relation with food, this happens because it was strongly related with fruits, salads and citruses. Then, in frequency order, we found color red because of its relation with chili pepper and its presence in different food. The third place was occupied by yellow because it is highly related to citruses. The next color was pink and its association with desserts.

When information about colors and dishes was combined it was found that color red is the color most associated with them, mainly with dishes made with *tortillas* (*chilaquiles* and *enchiladas*) that are generally prepared with chili pepper, which occupies the first place in Table 1. *Mole* and sauces, prepared with chili peppers were found too. Then, in order of importance, we have the relation between pink and desserts and cakes, and the color yellow present in almost all the dishes.

Emotions

When colors and emotions were related, it was found that emotions can be grouped on positive and negative emotions. Positive emotions are happiness, love, compassion; and negative ones are danger, insecurity and sadness. As it could be appreciated, green, pink and red colors are separated from the other colors by the number of mentions they had.

It was found that red (as always) show ambivalence since it was related with love and happiness at the same time that it was associated with anger. The color green was principally integrated with negative emotions such as anger, insecurity and sadness. It should be said that sadness has no presence in red or pink.

As it was expected, pink was related principally with positive emotions. The colors that were not present in the previous group were white and its association to insecurity, blue with anger and purple with happiness.

It was found that the most relevant associations were:

Sweet. This flavor is related to pink, fruits, candies and chocolates. It is also associated with desserts, cakes, happiness, love, affection and tranquility.

Bitter. Related with yellow and green colors, with citruses and its higher relation was with sadness.

Salty. It has no important relations with food, although it has an important relation with insecurity.

Sour. It was principally related to citruses and salads, insecurity and to color green, anger and sadness were important too, with same color and same emotion.

Spicy. It exist a correspondence between happiness and love, chili peppers, red color and *chilaquiles* and *enchiladas* dishes.

Bittersweet. This flavor is represented by orange color. It is associated to Chinese food and anxiety.

3. CONCLUSIONS

As it can be appreciated with the results of the study:

- Every flavor has, in general terms, its own color like pink for sweetness, white for salty, red for spicy and orange for bittersweet. Bitter and sour flavors share green color.
- The same phenomenon occurs with food, each one has its own color except for the case of the citruses and fruits.
- Vegetables and processed meat food were found for different flavors.
- Anger and happiness are shared, however, with a more detailed analysis we found that many of the emotions coincide with the meanings of colors found in other studies whereby it could be affirmed that there is no relation between emotions and food but it exist between colors and emotions.
- All results were found in a determined cultural context.

Table 1. Colors and food.

Food	*Red*	*Pink*	*Yellow*	*Brown*	*Green*	*Blue*	*Black*	*Grey*	*White*	*Purple*	*Orange*
Dressings	1		1	1						2	6
Beverages			5	11	10	2	2	1			1
Meat	1	1	4		1	2			9		
Chili pepper	67										2
chocolate		11	1	1							
Citruses	3	1	32	5	89	6	2	1	3	5	22
Candies	1	21	2	1						1	2
Salad	1		1	1	12						1
Fruit	5	25	12	5	9	3		4		6	12
Salty crackers			3		1	1			3		2
Cakes			2	1	6						
Fish & seafood			4	1		5	1		8		1
Salt	1		2			3	3		13	1	
Sauce	8	1					1				
TOTAL	88	60	69	27	130	22	9	6	36	15	49

Table 2. Emotions and colors.

Emotions	*Red*	*Pink*	*Yellow*	*Brown*	*Green*	*Blue*	*Black*	*Grey*	*White*	*Purple*	*Orange*
Apiñes	20	47	6	2	7	4	1		2	5	11
Love	15	20	2	1			1		2		1
Anxiety	1	2	1	1	2					3	7
Compassion	1		2	1				3	6		1
Conflict			3	1	1						4
Dissapointment	1	1	1		1	3			4		2
Anger	35	1	12	8	17	6	3	3	7	1	6
Instability		1		1	3					2	2
Insecurity	1		9	1	18	3			8	2	1
Halter			1		7	1					
Sadness			9	8	21	2	1	3		1	1
TOTAL	74	72	46	24	77	19	6	9	29	14	36

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The psychology of color: A relevant instrument in marketing and design

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ABSTRACT

The aim of this work is firstly to attempt to conceive and examine the alterations in appearance resulting from chromatic effects, which the expressions of color give rise to in the human psyche. Secondly, it is aimed at revealing and presenting the emotional value of color in decisive and strict aspects as a relevant instrument in marketing and design. Color is critical to attraction, and it must direct the reactions of people, becoming a protagonist of consideration when it comes to the success or failure in selling food products on the market. In spite of personal preferences regarding color, designers have to try to limit the consumers' associations through reduced groups, interviews, consultation with color forecast groups on market research, advertising and all the specialities which cordon off the launching of a packaging item with foods. Thus, analysis and revelations enable the understanding of the differentiation of food products on the market, making use of the phenomenology of color, when it receives a signification or attribution of sense and enhancement through dissimilar associations with a translucent language.

INTRODUCTION

The main aim of this work is firstly to attempt to conceive and examine the alterations in appearance resulting from chromatic effects, which the expressions of color give rise to in the human psyche. Secondly, it is aimed at revealing and presenting the emotional value of color in decisive and strict aspects as a relevant instrument in marketing and design, taking into account the chromatic value of foods, their packaging and the environment where they are exhibited, as a factor of unity. Color is critical to attraction, and it must direct the reactions of people, becoming a protagonist of consideration when it comes to the success or failure in selling food products on the market.

THE PSYCHOLOGICAL ASPECTS OF COLOR

Colors are understood as mirages of the excitement of people and at the same time, reflexes of sensitive promptness. In practice, we attempt to analyze the psychological problems of color, the way in which they play upon the unconscious and the attribution of sense we grant them. The sensation we experiment when looking at shape and color is a psychological process of creation. The eyes receive information from the light energy and transform it into the nervous impulse up into to the cerebral cortex, going through numerous changes. The brain operates the translation of the information coming from the material world into the visual perception of our three-dimensional and colorful world. This psychological creation of beauty in the world that has become visible and surrounds us is nevertheless produced in ourselves.

In the contrast of psychological colors, the great emotional distance existing between two tones of colors is defined in concepts such as hot-cold, active-passive, strong-weak, feminine-masculine, etc. These are visual techniques of bipolarity or opposite pairs; they highlight the diverse possible operations and are fundamental for the visual expression.

ASSOCIATION AND MEANING OF COLOR

Over the years man has given an emotional and symbolic meaning to colors. Significant colors differ mostly according to culture and time and they cannot be understood outside the cultural context of a particular historical period.

Several of the concepts that were represented by certain colors are elements from which everything is made of: water-earth, fire-water, the four winds, and four seasons. Spring is composed predominantly by pastel colors; summer, by temples; fall, by oils and winter by watercolors. Let us consider red as an example. Red contrasts cyan, following the association and symbolism of colors.

RED: From the psychological-symbolic viewpoint, red has been used as a symbol of passionate extroversion. It is a color of difficult attenuation. The human eye perceives it at a high speed compared with other colors. It is a very accommodating color, which is flexible, and receptive to light.

YELLOW: From a psychological–symbolic viewpoint, it has always been used in the artistic iconography of the past as a symbol of reason, intelligence, wisdom and knowledge. It is the most illuminated color after white.

BLUE: It is a passive color. It becomes active when used or observed from the psychological-symbolical viewpoint. It has been used as a symbol of spiritual introversion, and feelings.

Psychology has proved that the function of color is not merely ornamental or static; it responds to sensorial as well as physical motivation.

The human crystalline focuses on different colors differently, thus explaining that due to the approach similarity for near objects and warm colors, these get near whereas the same correspondence between distant objects and cold colors make them move further.

When lighting a dining room with red, yellow or green lights, the dishes display red, yellow or green reflexes and sparkles, in a way that people at table lose their appetite, since they cannot bear seeing yellow or green meat, which gives them a sensation of putrefaction.

COLOR IN FOOD, WRAPPINGS AND PACKAGING

Theorist Faber Birren thought that vermilion, the color of apples, cherries and raw meat, is the most attractive color, which also bears an affinity with orange. When yellow is introduced attraction begins to fade: yellow-green have the lowest primacy among food. It is obvious that they are related to lemon and lime, whereas it is not so evident that apples are associated with green.

Pure green attracts for its pleasantness and vitality. Likewise, blue and violet are fascinating but not appropriate for main courses. Birren pointed out that tones do not upset nor irritate so much and are not so tempting as pure colors. He stated that orange seems to be the best tint for food, whereas a yellow tone is better than pure yellow, and blue-violet tints are not appropriate for food.

There are some examples of cases in fashion now, such as purple wines and yellow and green soft drinks, and even though blue is not tempting as a color in foods, its affinity makes it appropriate for packaging and containers.

Very often colors are associated with certain food in particular. Warm colors as orange, yellow and red are associated with prepared food and cold colors are associated with fish.
For certain foods, some colors are accepted by consumers. Many times confectionary covered in chocolate is packed mainly in brown. Blue, implying deliciousness and quality, may be introduced.

HOMOGENEITY OF COLOR AND CONDITIONS

Sometimes the identity of the brand and the nature of the food product grow stronger with each other. Each company creates its own color through thorough research. Certain colors may have a great potential, call attention and even more, if it is equivalent to the name of the brand. Therefore, it is suggested not to be altered. For a new brand to be connected to its competitors, it must take into account the color established by the leader, which signals a hint of color through the years.

This tactics may grant the product an immediate association. For example, Coke has used red –and kept it– over the years.

Contrast constitutes significant power in the development of the visual link, it is a revitalizing energy for the conception of a coherent whole, intensifying the meaning and simplifying communication.

With the creation of contrasts we reach a basic point, easily understandable, of an eminently practical application to achieve interest, vitality and variety within a unit.

To distinguish a food product, contrast is the best strategy to attract attention from the shelves and aisles of the grocery stores, using a container of a color different from the kind or condition frequently used and taken advantage of. To further stress the difference among products, designers use photographs of fruit and cereal on packaging materials, in addition to the usual photos of tea and coffee.

On certain occasions color already defined and having been on the market for a long time must be renewed or substituted by another so as to be able to compete with more firmness and soundness. Colors cause very strong psychological currents and affect more than the cost and design of the product. Therefore, when it comes to color, designers have to take active part in two fields: on the creative side and also on the marketing side.

CONCLUSIONS

Designers definitely have to work as a team with those responsible for the printing, so as to obtain a proper color that really suits concerning containers and packaging of diverse foods, since if such corollary is not followed, failure can follow. For example, if consumers notice fading colors they can assume the product is old and that it has already reached its expiration date.

The proliferation of new packaging material has flooded the shelves in food stores. Therefore, marketing needs consideration. Dissemination can come second, but the main premise to take into account is that packaging must demand consideration, trace and belonging. Color has to intervene in an integral and well balanced way so as to transmit a coherent design strategy. The use of color in different designs of containers and wrappings without a strong concept can be damaging instead of being convenient, whereas color abuse can sometimes be suggestive and ornamental. Design depending on color usually dissipates very soon. Design forms part of a superior whole: *communication*, and it is encompassed in market research, strategic planning, advertising and all the other specialties which cordon off the launch of a food product. Brand and product constitute an indivisible whole.

The emotional values caused by colors lead us to realize that color does not exist on its own but it is always an aspect of the object –in this case food and its packaging–, considering also the environment of its exhibition. The chromatic effects that color objects cause on the human psyche are a relevant instrument in marketing and design.

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Use of color in the promotion of consumption of fruits and vegetables: The experience in the program "5 a day Chile"

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ABSTRACT

The present research has raised several questions to be resolved in their development by means of observing, recording, analyzing and concluding about the use of color in the material to encourage of healthy eating behaviors. In this particular case is based on promoting the inclusion of fruits and vegetables in the daily diet of the Chilean population. The case of study is the program "5 a day Chile" and the material used was provided entirely by them. Among the main questions posed at the beginning of this work is to establish the degree of relevance of the colors chosen for each parts and components. Those are designed to be carriers of the nutritional message and the visual coexistence with other design elements such as photographs, illustrations, fonts, backgrounds and other things embodied in the various graphic and elements analyzed and their degree of effectiveness and contribution to the message sought to convey. It is also interesting to conclude recommendations and standards to be incorporated in the decision of choosing colors, to be implemented in future initiatives of the organization.

1. INTRODUCTION

5 a day is an international movement that promotes the consumption of fruits and vegetables in the world and is present in over forty countries on the five continents.

Its name is based on the minimum amount of daily consumption of fruits and vegetables recommended by the scientific and medical community in healthy eating. This program exists in Chile since 2006, implemented by the Corporation 5 a day,[1] having an exemplary impact in Latin America.

The paper described here is the presentation of the research, conclusions and recommendations on the application and use of colors in the "5 a day Chile." All this is based

[1] The Corporation 5 a day is a nonprofit organization founded by the Instituto de Nutrición y Tecnología de los Alimentos (INTA), Facultades de Ciencias Agronómicas de la Universidad de Chile, Pontificia Universidad Católica, Pontificia Universidad Católica de Valparaíso and Universidad Mayor. And representatives of the private sector as the Asociación Gremial de Supermercados de Chile, Asociación de Exportadores de Chile (ASOEX), Central de Abastecimiento Lo Valledor, Comité de Hortalizas de Chile, Federación Nacional de Productores de Frutas de Chile and Sociedad Nacional de Agricultura. And the continued support of government agencies such as Ministerios de Salud and Agricultura, and international organizations such as World Health Organization, Pan American Health Organization, United Nations Development Program, and Food and Agriculture Organization of the United Nations.

on observations and analysis of choice and color scheme, proposed by the program in the publicity materials produced and used between 2006 and 2010. This analysis considers color and perceptual aspects of the different graphics and digitals parts that are used for the promotion, publication, educational material, recipe books and other products.

2. DEVELOPMENT

The advertising campaigns of "5 a day Chile" are base on the relationship between a group of fruits and vegetables and their natural color. For the recommendation of daily consumption they are classified in five groups, relating each one with a different color (red, green, blue/purple, white and yellow/orange). So the daily recommendation of eating five portions of fruits and vegetables is combined with the suggestion if it is possible to include of all groups and therefore of all colors proposed by the program.

This type of recommendation of "five portions of five colors" as researched, is a peculiar feature of the Chilean organization. In other countries, while they maintaining the concept of "five a day", this is referring rather to the number of servings, without specific reference to the inclusion of the five color groups.

In a first look of institutional websites available on the website of similar organizations in different countries, the five groups represented by five colors are in all of them present in the corporate image, with color and tonal variations that are recorded and analyzed visually and like references of the Chilean case underlying on this paper.

This primary analysis based only on visual observation of what is available on the Web, confirms that the Chilean case, for the purposes of research and analysis from the point of view of the discipline of design is particularly interesting.

In contact with people in charge of the organization "5 a day Chile", especially in interviews with Mrs. Isabel Zacharias, a nutritionist at the Institute of Nutrition and Food Technology (INTA), University of Chile and developer of the program "5 a day Chile", we detected in her and her team great sensitivity and conscience of the relevance of careful work with the colors for the effectiveness of nutritional message and also the need to bring in specialists to make decisions on proper handling and application of the five color tones, and finally concluded on the importance of regulating the use of colors, by proposing a color chart, to be applied in various communication media used in the future.

This deficiency detected in the work of nutrition specialists and designers, is easily explained, since the scientific training of engineers in food and nutrition team "5 a day Chile", suffers visual parameters guiding to make design decisions. Therefore they have to face a role in graphics and chromatics decision making in the materials of promotions, doing that without proper discipline and experience it.

3. MATERIAL OF ANALYSIS

As part of this research is used a variety of printed material produced in the intervening years, such as:

- Brochures printed in color that motivates the consumption of fruits and vegetables associated with colors to be spread among customers of a major supermarket chain in Chile.
- Brochures printed in color with similar content of the previous case to be broadcast in favor healthy eating campaigns undertaken by the State of Chile and funded by the Ministries of Health and Agriculture.

- Brochures printed in color for students and their parents with consumer recommendations and motivating the incorporation of fruits and vegetables of the different colors in appropriate portions in the usual diet. This material is distributed in government campaigns that promotion of healthy diet and obesity control.
- Brochures printed in color for food school guides, to be distributed in clinics under the Ministry of Health, which offer healthy eating advice and examples of dietary patterns and physical activity tips to fight obesity.
- Brochures with information about the “5 a day” program, its objectives, action areas, participants, founders, member’s adherent and motivation for the incorporation of the recommendations suggested by them.
- Brochures printed in color with full information on the nutritional intake of different fruits and vegetables and information on the five recommendations and their implementation in a balanced daily diet according to the characteristics and activities of consumers.
- Brochures of recommendations on healthy eating and its relationship to cancer prevention to be distributed in campaigns initiated by the State of Chile, funded by the Ministries of Health and Agriculture.
- Materials designed for schoolchildren and their parents, such as notebooks, diaries, pencils, coloring sheets, rulers, magnets, badges and calendars to be distributed among students in the scholastic system, as part of campaigns on healthy eating, promoted by various educational establishments “5 a day Chile” and supported by the Chilean state.
- Book of healthy recipes that encourage the inclusion of fruits and vegetables through the delivery of recipes and daily feeding recommendations, easy to understand, to be applied in everyday family life.
- Compendium of the “5 a day Chile” program reporting its importance, implementation, challenges, goals and action plans, among others.
- Textiles clothing such as aprons, t-shirts and others that promote the campaign “5 a day Chile” with the institutional logo.
- Bags for transporting fruits and vegetables, with messages and logo printed to replace the plastic bags provided by supermarkets and sales of fruits and vegetables to their customers. The institutional website of the program 5 a day.

4. CONCLUSIONS

In the investigation are research coloristic and sensory relations between color, taste, texture and even smell of fruit and vegetable, symbolic and significant associations between the color that is assigned to the classification and the concept that is transmitted through it to consumers.

During the investigation, sensitive color observations were made, to decode the chromatic proposal raised by the program, identifying certain stimuli that cause sensory and psychological associations with the colors, their relevance and the degree to which they affect consumer perception. It seeks to demonstrate through empirical evidence that the colors provide more than just visual information to recognize them expressive and communicative functions.

In the development of perceptual analysis color observations are made, leading to make recommendations, proposals and color and visual standards, embodied in color charts, in order to be considered in the production of graphics and digital material.

The present research is raised from the gaze of the designer, who works with food engineers and nutritionists, through a collaborative work, provide an appropriate chromatic language that contributes to the success of the program.

ACKNOWLEDGMENTS

Special thank to Mrs. Isabel Zacharias, nutritionist of the Institute of Nutrition and Food Technology (INTA), developer of the "5 a day Chile" and Mrs. Alejandra Domper, INTA food engineer, for their cooperation and generosity in providing materials and information.

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http://www.inta.cl

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A study of the relationship between color and the Chinese five elements –exemplified by the color schemes of health food in Taiwan

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ABSTRACT

Not simply for satisfying people's appetites, Taiwan's diverse food diet has been developed and influenced by the natural environment, the economy, politics, religion and culture. The health-enhancing concept of "tonic foods" is inherited from China's "I-Ching" (*Book of changes*), including the philosophies of Yin-Yang and five elements, which affect the taste, appearance and cooking method of health foods.

Moreover, seasons are important to tonic foods. Special attention must be paid to seasonal rhythms in order to maintain the original flavor of the ingredients with respect to color, smell and taste. When serving food, containers of appropriate color, shape and texture are selected for different dishes and seasons.

The focus of this study is to discuss literature relevant to the preparation process of health foods, from raw ingredients to cooked dishes. Color survey samples will be selected and evaluated for investigating taste and smell. The "color image scale", developed by Shigenobu Kobayashi, Japan's leading color psychologist, will be used to explore the effects of food color on human senses and appetites on a psychological level (Kobayashi 1990, 1998). By studying traditional eating habits, a health-enhancing color scheme that integrates Eastern philosophy with modern food culture will be proposed.

1. THE RELATIONSHIP BETWEEN THEORY OF FIVE ELEMENTS AND HEALTH PRESERVING IN FOUR SEASONS

Birth of every life in the universe is formed from a kind of invisible 'Qi', and human body also depends on the air, water, energy, materials and land for a living. The great cosmos of nature world and the small universe in human body hold a constantly balance by contributed changing of Yin and Yang, and then naturally form a relationship of interdependence (Figure 1). Ancient Chinese believed that there are five kinds of energy mutually reinforce and neutralize each other, which are Wood, Fire, Earth, Metal and Water, in the atmosphere. In nature, seasons change with Spring, Summer, Autumn and Winter. Human and nature have closely related phenomenon, not only affect the human's physiological function and pathological changes, but also has intergeneration with the nature. Therefore, paying attention to the change between the small universe in human body and the great cosmos of nature world, and maintaining a harmonious symbiotic relationship with each other become important health concepts of five elements (Table 1).

Today, the spirit of theory of the natural health perspective, the key is 'according with the law of the nature and the will of the time, then focus on seasonal health preserving'. So we should gradually implement health tonic and maintenance under the 24 solar terms of their climatic characteristics. ‘You are what you eat’. It has a positive significance on disease prevention, and also implements the ideas of health prevention (Figure 2).

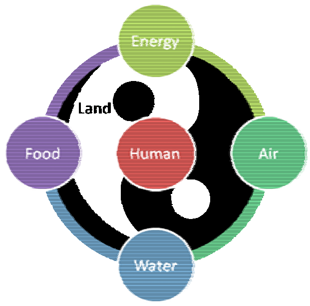


Figure 1. Symbiotic relationship between human and nature.

Table 1. Five elements theory correspondence table.

Theory of five elements	**Five elements**	Wood	Fire	Earth	Metal
Theory of food and five elements	**Five colors**	Green	Red	Yellow	White
	Five flavors	Sour	Bitterness	Sweet	Piquancy
	Five properties	Mild	Warm	Flat	Cool
Theory of human body and five elements	**Five internal organs**	Liver	Heart	Spleen	lungs
	Five entrails	Gallbladder	Intestine	Stomach	Colon
	Five senses	Eyes	Tongue	Mouth	Nose
	Five Substances	Tendon	Blood Pulse	Muscle	Skin
	Five Limbs	Fingernail	Facial expression	Lip	Fur
Theory of space-time and five elements	**Five Directions**	East (Left Green Dragon)	South (Front Vermilion Bird)	Central (the Central Unicorn)	West (Right White Tiger)
	Five Seasons	Spring	Summer	Midsummer	Autumn

Source: Reference and modify from Chen (2002: 125).

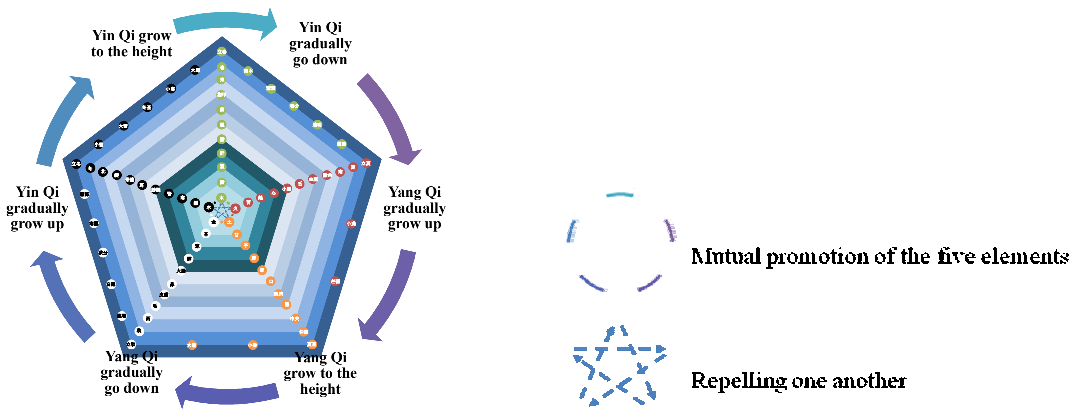
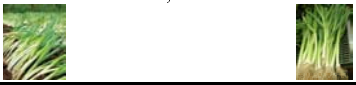
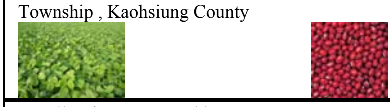
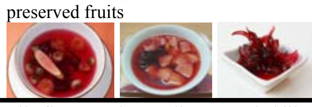
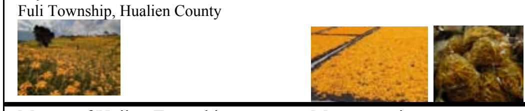
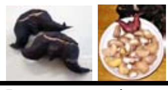
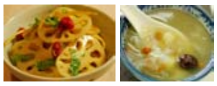
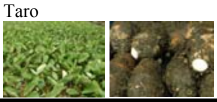
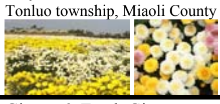
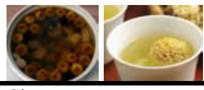
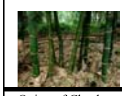
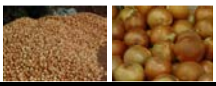
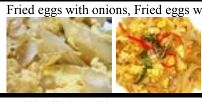


Figure 2. Relationship between Yin Yang five elements and health preserving in four seasons.

2. THE APPEARANCE OF HEALTH FOOD IN TAIWAN

We could carry on tonic health under the 24 solar terms. In addition, farmers can also do spring planting, summer cultivation, autumn gain and winter stockpile and other farming activities according to solar terms, to suit the four seasons and keep grain not exhausted. Following is characteristic for the industry in Taiwan for four seasons health food samples (Table 2).

Table 2. Five elements theory correspondence table.

Season	Ingredients of five colors: Appearance in origin place	← Change →	Cuisine of five elements: Table showing
Spring	Sunshin Green Onion, Yilan. 		green onion pancake, chicken in Scallion oil 
Summer	Red beans field of Daliau Township , Kaohsiung County 		Tofu pudding with red beans, sticky-rice ball with red beans 
	Roselle of Luye Township, Taitung County 		Roselle and chrysanthemum tea, Roselle and apple tea, Roselle preserved fruits 
Midsummer	Lily flower of Lioushihdan Mountain, Fuli Township, Hualien County 		Lily flower and sparerib soup ,Fried lily flower 
	Mango of Yujing Township, Tainan County 	Mango section 	dried mango, Fried shrimp mango, fried Mango abalone mushrooms 
	Water chestnut of Guantian township, Tainan County 		Braised water chestnuts 
	Lotus field of Baihe township, Tainan County & Lotus root 	Lotus root section 	Cold lotus root, Tremella lotus seed soup 
	Sweet potato 		Roasted sweet potatoes, Sweet potato chips, Sweet potato's leaves, Honey sweet potato, Candied sweet potato 
	Taro 	Cube taro dice 	Rib soup with taro, Rib noodles with taro, Taro cake 
	Chrysanthemum field of Jiouhue village, Tonluo township, Miaoli County 	Dried Chrysanthemum 	Chrysanthemum soup,Chrysanthemum tea 
Autumn	Ginger & Fresh Ginger 	Ginger section 	Ginger tea 
	Bamboo shoot 	Bamboo shoot 	Dried bamboo shoot ,Stir-Fried Chicken with Bamboo Shoots, Fried hot bamboo shoot, Bamboo and chicken soup, Bamboo and chicken soup 
	Onion of Checheng township, Pingtung County 		Fried eggs with onions, Fried eggs with hot onions 
	Fresh milk fish 		Milk fish ball 
Winter	Striped mullet 	Mullet roe 	Mullet roe slice, mullet roe 

3. APPLICATION OF MODERN FOOD CULTURE

We use the color image scale (Kobayashi 1998: 11) to carry on perceived association for five colors and five flavors of food. Horizontal axis is for the visually warm to cold, and vertical axis is for the palate light to strong. Color image present changes on place of origin, harvest, cooking, conditioning and collocation (Figure 3).

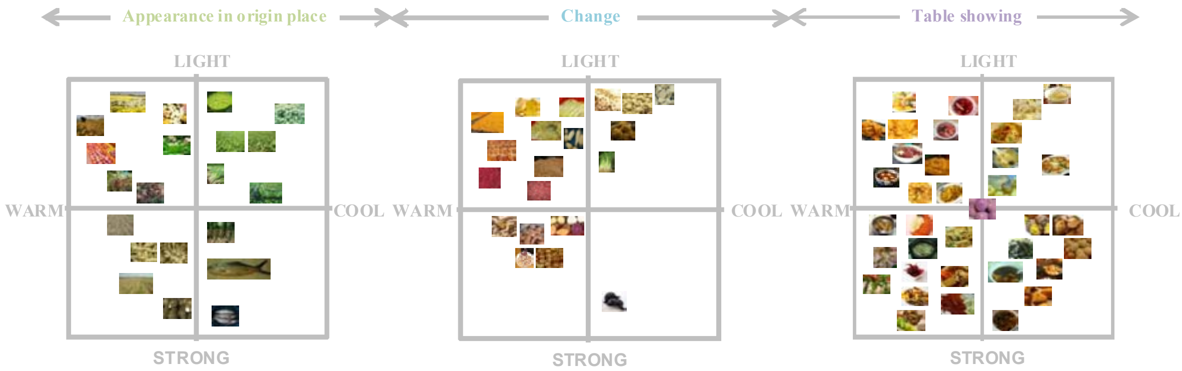


Figure 3. Color presentation of health food in Taiwan from place of origin to dining table.

4. CONCLUSIONS AND RECOMMENDATIONS

We Use 12 sets of image words to do color collocation base on five colors (green, red, yellow, white and black) of food (Kobayashi 1998: 15), and use five colors (five elements) in modern food culture dishes (Figure 4).

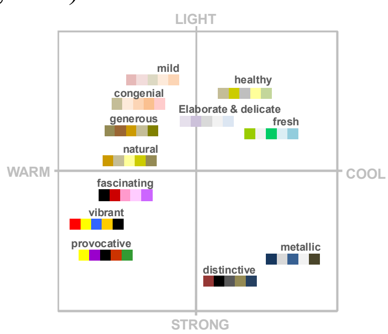


Figure 4. Color image of health food in Taiwan.

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Color strategies for food packaging: Systematic compilation and analysis of chromatic palettes of olive oil's package

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ABSTRACT

The present work represents the initial stage of an exploratory research project on the field of packaging design for food. This project aim to analyze chromatic strategies used on different packed products segments, understanding as segment each one of the groups –milky, canned, oils, etc.– in which the diverse food products are gathered and sold on retail.

Our work is based on the hypothesis that for the different food products exist certain chromatic conventions and codes, born from consumption traditions and habits. Our research will try to make visible the strategies of adhesion or transgression to these codes, implemented by the companies in their attempt to establish a position on consumer's mindset.

In this occasion, we will present the methodology developed to compile the information and some initial results of the analysis of olive oil segment.

1. THEORETICAL FRAMEWORK

Considering the aim of the project, a theoretical framework is built on the crossroad of three fields: human vision –as the mechanism which allows the subject to have a perception of products–; morphology –as the taxonomic dimension of different formal aspects of product–; and semiotics –as the combination of perception with socio-cultural values. The main approaches are summarized in Table 1.

Table 1. Theoretical approaches that build this project's framework.

Field	Approach	
Human vision	Color is a psychophysical phenomenon, trigged by the light that stimulates color receptors in retina –whether if it comes from a direct source or remitted by the interaction with an object.	
Morphology (Categories taken from Jannello, 1984)	Form	It is defined by the registration of the alternatives on four parameters: spout, neck, body and label (Vila Ortiz 1992)
	Color	It is defined according to NCS system, using its notation code and variables: blackness(s), chromaticness (c) and hue (φ)
	Cesia	It is defined by determining the levels of darkness (absorption), permeability and diffusivity of each element of package (Caivano 1991, 1996)
	Texture	It is defined by three variables: direction, size and density (Jannello 1961)
Semiotics	As defined by Morris (1938) our project works on the field of semantic: the study of signs according to its ability to represent and transmit information of an object, which is beyond the sign itself (see also Caivano 1998).	

2. METHODOLOGY

Our analysis is carried out through a methodology that combines different levels of information: on the one hand, the systematic collection of colors and color-combinations present on packages which are distributed in local market; and on the other hand, a semantic analysis of package's elements, both structural (bottles, caps, cans, etc.) and graphics (typography, miscellaneous, illustrations, etc.).

To compile the necessary information for this analysis, a photographic register of package's fronts is made, in order to reproduce as far as we can, the average visual conditions –lightning, scale, position, etc., in which the product meets the consumer on retail.

The data collection of each case is made through a form, with the aim to compile all information of samples at a same level of depth and detail. The data sheet (Figure 1) includes:

a) *General information*: brand, product, contents and origin.
b) *Form* (both structural and graphics): components, materials, finish and % of surface.
c) *Color*: color map, NCS notation, location on NCS solid, and % of each color over total surface.
d) *Cesia*: levels of darkness (absorption), permeability and diffusivity of each element of package.
e) *Texture*: direction, size and density.

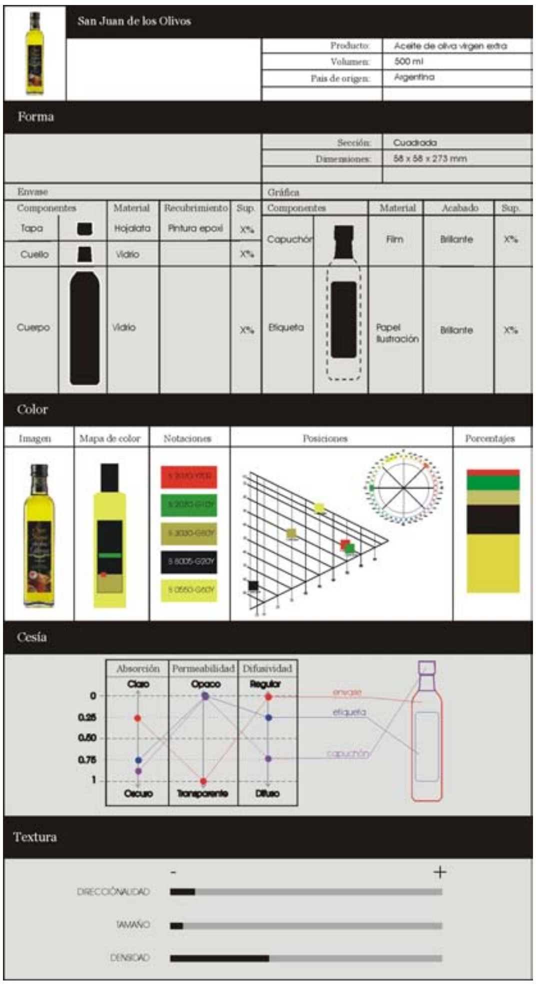

Figure 1. Sketch of data sheet for collection and systematization (in Spanish).

3. PRELIMINARY EXPLORATIONS AND FURTHER TASKS

In the first stage of this research project, it has been made some preliminary explorations with a double aim: to assess the methodology tools; and to generate the first color palettes for semantic analysis.

In these sense, olive oil segment have been chosen as a test group, to use it for final definitions on methodological approach and data collection.

One of the key issues for data collection, as the methodology is based on images taken within lab simulation, is the definition of lightning and scene conditions for photographic register.

a b c d e f g

Figure 2. Exploration of lightning conditions for photographic register. (a, b, c, d, under fluorescent light; e, f, g, under tungsten light).

Based on these explorations, it has been defined the following conditions for the photo scene:

a- Product position: package must be in front position, with main side perpendicular to visualization direction, in order to maximize the exposition of label and/or graphic claim.

b- Lighting condition: department store light (CWF or TL84), front-zenith position, as the aim is to simulate the conditions in which products meets the consumer.

A second issue was to determine how to process the pictures, in order to assemble the color palettes, and define the percentage of surface occupied by each color. To that purpose, it has been started an exploration of techniques –pixelation, blur, color maps, etc.– and software – mainly Photoshop and MatLab– to determine the best set of tools to be used on picture processing.

Figure 3. Exploration of lightning picture treatment to create color-maps. In this case, a process of pixelation is made, from original picture (left) and increasing the size of pixel to visualize dominant colors and color distribution.

On this stage of the research, the operative process of image treatment is being defined throughout different explorations. Once this step is completed, we will be facing the data collecting and systematization stage, in which we will make a thorough gathering of the information related to selected sample –olive oil package. Fourth and final stage will be work on the classification and comparing of these data to undergo the final semantic analysis.

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Colour as a code in food packaging: an Argentine case

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ABSTRACT

Intellectual and emotional aspects of the product's image raise the concerns about its qualities; concerns about nutrient content, the ingredients, the amount of sugar, salt, fat. The product appearance induces expectations. "Expectations govern our attitude to food and the food scene. We deduce from the appearance of the food in front of us whether it will harm us or be good for us", says John Hutchings (2003). The consumer searches for the attributes he considers most suitable according to his internal needs, in the products he wants to buy. It is necessary to define a target segment to propose the product that is effectively closer to the ideal of the buyer and to communicate its benefits. This is why the packaging has a big responsibility. Emotions, memory, social patterns, are behavioral areas in which colour plays an important part. There is a message to remember, and the packaging is a message in itself; it helps to guide, motivate and encourage consumers in their purchase decision. It is imperative to choose the potential customer for the message; each target has its language, its expectations.

1. SEGMENTATION

It is significant to consider two types of segmentation: functional segmentation and psychological one. In the functional segmentation the idea is to group consumers according to the functional advantages the consumer is looking for. When the products are addressed to health conscious consumers, the packaging, associated to the product concept, can produce a functional segmentation. Packaging has a decisive influence on the consumers perception, and therefore, in the purchasing decision.

Psychological segmentation is based on the characteristics of the consumers social class, their lifestyle, reference models, their personality, involved in the emotional satisfaction they obtain in the purchase. The psychological differential advantages are often more sustainable than the functional. Packaging must show specific signs, build confidence as much as unambiguous product identity (or clear).

2. CHANGES IN CONSUMER

Consumers, increasingly informed and demanding, have taken the lead. They show new desires, seeking harmony between quality and wellness In the twenty-first century the will to live in a more human and less frivolous world emerged. Banality is being outdated. The importance of healthy living, honesty and revaluation of emotions are values that flourished and increasingly permeate many aspects of life. Packaging design is one of them. Information and consciousness: accompanying the suitable healthier urban living, many products are incorporating functional values as a vital part of their communication systems. Nutritional and functional information are relevant when choosing a brand or a particular variety.

3. VISUAL IDENTIFICATION

Colours are created in our brain as a perceptual tool to facilitate our visual-cognitive and visual-emotional functions. Colours are more than a physical process: they works as a signs system, a source of information decoding the world around us. In this world, the products we buy every day are present. The consumers develop their opinion about the products they see in less than 90 seconds from their first interaction with them. Between 62% and 90% of that assessment is based on the colour of the product (Institute for Color Research, Color Communications, Inc.). A complex semiotic process enables the understanding of products differentiation on the market. The impact of colour on the decisions about what product to buy is due to the fact that it is a symbol that reflects the image we have of ourselves, our personality.

4. THE COLOUR OF THE PRODUCT

Colour is an essential element used a sign to represent desirables product attributes. Consumers respond to the "total product" that also includes their image. Successful design requires an awareness of how colors communicate meaning. Colour can provide information about the quality of a product and can also show a strong association with certain product categories. Green, for instance, is associated with natural products (Figure 1).

The graphics and colours used in the package must be consistent with the status or image or expectations t it wants to satisfy and must serve to identify and locate the product. Colour improves readership. Colour can be used as a referent code system for the product. Colour coding helps to clearly identify the desire product.

In package design some actions apply to the expected typology change in order to produce a strong identification with the brand (Figure 4) We also find the opposite strategy, which is to favor the association with the category identity. Breaking the category code can be a key to differentiate a new product. In spite of the fact that some brands traditionally use green as a strong identifier (Figure 2), green colour is used in associations with the green countryside and healthy products in most countries. Green is related to nature, freshness, fertility, peace, hope, humidity, regeneration, growth, relaxation; is calming, curative, and balsamic, in its positive meanings. In many countries is used to identify bio products. In some others, green is also a visual attribute related to low fat; so do pink and light blue (Figure 6 and 7).

5. DIET OR LIGHT PRODUCTS

Important changes in consumption values caused a typological substitution in the colours expected for certain products. The irruption of diet and light products and the explosive growth in value reached by the concept "low calorie" produced an unexpected change in the colour paradigm.

The first experiences in colour for diet products focused on white, silver and pastel colours as pink. Finally, green, associated with nature, became a strong identifier for this type of products. Then, colour is not talking about product attributes but on their feature of being "light" instead.

Colours meaning can also have a regional value, given by a mixture of cultural interpretations associated with some colours and their historical use. In Spain, for instance, light products began to appear in the 80's proposed as healthy products. Begoña Hernández Salueña, from the Department of Physics of the Public University of Navarra, after consulting several dairy companies, says that there is no official code for the colours of the milk pack. The use of colour by type of milk (blue for the whole, green for semi-skimmed and skimmed) has to do with the organization in supermarket shelves and with the communication for consumers. These colours appear having being selected by the first brand that sold these products, followed for the other brands. But several brands have recently decided to break that tradition and begun using colours more for identifying the brand than the category (Figure 3). Central Dairy Asturiana, for example, has decided to use red for whole milk instead of blue and blue for the semi-skimmed and green for the skimmed. Pascual, uses dark blue for whole milk; light blue and pink for semi-skimmed and skimmed.

6. LIGHT PRODUCTS IN ARGENTINA

It is interesting to see how in Argentina, green colour has definitely been adopted as a category code, especially in dairy products. The low fat dairy products area at the supermarket is easily recognizable from far away in a green spot.

Gonzalo Petracchi, packaging designer for Sancor, says: The green code emerged in the argentine market around the 90s, when the changes from diet products to light ones came out in order to clarify what was being offered to consumers. Diet products sought a cleaner and pure image, in association with reduced-calorie diets choosing a colour as blue/cyan. At the beginning of the change, diet and light were virtually synonymous, but light category products wanted to find their own individuality in a codified meaning, an identity charged with emotional values as care and health, without giving up flavor (Figure 8).

The official Argentine food code and that one of Mercosur include the requirements for food labeling, in order to give the information that builds confidence, but no rule appears mentioning the use of colour as an identifier.

Green is the colour of security. It is also the colour of permission. Green packaging assure us to eat healthy, preventing us from getting in a colour as blue / cyan fat, with safety, confidence, certainty. Big companies of massive consumer products invested heavily in communication to encourage the establishing of an expressive symbolic code. In the last two years, in Argentina, this code has widely spread to others categories (Figure 9).

We are here celebrating the power of colour. I would like to end remembering what Charles Riley wrote in his book *Color codes*: "completely mastering color is impossible, but the power it imparts to those who dare to handle it is as profound as that of light itself". He says also "colour is a third Promethean gift, like language and fire" (Riley 1995).

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1. Green = Natural

2. Green as brand identifier

3. Spain
Red-Blue=Whole/Blue-Pink= Light

4. USA
Red=Whole=Fat Free=Low Fat

5. Germany
Green=Whole/Red=Low

6. Italia Blue=Whole Pink=Whole
Pink=Low Green=Low

7. Chile
Blue=Whole/White+Blue-Blue-Green=Low Fat

8. Argentina
Green=Low/ Blue=Whole

Red=Whole
Green=Low

9. Argentina- Others categories using Green as light=Low fat

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Food package chromatic design:
An analysis from the point of view of visual perception

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ABSTRACT

The purpose of this paper is to present an application of Visual Perception Model Sens-Org-Int to a chromatic analysis of food packages. Sens-Org-Int Model was devised by the present author, published and awarded in IVLA's (International Visual Literacy Association) 2007 *Book of Selected Readings*. The model differentiates three processes that occur in human perception: sensory impressions, organizing processes, and interpretive processes of visual perception. Sens-Org-Int Model was devised in an attempt to differentiate which principles or laws of design and art are common to all human beings with normal eyesight from the concepts that are not common to everyone. Those that are not common therefore are learned or otherwise acquired. This theoretical model is now put into practice, in an attempt to analyze food packages. This paper, thus, shows the results of such analysis conveying some important information on food package chromatic design. Examples of packages are shown to illustrate the concepts discussed. Results include reasons on why some chromatic packages work better than others.

1. VISUAL PERCEPTION MODEL SENS-ORG-INT

In the 19th century, perception was studied as a *passive* stamping done by exterior stimuli on the retina. It would then reach the visual cortex, the zone of the occipital cortex that receives stimuli generated in the retina, resulting in an identical image (isomorphic) as the primary stimulus.

Modern psychology refutes this notion and views perception as an *active* process that involves the search for corresponding information, the differentiation of essential aspects of an image, the comparison of these aspects with each other, the formulation of appropriate hypotheses and the comparison of these hypotheses with the original data (Bruner 1957, Leontiev 1959, Luria 1981, Vygotsky 1956, 1960, Zaporozhets 1967). Familiar and non-familiar images can be differentiated by longer or more contracted paths of perception (Luria 1981).

Telford (1970) differentiated sensation from perception in that the first comprises a simple conscience of the dimensions of experience, while perception implies the sensation and the meanings that are attributed to the experience. Thus, for this author, the determinants of perception are: context, constancy, distance, perspective, interposition, brightness, position, direction, accommodation, convergence, motivation, emotion, and personality.

Theories about perception tend to emphasize the role of either sensory data or knowledge in the process. Some theorists have adopted a data-driven, bottom-up stance, or synthetic approach, according to which perception is direct: visual data are immediately structured in the optical array prior to any selectivity on the part of the perceiver proposed by Hering (1850), Gestalt theories, and Gibson (1979). Others adopt a constructivist, top-down or analytical approach emphasizing the importance of prior knowledge and hypotheses, argued by Berkeley (1709), Helmholtz (1925), and Bruce et al. (2003).

Sens-Org-Int Model was devised in an attempt to differentiate which principles or laws of design and art are common to all human beings with normal eyesight from the concepts that are not common to everyone. Those that are not common therefore are learned or otherwise acquired. Therefore, this model unites the synthetic and the analytical approaches to psychology as well as neuroscientific explanations (Chalupa and Werner 2004, Knoblauch and Shevell 2004, Pinna and Spillman 2001, Shimojo et al. 2001, Spillman and Levine 1971, Zeki 2000) on how the brain works, and relates them to classical art and design principles. With this framework, we are then able to tell, from the classical art and design "laws," which ones can truly be considered a principle valid for all human beings from those that cannot.

The term law sometimes carries the connotation of something that was decided by someone or a group of people. Therefore, it is natural to want to question laws for the sake of creativity. Now, when we consider the model, we can differentiate what truly is a law that cannot be questioned simply because it was not decided by someone. We are talking about the nature of the human eye and the human brain and not about someone's decision that could be questioned.

The proposed model of Visual Perception is shown in Figure 1. The variables intrinsic to the model are SENS, ORG and INT respectively explained below.

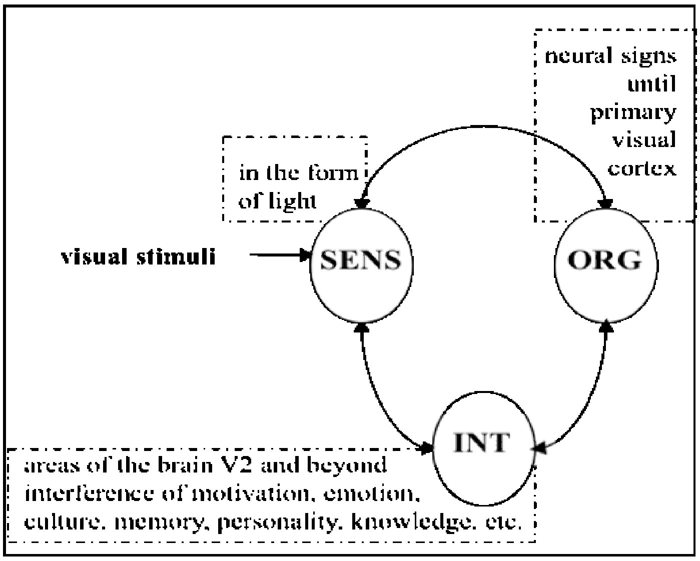

Figure 1. Sens-Org-Int Model.

Sens variable is related to information received through the pupil in our visual sensory organ. This aspect of perception is a phenomenon that occurs in the eye only, where visual stimuli are still in the form of light, before they become neural signs in the retina.

Org variable is related to organizing aspects of perception that occur starting in the retina, including what is considered the primary visual cortex, in area V1 of the striate cortex. Org is related to the bottom-up approaches of visual perception in psychology. The phenomena of perception that occur as Org are what can be considered as laws in art, like *Gestalt* laws were named.

Int variable refers to the elaboration of Org in the extra striate visual cortex, including approximately areas V2, V3, V4 and V5 of the brain, and moving on to other areas of the brain. This variable refers to the top-down approaches to visual perception in psychology. It is in this moment of perception, that neural cascades occur, which undergo the interference of motivation, emotion, personality, culture, knowledge, etc. This aspect of perception causes variation and interpretation in art and design and in the proposed model, is called interpretive processes. Topographically, there is no exact location for Int to occur in the brain; complex meanders and cerebral elaborations are here intertwined, not to mention the brain's plasticity, permitting functional compensations (Gatass et al. 2001).

2. APLLYING THE MODEL FOR FOOD PACKAGE DESIGN

This theoretical model is now put into practice, in an attempt to analyze food package design. The oral presentation to this paper will have many more examples, but due to space limitations, here only four examples are described. In Figure 2 we have a picture of four packages of a Brazilian brand of fruit juice, designed by Narita Design office in Brazil.

Starting with Int variable, which is the variable that opens a wider range of interpretations, we can see the following perception items: the iconic representation of fruits, words and a splash. These three items belong to Int (which refers to the top-down approaches to visual perception in psychology), because all of them require previous cultural codes for their understanding. For the fruits shown to be understood by the observer, he/she must know the fruit beforehand. The first three fruits are well known worldwide, but the last one, is the Brazilian fruit Caju, which probably won't communicate to everyone in the world. Just as the words used, only people who read Portuguese and/or know the Latin alphabet can understand what is written. Apart from these three Int perception cues, also issues of aesthetic preferences could be discussed.

Now, going to Org variable, which refers to the objective aspect of visual perception, we can see an efficient color package design. This is so, because there are perception cues used that can be generalized to all human beings, independent of culture. These relate to the colors used, more specifically, the contrast of cool and warm colors. This contrast can be classified as Org, because of chromatic aberration and physiological factors. Classifying this contrast as Org, means that to all human beings with normal eyesight, cooler colors would recede while warmer colors would advance in our perception of the image.

According to Kaiser and Boynton (1996), perhaps because the human eye is not made of glass, no correction for chromatic aberration has evolved. If the eye is accommodated (focused) on a distant red target of wavelength 700 nm, a distant violet one of 400nm would be seriously blurred. Apart from chromatic aberration, there is evidence that the excitatory and inhibitory features of perceived warmer of cooler colors do have a physiological impact, as revealed in increases and decreases in ordinary vital signs (e.g. blood pressure, oxygen uptake, heart and breathing rates), alpha wave activity, galvanic skin response, the effect on hyperbilirubinemia (jaundice), the frequency of eye blinks and epileptic seizures, among others (Kaiser 1984).

In these examples, if the relative warmer colors were inverted with the cooler ones, of course the packages would have been able to be understood, but the wrong elements would catch the eye. Therefore, these are examples of packages that communicate efficiently to the human eye, since their Org perception attributes are correct. In the oral presentation, more Org attributes will be illustrated in other food packages, conveying examples of package chromatic design fundamentals. Chromatic Org attributes may be considered as chromatic design fundamentals, since they establish the objective perception cues for the human eye.

Figure 2. Brazilian fruit juice package.[1]

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[1] The image in color is available in the enclosed CD.

Compatible colour palettes for natural food packaging

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ABSTRACT

The idea of packaging is as old as human civilization, since the transportation and storing of products has always demanded putting them in containers and boxes, as well as the protection of food from dust, rain, humidity and other deteriorating agents. Similarly, the influence of colour as an identifying and communicating element of the *attributes* of those signs, acquire today a central role, key in the visual communication of the product image.

In the case of consumer goods, particularly food, the packaging is not only a simple wrapping for protection, but it becomes a mean of communication, used to reflect the product *image* that is intended to transmit to the consumer. Consequently, the packing size, shape, colour, the typography for the texts and materials used in its elaboration, become of key importance making the packaging its own seller and becoming sometimes the connection with the consumer, since it anticipates what the consumer thinks or awaits from the packaging, generating a sort of *meta-communication* since it expresses what the packaging contains or supposedly contains.

There are many factors in our reality, either psychological or visual, that determine the appropriate choice of the packaging colour, shape and material, according to the adopted commercialisation strategies. These factors become more important day after day, and they vary according to the cultural traditions and tastes of the different societies.

Food packaging design has been one of the disciplines that has been more related to the graphic industry in the last decades. We intend to investigate this issue and show some incompatibilities that certain design decisions have, regarding the colours used to represent the natural shapes and the resulting colours of the production of the printing standards. We will also offer some possible solutions to these conflicts which occur between one system and the other in the colour treatment. It is also the objective of this work to offer some ideas to the designers providing some conceptual and visual tools, establishing a series of compatible chromatic palettes between the suggested colour and the depicted colour.

In this opportunity, we do not intend to deal with the packaging colour as an industrialized product material, but we want to deal with some particular colour features in the graphic messages and its relations with the possibilities of reproduction, taking into account general types of materials for packaging or, even more important, the covering materials which are the visual media for the messages.

It is in this particular issue this paper deals with, where product identity, laws of marketing, technology constrains, rhetoric, persuasion among others, coexist –or not.

1. ESTHETICS OF PACKAGING

Certain categories of intervention are established, matching the types of packaging materials in products of daily, periodical and occasional use. This classification corresponds with the variables of *cesias*, since they determine sensory differences in the perception of colour in accordance with the concerning topic. In this opportunity, the following classification is used:

1. **Transparent**: We can observe that in transparent packaging for fruits, vegetables or pasta, the representation of colour comes from a natural fact, since the same product is the one being exhibited in its most pure expression; consequently, the perceived colours will be a combination of the colours of the product interacting with the proposed colours for the visual message of the container. The harmony or incompatibility should be seen in the combination of these two semantic fields.
2. **Translucent**: In this case, its own composition produces a combination of overlapping colours due to the semitransparent veil covering the product.
3. **Opaque**: This kind of packaging requires a colour treatment to access the identity of the content, in addition to photos or 2D or 3D illustrations to exhibit it. In this case, the participation of the designer and the areas of knowledge presented in this work are of essential importance.
4. **Reflective**: Similar to the previous material as regards the treatment of colour, but it has interesting possibilities in its colour display due to the reflexion of light over the covering material.
5. **Blended**: Combinations in pairs of the materials mentioned above. The characteristics aforesaid for each type also apply here.

2. FOOD COLOUR AND IDENTITY

One of the basics conditions of colour in packaging is that is has to be *useful* and support its shape in the identification of the product. In now a days society the visual identity already established its value as a basic need of every entity or item. There are some categories that have a direct influence in the colour choice of the graphic proposals for packaging, where there has to have:

- **The brand's identity**: the shapes that represent the production company and/or the logo of the product.
- **The product image**: the leading companies establish a colour associated to its identity assigning to it meanings that may refer or not to the food they represent.
- **Selling requirements**: Visibility, readability and unity in its writing, with the objective of facilitating its localization and recognition.
- **Semantic association**: Basic relation between the content and what it is displayed. Colours help attract the buyer's attention and provide information related to its content.

3. FOOD AND NATURAL COLOURS

When we talk about the *natural* characteristic of colour, we make reference to a semantic distinction in the faithfulness of the colours of the product, which can be verified mainly in photographs, where it is presumed that colours do not suffer alterations. We can also include any type of image manipulation that does not modify the original colours. Consequently, it is necessary to talk about colour "naturalness" in the packaging graphics, since it is in this instance –the design– where decisions which are usually contradictory are taken. This is why we start with a classification of the degrees of naturalness:

- Natural (unprocessed)
- Processed (manufactured)

If we accompany this classification with a palette of colours, we can establish a range of *natural colours*, that is, those which are *from the same nature of the product* and *processed colours* or artificial, since it would fit a sort of logical and semantic response.

This classification is essential to determine the colour fidelity as regards its *naturalness*, because it is a highly positive attribute in advertising content, since it is related to *freshness*, *healthy*, etc.

We will now try to establish which are the *natural colours* for *natural food*, within a general category, according to its origin:

- Mineral (whites, browns, sepia, yellows)
- Vegetable (greens, reds, violets, blues, oranges, yellows)
- Animal (reds, whites, pinks)

We would like to focus on the ones classified according its dominant colours, since they present substantial differences even if they look similar, such as:

- Fruits (reds, yellows, oranges, greens, blues, violets)
- Vegetables (greens, yellows, oranges, red beet, cabbage, eggplant)
- Meat (beef, pork, poultry, fish)
- Dairy products (milk, cheese, creams, by-products)

With this classification we tried to list what we are interested in highlighting about the colours' semantic attributes regarding *naturalness* and the different packaging graphics that sometimes are not in harmony with the election and treatment of colour. We are including some examples considered incompatibles (or at least inharmonious) from different semantic fields. For these considerations, we find that certain packages contain colours according to the *sensations* they produce, and this generates contradictions and opposing or wrong interpretations in the identification of the content.

4. NATURE VS. COLOUR PSYCHOLOGY

Having in mind the product' general categories mentioned before, we think that packaging must contain colours that represent the semantic attributes of its content, therefore, the colour palette of its design should match them. Some incompatibilities can be found. For example, earthy colours are a good match for items of mineral origin, but for fruits, vegetables and dairy unprocessed products this colour can be associated with "oxidation". Therefore, it can be said that not all the assessments made about *colour psychology* are effective, since for some food items the colour white can indicate *purity* but for others it is linked to its *fermentation*. Black is a sign of *excellence* for wines but it is hard to attribute this meaning to other food items.

Packaging serves as a container, but it is also a product identifier. This last function cannot be achieved by what it is called the colour *personality* if it is not directly related with the product attributes it identifies. We would like to make it clear that this particular approach is directed towards graphic productions of illustrations or backgrounds and not towards photographic images (or transparent packaging), since in those cases, the photography captures and reproduces the colour that the product reflects, which –except in the treatment of some relative variable– are not the result of the designer's "*colour decision-making*". It is also important to mention that the colours of the graphics depend in great extent to the percentage of the area that takes up in the packaging as a whole.

5. CONCLUSIONS

"Colours have a meaning that makes the objects' attributes stand out. They can be general attributes, when colours mean the same for every individual (the sky, the trees, the earth, the sun, blood), since colour categories are socially constructed" (Goodwin 2000). It can be inferred that colour associations are the result of some type of experience with the product, and thanks to the contact with it, the person acquire the capacity to relate colour, form and function.

It is very interesting the idea that, "…when the consumer observes similar products, he generalizes this learning and gives similar attributes to products looking alike in its appearance even if he recognizes them as being from different brands" (Warlop and Alba 2004, Miaoulis and D'Amato 1978). There are many cases in which the image and colour of the leading brand are used as a generic identifier of the product.

It is very common to confuse packaging of different categories because of the similarity of the codes, and this strengthened the need to use standard codes for the category. Assertive reading is given not only by the packaging´s shape and material but also the image and colour consistency.

To conclude, we would like to say that the goals of our work –because of the extent and diversity of the topic–, cannot be completed in this speech, but some solutions are given and it is complemented with another work displayed in poster format, named "Natural Colours for Natural Food", where we depict a series of compatible colour palettes for natural food packaging.

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Study and analysis of the consistency of the color from the piece of food to the virtual representation in the screen and in the packaging

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ABSTRACT

The objective of this job is to show the main results of the applied research project performed by Gutenberg in association with the Federación Gráfica Argentina (FAIGA), and the Unión Industrial Argentina (UIA), with the support of the Consejo Federal de Ciencia y Tecnología (COFECYT).

This work focuses on the technical and non technical variables that interactively impact in the consistency of color during the analysis of a graphic workflow for packaging.

Herewith appear the main steps of the graphic workflow, which appear to be critical when it comes to obtaining color consistency:

The selection of the printing support is the first step that initiates the technical printing process of the packaging of food, from the printing point of view. This support is selected together with the total production required and it will determined which is the best printing system for its production.

Once the printing system has been selected, it should be established what kind of standards will take place during the technical evaluation of the printing production. Therefore, there could be American, European or Japanese regulations or even the standards defined by the company, for instance. This work deals with the ISO European regulations, which printing standard is ISO 12647. Considering the choice of the printing standard, the designer should base all of his/her decisions to create the digital file accordingly with the selected standard. As in every other phase of the graphic workflow, the design phase has critical points directly affecting the consistency of color from the conception of the file like the formats and modes of color when the designer receives the images that were obtained through scanners or professional photographers; the monitor visualization of the work files; the parameterization of the design programs, in accordance with the printing system; the color conversion from RGB to CMYK and the type of format of the final file; among other things. All of the above are critical points. However, the critical points depending from the selected printing system should be distinguished from the critical points not depending from the selected printing system. There are many depending critical points in the graphic design phase, but we can mention the parameterization of the design programs and the color conversion from RGB to CMYK, which has to be performed through ICC profiles. We can also mention [Damián R.1]the transformation of the RGB and CMYK images through the Fogra 39 profile to convert images from RGB to CMYK when an Offset [Damián R.2]printing process using coated support is selected. By doing this, the ISO 12647 Offset printing standard is being followed.

Moreover, we can mention critical points which are independent of the design printing system: the technical conditions that should be followed by the monitors to offer a good visualization of the images in accordance with ISO 12646 regulations, and the visualization conditions established by the ISO 3664 regulations. The visualization of images in monitor and in the comparison between the monitor and the test, or the comparison of the color test with the printed material, is perfectly established by these regulations. This means that there are some conditions clearly specified of how the processes of visualization of files in monitors or comparisons are performed. In this manner, the fact that a designer should correct images in an inappropriate monitor or under poor lighting conditions is excluded. It is also excluded the fact that a graphic salesman would show the color test to the client in his office without considering these conditions in cases where the color test is technically correct.

The designer could create the final file in PDF format, which is also accepted by the regulations. Through preflight programs, this format allows the detection of other variables which impact on the color consistency like resolution and bits quantity of the images.

In the prepress area, after the file goes to prepress, the ripping of the file is one the key points when it comes to maintaining the color consistency. In this process, the required technical data to color separation is specified for the selected printing system. The ISO printing regulations suggest parameters for line, angle, point gaining, etc., which are defined during the ripping phase. The obtaining of the CTP plates, the digital multimeters or the rotogravure cylinders, which are obtained after this process, is controlled through color strips that determine if they have been obtained in accordance with the quality standards required to achieve consistency.

The color tests by contract which are also performed during this workflow phase should agree with ISO 12647-7 standard. The test by contract that does not agree with this condition should be considered as a reference test. This regulation establishes requirements such as the obligation of the test to have an ID tag that records the printing system simulated by the test, the printing system for tests that was used, the date of the test printing, the line registries of the digital printer that was used, the name of the support and of the inks that were used, the color rendering used to obtain the test and if it complies with the colorimetric tolerances which link it with the printing conditions that were selected through the demand of the color test with a control stripe.

In this phase, the independent critical points are the monitors, the imagesetter of the CTP or polymers plates, and the digital tests printer. All of these points, as well as other equipments, should be calibrated, profiled and in line. In order to carry out these processes, densitometers and spectrophotometers are used, and their parameterizations, although they are independent of the printing system used for the production of the packaging, should also comply with the graphic standards of the ISO 12647-1 regulations which are based on the ISO 5-3, ISO 5-4, and ISO 13665 regulations. Consequently, before going to the printing phase, there are many critical points that should be checked to obtain consistency. When the previous points are not considered, the work performed no longer falls under the standardization concept of the color consistency. In the everyday use, the test printing is used as an approximation leaving the color definition in the hands of the printer during the printing process. In order to exclude this situation, that is the printing color test not being adequate, the regulations establish that if the workflow is standardized by the regulations, the printing material should comply with the colorimetric and densitometric technical specifications established by the regulations.

In this phase of the printing process, the critical points depending of the printing system are the choice of the ink, specified by the ISO 2648 regulations and the selection of the substrate which technical specifications are described in the ISO 12647 printing regulations.

Up to this point, we have mentioned the most important points affecting the color consistency in a selected printing system and, as we have established already, all of the phases of the graphic workflow have critical elements that should be controlled for the color consistency to be successful. In the packaging of food, the color consistency is required in more than one printing system. The packaging of the same food could require an Offset printing and flexography. Working in a standardized manner is the only possible methodology that could be applied to achieve color consistency between printing systems in the packaging of food. By doing this, the color of the brand of the food is preserved, which facilitates its unique identification.

This research project emphasizes the study of these critical points because, in accordance with what we have already showed, not every professional that participates in this process have the same level of interest in the color consistency. The following comparative table summarizes the state of the art at the beginning of the project. Table 1 relates all of the players of the graphic workflow chain for the packaging of food with their respective production tools, environments, evaluation tools, color measurement and color consistency relevance granted in their job. For instance, a publicist cares about the color of brand. The color consistency could be granted with great importance, but when it comes to advertising, the requirements of the monitor or of the visualization conditions are not considered, at least, most of the times.

Table 1. Relationship between the actor, the tool of reproduction, the color mode, the tools used for measurement and the importance attributed to the color consistency.

Actor	**Color object observed-Reproduction tool**	**Medium: Physical-Real Color mode**	**Tools most commonly used for color measurement**	**Importance attributed to the consistency of color in all the workflow**
Producer	Food	Physical sample	Visual observation	Low
Publicist	Screen	Digital RGB	Visual comparison with pantone or with a real piece	High
Photographer	Image in digital camera or screen	Digital RGB	Color chart, spectrophotometer	Medium
Designer	RGB screen Contract Digital Proof	RGB digital CMYK digital	Photoshop information tool (info), pantone, spectrophotometer	Very high
Operator de preimpresión	Screen+rip+image setter Proof printer	Digital: RGB Digital: RGB	Spectrodensitometer	Medium
Printer	Box - Production printing machine	Physical CMYK-Pantone	Spectrodensitometer	Medium
Distribution	Packaging	Physical CMYK-Pantone	None	Low
Buyer	Box - Box - Box - Food	Physical: CMYK	Visual comparison	High Low

In the study, it was also determined that the loss of interest in the color consistency is originated in the associated costs, which implies color measurements in the corresponding actions that have to be performed in the diversion correction.

Performing color management implies that the company has pay costs such as the ones detailed in Table 2.

Table 2. Percentage distribution of the additional costs in order to achieve color consistency.

Necessary item	Annual % incidence
Color specialist	23%
Spectrodensitometer w/ soft	10%
Normalized light camera	1%
Test paper	6%
Adequate screen	16%
Bright D50 installation	1%
Maintenance of building conditions	1%
PC or Mac and printing server	5%
Test printer	5%
Original inks	21%
Calibration	2%
Rip for the creation of weave and linearization Printer with control strip	9%
Tests in production printers	19%

Even though the cost of the test printer ink, the color specialist and the production test costs can be considered to be the most typical ones, other unexpected cost appeared. The higher costs come from: 1) Difficulties for the provision of normalized consumables, 2) equipment and software highly sensitive to problems in the electric network, 3) the need of building adequacy incompatible with the comfort of workers (light conditions, neutral gray color in walls and clothes), 4) impossibility to achieve certification and calibration of foreign equipments, 5) repetition of plates and tests for the different behavior in the RIPs (compensations occurred in the control strips when it was not expected), 6) fluctuations in the material specifications: inks, plates, cards and papers, 7) the need of the external supplier to determine the properties, such as brightness and endurance to the rubbing of stands, 8) the need of adequacy of the printing machines, 9) reproducibility of different spectrodensitometers, 10) resistance to change in the work modality.

CONCLUSION

There are several factors on each stage of the graphic workflow that may affect negatively the color consistency. In order to achieve the color consistency in the packaging of food, it is necessary that all the work chain operates in line with the working directives and objectives determined beforehand.

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ISO 3664: Graphic technology and photography. Viewing conditions.

ISO 10128: Graphic technology. Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data.

ISO 5-4: Photography and graphic technology. Density measurements. Part 4: Geometric conditions for reflection density. Spectral measurement and colorimetric computation for graphic arts images.

The color of the tiles in the architecture of Valencia's Central Market (Spain)

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INTRODUCTION

The final launch of the ceramic industry in Spain starts in the last quarter of the 19th century, this stage is linked to the renewal and growth of the main cities, being the ceramic coating one of the materials linked to the architectural building that registered the highest growth. Valencian manufacturers will become, in the first third of the 20th century, the main national market suppliers, only some industries close to prominent cities such as Seville and Barcelona produced tiles that competed with Valencian ones.

Population growth and its urban concentration was, therefore, an essential factor that fueled architectural development, together with other factors such as the Hygienic Movement and the decorative fashion expressed both inside and outside the buildings. The hygienism was considered a sign of the improving in living standards that the middle class experienced in this early period of the 20th century.

The wall surfaces of the flats, especially in "wet rooms" (bathrooms and kitchens), were covered with such a material, that commercial catalogues described as hard, durable and washable. In this context it highlights its use on the markets, big civil buildings for a new flourishing urban society. Valencia's Central Market, beyond its hygienist aspect, is a magnificent representative of the use of architectural ceramics in its public space, both inside and outside.

TECHNIQUE AND SHAPES

During the second quarter of the 19th century, for economic reasons and to ensure the accuracy of the motifs they represent, it starts in Valencia the use of *trepa* tiles, as it happens in the case we study. In 1836, in a list of materials used during the building of the market, architect Franco Calatayud noted: *tiles with flower released, of trepa*.

In this time, coloring methods are improved and hue finds the following shades: basic colors, oxides, are few and constant; yellow of lead or antimoniate; brown ferruginous; cobalt blue, manganese purple and copper green.

The shape of tiles is square, a handspan long (about 22.5 cm, 1/4 rod) or the result of the partition of the square into two equal rectangles for the friezes.

THE GLAZED CERAMICS OF VALENCIA'S CENTRAL MARKET

All Central Market glazed ceramics are made with this technique. The historical manufacturing process has remained pre-industrial up to the present in a number of workshops with a semi-artisanal production, only changing the cooking system by the replacement of wood kilns for electric ones. A manufacturing process to replace some broken tiles has been done during the restoration works, with the following steps:

Preparation of the bisque: Brought the bisque from the ceramic manufacturing plants in Castellón, a material that passes the tests of bending strength, breaking load and linear thermal expansion. Executed in a workshop, it will work as a basis for the glazes.

Preparation for the glaze: White opaque applied in a bath on the bisque, dried for 4 minutes, after 24 h. of outdoor drying it is ready to start the glaze painting.



Figure 1. Preparation for the glaze. Figures 2 and 3. Application of glaze with trepa.

Application of glazes: Water based colors are used, adapting the RAL letter to the references given in the color palette provided by the technical specifications, its application is made by *trepas*. The *trepa* is made on waxed paper that matches with the size of the piece, on which the picture to reproduce has been drawn and cut. The number of *trepas* depends on the composition. The paint is brushed manually on the surface, broad bristle brushes for wide spaces, or in a more intense way for small spaces.

Firing: At 985 ºC for 8-10 h. The tilt detects the temperature and automatically keeps it, for 30-45' cooling naturally, it is in this moment that the liquid glazes turn solid, acquiring their final brightness and living colors.

Figure 4. Glazed with trepa, before and after the firing.

These ceramics are widely used in the market, either as a decorative or finish material. On the facades it is used extensively as a finishing over the hidden surfaces of the market, on the “fish vault” and as finishing on the upper parts of the arches in windows. We found them too in the spaces between the pairs of cast-iron columns that separate the different windows of the market.

In the inner spaces, there are tiles in different positions. First, tiles cover inner surfaces of the market walls. These are generally white, although there are decorative friezes on two different heights. There are also tiles set on the friezes at the base of the skylight, inside the vaults and on the sides of the low skylights.

The decorative motifs on tiles are, generally, floral, stylized leaves, usual fruits from Valencian orchards and zoomorphic shapes.

The pathologies they suffered were: bleaching at the base of the tile walls due to the use of inadequate cleaning products and loss of tiles in some places due to mechanic aggressions and humidity.

Figure 5. Motifs.

All the motifs of the market have been analyzed and investigated; the result of this work is set in the technical cards that follow with some representative examples of such an investigation. The colors of tiles have been noted with the Pantone color system for a future identification and an accurate color printing, and also translated to the CIELAB colour notation which will make it possible a rigorous and complete study of color properties in future restoration. Here we show one of the color cards of the project, settling the composition and color mapping to identify tiles located in one of the rooms in Central Market.

Table 1. Color notation of tiles from the “fish room”.

	CIELAB
Blue PANTONE 7455	L:40 a: 11 b: -50
Light blue PANTONE 5425	L: 61 a: -6 b: -15
Yellow PANTONE 7492	L:88 a:-9 b: 40
Light green PANTONE 5575	L:82 a: -8 b: 2
Dark green PANTONE 556	L: 63 a: -19 b: 5
Red PANTONE 5195	L: 27 a: 52 b: 8
Orange PANTONE 7517	L: 42 a: 30 b: 58
Light orange PANTONE 7510	L: 75 a: 15 b: 57

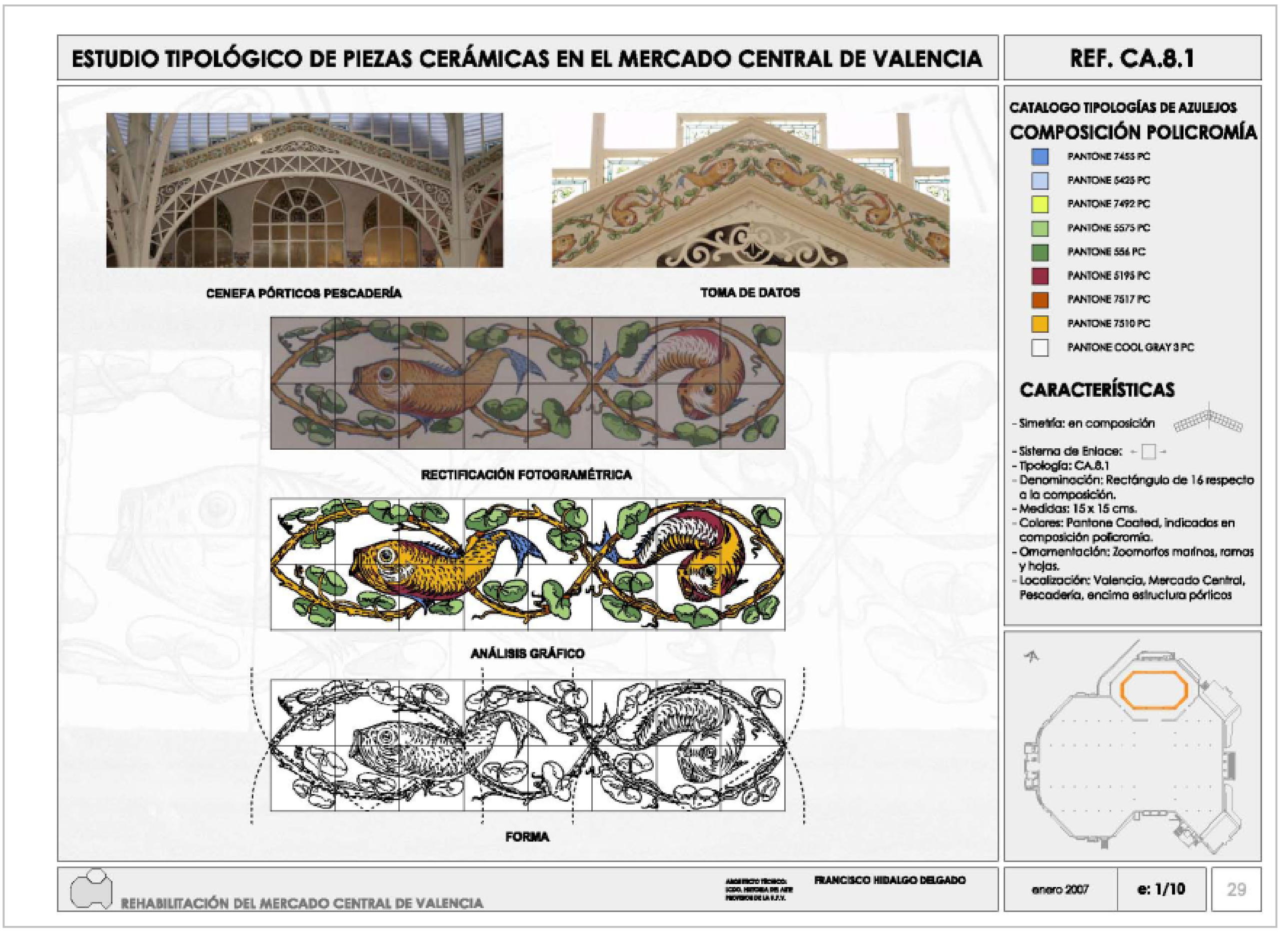

Figure 6. Typological study of tiles. Fish room, inside the market. Data gathering. Photogrammetric correction and graphic analysis of the pieces. Composition and polychromy.

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Chromatic expressions in commercial architecture: Córdoba, Argentina

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ABSTRACT

On behalf of the researches on the subject of color within the framework of the Institute of Color, Faculty of Architecture, Town Planning and Design, National University of Córdoba, Argentina, in this presentation we focus on the color of commercial architecture related to food, that is gastronomic architecture, in two traditional neighborhoods of the city of Córdoba, Argentina. The emerging commercial architecture in *General Paz* and *Nueva Córdoba* neighborhoods deserves a particular study from the sociological approach. It has created paradigmatic situations in the city within a few years due to the substantial increase of places for gastronomy. They are situated very near from the city center and are mainly residential; trade in supplies and services activities work during the day; at night the movement gives way to restaurants, bars, pubs, and the whole gastronomic trade situation. This development is generating a very particular and highlighted renovation in the image of these two areas of the city townscape.

1. INTRODUCTION

Over recent years eating has turned from usual routine into art and social custom. Due to this new concept of eating and drinking around the world, the food service sector has become one of the most dynamic areas. Another factor that accounts for this growth is the boom of tourism, which has produced deep cultural changes and increased significantly the number of clients who are accustomed to high-class cuisine and demand international standards from Argentinean restaurants.

Globalization and access to the diversity of media contents have encouraged new patterns of gourmet food consumption. These consumers are more demanding and eager to have new gastronomic experiences, as is evidenced by the media, books and streets, which show the public that food consumption is the source of energy for human beings and that taste is central but not the only sense implied in this experience. The booming of Argentinean food services occurred in Buenos Aires and it later spread to the rest of the country. Within this context, there have been a number of innovative undertakings in the city of Córdoba, emphasizing a new specialty in commercial architecture: gastronomy architecture.

1.1 Character-defining features

In order to design a gastronomic place with distinctive architectural features, the spirit of the enterprise must be interpreted in a creative way. Among the principles on which this type of project is based, the interaction of colors, forms, textures, shine, lattices and lighting design are basic elements to develop such character-defining features and to create the atmosphere for the desired image. Besides, other components of the language of design and decoration, which comprise advertising, canopies, sunshades, entrance design and materials, are also essential in order that the outdoor image of the place can be understood and would remain on people's memory. As regards interior design, furniture, the employees' clothing, table linen, the menus, glassware and dishes should also be considered as meaningful visual elements aimed at projecting an image of the place.

This project seeks to prove that the use of certain components that help to develop distinctive architectural features in commercial architecture, such as color, enables work to be done on the interaction of symbols and functions, conveys a distinct meaning to new uses of architecture, gives new value to cultural heritage, and enhances the quality of urban spaces and therefore, the quality of life.

2. IMAGE OF GASTRONOMY ARCHITECTURE IN CORDOBA

Throughout history, traditional architecture in Córdoba has undergone a transformation in the conception of bars and restaurants design. In times of economic prosperity, in the 50s and later in the 70s and 80s, these enterprises design was based on practical and luxurious premises, and large rooms were designed in order to see and be seen. At present both the technological and the formal design have changed, and new concepts have emerged regarding the use of these spaces, in which the lighting and color design play a central role, interacting constantly with people and influencing strongly their attitude and permanence in such places.

In gastronomy architecture design, the concept of space, the expression of its figurativeness and the design of an atmosphere or the creation of an image are essential aspects, as well as thorough planning of service areas, on which the quality of the service is founded. The characteristic that these spaces have in common is the need to differentiate from competitors, through development of their own distinctive features. Beyond appearance and the style of decoration, the purpose of these spaces is to communicate and to create a sensory experience, which fosters in clients a sense of emotional bonding with the place. Within this frame, different tendencies arise from the type of food offered, the target clients, the premises location, and the resources available there, among others. However, the most important aspect is creating a design that meets the operative, service and marketing needs of the unit.

There is a trend in contemporary society towards including eating out in the cultural agenda. Indeed, the confluence of food and culture has proved to be successful and there have been a number of enterprises which merge gastronomic services with art exhibitions, concerts and live drama presentations.

2.1 Study of paradigmatic examples

The emerging character of commercial gastronomy architecture in the neighborhoods studied needs to be analyzed in particular from the sociological point of view, since in a few years paradigmatic situations have risen in the city as a consequence of the growing number of gastronomic places. It is worth mentioning that this growth has also taken place in similar areas of the city; however, we will only analyze thoroughly "General Paz" neighborhood and "Nueva Córdoba" neighborhood.

The neighborhoods mentioned are situated near the city center and are characterized by residential use; goods supply and services business premises are open during the day while pubs, bars, restaurants and all kinds of gastronomic places open at night. This situation generates a peculiar physiognomy in both sectors of the city.

These gastronomic enterprises have characteristics of the Mediterranean, Mexican and gourmet cuisine profiles, among others. Nevertheless, situations are different in each neighborhood; facades differ in both areas from the perspective of expression, which confer distinctive features, providing partial syntaxes present in both sectors.

2.2 "General Paz" neighborhood

This neighborhood has the characteristics of an urban space, rooted in a specific time and architectural form of the city. Its morphological features show thought-provoking expressions, holding significant symbolic value and syntactic and semantic codes that contribute to its character-defining features and interpretation.

Nowadays, its urban landscape is being altered due to outstanding chromatic interventions on existing buildings that denote in the urban space a change in function, though there are fortunately some aesthetic exceptions. This situation is characterized mainly by the installation of gastronomic places in mansions of the early 19th century, with an Italian style, some of which were rationalist. Most of these houses are situated on corners. According to the different commercial concepts of their cuisine style, these mansions present a renewed external image and improved interiors, through the restoration of texture and primitive materials colors.

There are different strategies to highlight commercial architecture, in some of these buildings the color scheme harmonizes, while in other cases it is disharmonious. For instance, highlighting the construction with a saturated primary color that clashes with the environment produces a rupture in it. A further example is the use of dark colors to enhance moldings, cornices and columns, over a facade painted in a pale primary color.

Other treatments denote changes in the function of buildings through the use of elements that produce a rupture of the former order patterns, essential for support and defining-characteristics of the building; such as making use of vertical bands in contrasting colors that break the meaningful unity of the building, which aim at conveying to the public the diversity of functions that said building has at present. Such treatments are detrimental to the urban space since they destroy the possibility to understand the building typology, causing the image of the place to become fragmented. Coordination between symbol and function can be possible through appraisal of the value of the permanence of the existing architectural typology, but at the same time indicating the functional changes.

2.3 "Nueva Córdoba" neighborhood

In this case, the transformation of the landscape results from the substitution of the typology of 19th century constructions for a denser, residential area, characterized by its reddish brick buildings, with confer unity on the area. This change allows the detection of periods in the history of architecture. Firstly, the influence of architect José Ignacio Díaz can be appreciated in the extensive use of volume and bricks. Secondly, elements of postmodern architecture were incorporated, such as brick in the background, and glass and other finish details in the foreground, to obtain dynamic chromatic compositions. In recent years, architects have made use of colored plastering, colored glass and concrete walls in this neighborhood that concentrates the greater number of construction sites of the city.

A further transformation the landscape of "Nueva Córdoba" has undergone derives from reconversion of the 19^{th} century urban design, which included one-family residences, into an architecture characterized by tall buildings in which the ground floor is used for business premises, with use of bright colors, large advertising banners and a variety of textures, shines and lattices that have had an impact on the physiognomy of this neighborhood.

The existing architectural typology has become a part of the construction of a new urban image, meeting the requirements of the global culture. In this way a new language is generated, based on the requirements of new functions, becoming the support of corporate images rather than socio-cultural constructions, altering living experiences and the construction of meaning in the sector (Avila et al. 2002: 89).

The resulting architecture clashes with its environment. The new expression can be depicted as superficial, neutral and innovative in terms of technology because it presents itself as a large advertising support. The central issue is the expression of these business premises, the brand image, which proposes colors, typographies and the presence of global icons in the traditional landscape of the city. Color is the protagonist as it is associated with new meanings that arise from the appearance of global images that characterize this revamped expression of public spaces in the neighborhood.

3. DRAWING CONCLUSIONS

The city should be considered as a historical, evolving and dynamic organism where past and present coexist, and continuity and change occur. Its deterioration through the use of images that are totally unrelated to it cannot be accepted, since such images destroy the community characteristic features and collective memory, which are essential to the projection of the future. The challenge is to find what is the most appropriate for each circumstance.

Color, when coherent criteria are applied to its use, gives expressive value to different areas of culture and contributes with its presence to understanding and character building in Urbanism, defining with its presence new central ambits in traditional neighborhoods of Latin American cities.

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Urban image and color in the food industry architecture

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ABSTRACT

In the last decades, cities have experienced changes in their urban image due to local and global events. In this context, the city of Córdoba shows changes in its appearance and urban culture. The contemporary urban life proposes new meanings, behaviors and new uses of spaces. However, the urban experience still keeps its essence since it is basically a combination of physical and mental events, of material and imaginary ones. The components of the urban language cause different answers in the users as regards how they use the urban environments since they significantly qualify the expression and communication of facades in commercial architecture and especially in the food industry architecture. In many cases, the strength of this message is based on the optical contrasts, the chromatic synesthesias, the cesias and other signs of chromatic language which stimulate the sensorial experience of the city conditioned by new demands and meanings.

1. THE URBAN IMAGE

The faster and faster technological innovations in the age of information bring about transformations in the urban fabric. At a smaller or larger scale, the urban fabric presents features in urban spaces which respond to a new logic of producing the city: the logic of the global that interacts with the local. Homogenous images configure the new spaces of the city regardless of their location. In this context, the image of the city of Córdoba reflects changes in its spaces in different sectors which show alterations in the urban fabric and in the way to live and experience the city.

The present urban transformations represent new conditions, both material and contextual ones. The urban culture is characterized by new ways of communication and consumption. In the exchange between man with his environment, perceptions and sensations are generated, enjoyment and meanings come up as well as answers provoked by associations, analogies and values. In this experienced and interpreted environment, man builds a new reality, an existential image, an image-landscape considering his knowledge of the environment related to the color of the components of the city language. It is important to notice the significance of the direct experience of man with his environment in the process of building an image. Thus, the urban experience becomes essential since it is basically the combination of physical and mental events, of material and imaginary ones.

2. THE IMAGE OF THE FOOD INDUSTRY ARCHITECTURE

The urban public space is a living and meaningful environment where the inhabitant has a dialectic exchange with the surroundings. In this multi-dimensional experience, the appearance of urban facades or building enclosures, which work as elements of communication and developers of representations, become a special non-verbal language of the city.

Commercial architecture at various levels and specially the food industry architecture propose messages that allow various uses and behaviors according to present needs.

It is recognized that the commercial activity is no longer isolated but mixed or associated to activities that involve different fields such as culture, art, leisure and free time among others. This diversity refers to meanings that go beyond the strictly related to the food industry. In many cases they become real consumption facts in response to a constant search for novelty, an eagerness for food culture and a public that covers every taste and multiple ages. Therefore we could speak of a new culture accessible by means of a varied offer.

Figure 1. The image of the food industry architecture in Córdoba, Argentina.

As an answer to these social, economic and cultural demands, the urban architectural language includes new materials, unique shapes and different environments which offer more freedom of choice to the users. The different proposals act as a catalyst for the greater and greater expectations of users, making use in many cases of resources that temporally modify the image where color and light are the protagonists of true urban sceneries.

3. THE LANGUAGE OF COLOR OF THE FOOD INDUSTRY ARCHITECTURE

If we consider that every architectural phenomenon leaves an imprint as a witness and reflection of certain time, place and society, the role of color can be researched in this kind of architecture that at present struggles between local identity and the typical innovation of new determining factors. The approach to study this phenomenon is a complex task; however, it is possible to research the contact points derived from the global as well as the special features that come from local or regional contexts.

The social importance that food industry has gained can be seen in the different architectural proposals. The urban environments include expressions that respond to the standards of an offer of new and varied services. Among the most significant characteristics we find:

- The mixture in the offer, food associated to the cultural, leisure, free time, tradition and tourism among others.
- The associated image linked to a specific behavior, thematic spaces, multi-media spaces, fast foods, deliveries, the international, the traditional or the ethnic.
- The scenery as an aesthetic resource in response to the cultural imaginary of users.
- The use of color and lighting as a valuable resource to create a clear identity.

Figure 2. The language of color of the food industry architecture in New Córdoba neighborhood.

Figure 3. The language of color of the food industry architecture in Güemes neighborhood.

In this context, the components of the urban architectural language cause different answers in the urban environments since they significantly qualify the expression and communication of commercial facades in the food industry architecture. This iconic image which is expressed by means of colors, lights, textures, materials and shapes increases the sense of an active presence in front of the spectator.

In many cases, the strength of these messages is based on the optical contrasts, the chromatic synesthesias, the cesias and other signs of chromatic language which stimulate the sensorial experience of the city conditioned by new demands and meanings which transform the urban image in a global and local way as well.

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Colour and light in restaurant design

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ABSTRACT

The aim of this research, which is ongoing, is to investigate the interaction of light and colour with colours of food in restaurant or similar locations devoted to food consumption environment and eventual fallouts.

1. INTRODUCTION

The research focuses on providing the design information needed to make possible perceptual situations that can better interact with both the physiologic and psychological balance of human beings, through the identification of colour ranges appropriate to the exigencies of users and operators in food consumption environments. Additionally it aims to respond and give consistency to a colour planning extended to the problems that characterize this kind of surrounding.

The general scientific methodology, which is applied for this design research, is the one of a phenomenological and holistic approach.

The research is carried out through case analysis and workshops and is in progress within the broader frame of the international research named *LCS-Light, Space and Colour*, which is carried out by a number of universities in different countries.

There is a general understanding of the connection existing between light and colour, from a physical, visual and emotional point of view. Light and colour interact with each other and create visually one unit, a three-dimensional *picture*, which is experienced as a space. The space performance is the basis for our understanding of the physical environment.

The colour and visual impact of design products and services are the fundaments on which we are building our personal and *individual world*. The spatial appearance effect on humans happens both bodily and visually, and create feelings of wellbeing or, on the contrary, the very reverse.

Besides the codified use of colours in food consumption environments since a long time in use, lets think for instance at the well-known colours of the fast-food chain McDonald's, a number of studies on food and colour have been conducted, the same may be noted in the domain as regards coloured light interaction with prolonged sojourn, and further we have the testimonials of emotional usage of colour in this kind of contexts made by artists such as, for example, Vincent Van Gogh's descriptive letters and artwork known as *s.*

2. CASE STUDIES AND APPLICATIONS

The first workshop in program has been performed in the Design Campus of Pukeberg, of the University of Kalmar now Linnaeus University, in Sweden, during the autumn of the academic year 2009-2010.

It consisted in a full-scale experimental laboratory testing the connections between light, colour and space. The work was to be made in six different teams, five of which composed by students of the University of Kalmar and one by the students of the guest University Polytechnic of Milan, Italy.

A box made of plywood panels and measuring 2.5 × 2.5 × 2.5 m, provided with one entrance door of standard dimensions, was assigned to each team. The six boxes were set up inside a big space located on the first floor of an old disused glass factory.

Each team of students, directed by teachers belonging to both the universities, designed its own box, thus being free to experiment both with colour and light. Also, available on place, there were a number of lighting experts with a range of miscellaneous light equipment. The only compulsory limit was the one that it was not consented to cut the walls of the box.

The final resulting designs were very differentiated in both use of material, colour and light.

The five Swedish teams realized colour and light themes taking inspiration that ranged from the representation of good and evil, seen as warmth or love and coldness or hatred or even more indifference, through interior designs thought as natural or artificial enclosures, to interesting three-dimensional illusory spaces created with the interactions between mirrors, geometries, colours and light. In particular, the Italian team took inspiration from the British artist Jim Lambie, whose art works are referring to the Optical Art and who uses vibrant vinyl tape to cover entire environments, as a consequence totally changing the perceptual essence of the original location and producing a dematerialization of the contours delimiting the spaces wherein he intervenes. He participated in the exhibition *Color Chart: Reinventing Color, 1950 to Today*, at the MOMA of New York in 2008.

The Italian team, also employing the theoretical principles of Attilio Marcolli (1971) and Bruno Munari, used coloured stripes of paper applied with glue on all the walls of the box in a pervasive geometrical pattern (Figure 1), in order to create a negation of space. Further, through the texture an ever-changing colour impression was given that was interacting with each change of light. Actually they tested a play of coloured LED lights on this background.

Table 1. The box realized by the Italian team.

In fact the collaboration between artists, architects and designers is frequent. Recently a new restaurant has been opened in the Guggenheim Museum of New York, which is called

The Wright, which replaces the previous cafeteria and whose curved lines are derived from Wright's underlying geometries. The interior project is by the architect Andre Kikoski with the collaboration of the British artist Liam Gillick. The project visually creates a relationship with the museum where it is placed and features a wall of coloured bars that gives an Optical Art impression that is near to the works of Jim Lambie.

Liam Gillick is a representative of the artistic movement Relational Art, a term introduced by the critic Nicolas Bourriaud (2002), and in 2009, he represented Germany in the Giardini Pavilions of the Venice Biennial.

3. DISCUSSION

The projects, realized during the workshop and shown to an European delegation, constitute a hypothesis of perceptive elements usage that are consistent with the adequacy finalities of the environment, towards the intrinsic needs of the individual's prolonged sojourn in a specific place. The approach was innovative, explorative, experimental and the empirical studies carried out for the investigation and defining of essential factors as their features and connections to the complex performance.

The strengths of this first step of a study to be conduct in the research, the first workshop, are that, in this way, being in fact projects of abstract environments, thus bearing a variety of colours, finishes, textures and lighting conditions, they represent an ideal start from fresh grounds devoid of already existent premises.

The weaknesses may be that interviews on the spot were done only on oral basis this due to external factors as the public was large and the time for the visit very short, the written protocols of statistically collecting and verifying of the emotional states felt by the visitors, were to be carried out in a second time not coincident with the visit.

While the material referring to the workshop is freely available, the material regarding the conclusions of the preliminary phases of the general frame of the research *LCS- Light, Colour and Space*, is, until now, in form of private communication.

4. CONCLUSION

As said previously, in the introduction, the general scientific methodology applied to this research on progress, focused on supplying design information, for instance colour ranges and colour planning, suitable to the requirements of users and operators in food consumption environments, is of a phenomenological and holistic approach and the first step was successfully brought about.

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Art and colour design of commercial architecture devoted to food

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ABSTRACT

Today, most architects work in commercial architecture and especially in restaurant design. There are four stages to restaurant design projects: obtain client requirements, determine site location, create design proposal and submit a project plan. The space requirements for particular building types (color design in different food restaurants such as French, Chinese, American, and Japanese foods) required different approaches of colour design. Colour study of modern or historically precious buildings helps us to get a sense of local style, height, physical presence and use of color. New materials and technologies demand new solutions of colour design and its strategy. Thus colour design can no longer be understood as the design of surfaces: his consecutive perception embraces the overall effect of light, space and time, of movement and change, of fiction and reality. The harmony of colours in the art and design of restaurant architecture is a true colour 3D conception, with its nuances and details, with specific colour combinations, constantly changing in space and time. Architectural polychromatic restaurant design has two main parameters: Activity or magnitude of contrast between the elements of colour combinations (relationship between different colour components); and degree of independence of spatial colour composition and structure in relation to volume and space parameters of architectural form.

HISTORY AND PRACTICE OF ART AND COLOUR DESIGN OF COMMERCIAL ARCHITECTURE DEVOTED TO FOOD

The colour design in the field of food commerce architecture has been in place since the very beginning of architecture, and some of those structures are still available today.

The ancient Egyptians had developed a glassy material known as faience, which they treated as a type of artificial semi-precious stone. Faience is a non-clay ceramic made of silica, small amounts of lime and soda, and a colorant, typically copper. The material was used to make beads, tiles, figurines, and small wares. By a related technique, the ancient Egyptians produced a pigment known as Egyptian Blue, also called blue frit, which is produced by fusing (or sintering) silica, copper, lime, and an alkali. The product can be ground up and used as a pigment. The ancient Egyptians could fabricate a wide variety of objects from glass with great skill. A range of colors could be produced, including yellow, red, green, blue, purple, and white, and the glass could be made either transparent or opaque.

The ceremonial center of the Minoan culture in Crete, Palace of Knossos (19th century before J.C.) has had the walls in stucco and columns were painted in red colour for the private or royal residences. The decoration on the frescos of the Palace of Knossos was sophisticated and colorful in comparison to the roughly contemporaneous art of Egypt. The walls were covered by unusual stylistic frescos so cold “the impressionists of antiquity”, where the colors were re selected without preoccupation with a reality, but according to their only decorative value.

Roman and Greek commercial architecture included the building of elaborate structures, complete with specific colour design (painting, mosaics, etc.) for courtyards, market places and meeting rooms. Natural colours of marble, ivory and wood were considered not to be characteristic for architecture. Many buildings of Greek Forum according to research of G. Semper and J. J. Hittorff have had bright colouring of surfaces by encaustic. Encaustic painting, also known as hot wax painting, involved using heated beeswax to which colored pigments were added. The paste was then applied to the surface and did cover up the crystalline structure of marble, created the effect of deep luminescence. The main architectural elements (walls, pillars, flights of steps) were painted in colour of natural material; roofs, cornices, plastic of frieze and capitals of pillars and columns were stressed by bright colours (red, blue, ochre).

Tabernae as a part of Market has probably first appeared in Greece at the end of the 5th-4th centuries B. C. Upon the Roman Empire's expansion into the Mediterranean, the numbers of tabernae greatly increased, in addition to the centrality of the taberna to the urban economy of Roman cities like Pompeii, Ostia, and Corinth. Colour contrasts and gloomy magnificence creating the impression of grandeur were characteristic to Old Roma. Roman commercial architecture had strong colour contrasts: for the tectonic elements light colours were used, for the wall area – dark colours or vice versa. Multicolourness of decorative themes, imitation of expensive materials, and optical illusion for architectural elements using a perspective way of the presentation as well as special pigments (the Pompeian red, blue-green and black) were often used to enrich a strong decorative effect of ornamentation of public terms and forums used for food and pleasure.

The medieval buildings were built with stable and covered materials, persistent colours, constituting dominant urban complex. Their interior space devoted to food was literally enlightened and illuminated by the bright polychromy of the stained glasses. The rays of the sun penetrating through the multicoloured stained glasses gave the entire construction a fantastic image. The combination of dark gray and sharp green contrasted with the drawings and achromatic graphics of the houses "with wood sides".

Food catering establishments which may be described as restaurants were known since the 11th century in Kaifeng, China's northern capital. Growing out of the tea houses and taverns that catered to travelers, the restaurants blossomed into an industry catering to locals as well as people from other regions of China, Korea and Japan.

The architecture of the time of the Renaissance reveals in 16th century the ornaments, the decorations in molding, the "graffito" and the frescos by starting again the ornamentation in relief. The relief and the low-relief are painted in sharp and bright colours at that time. The colour in architecture space devoted to food appears powerful and spontaneous, giving a theatrical presentation and gorgeous effectiveness to the environment.

The curved and oblique lines, spectacular torsions, the overloads of colours and chromatic contrasts of the Baroque architecture are there to break with the preceding styles. Baroque expressing on the outside had an important contrast between the polychrome frescos of the walls and the rhythm of the arcades creates an urban environment where several thousands of people could contemplate the spectacles and the food festivals which occurred there: tournaments, bullfights, proclamations of kings, royal marriages, executions, etc.

At the end of 17th and 18th centuries the mode of decoration for architectonic elements using "azulejos" (the term "azulejo" derived from the word Spanish "azul" which means "blue"), was spread in Europe and especially in the Spanish and Portuguese restaurant's decoration.

Than in reaction to the rationalism of the classicism with domination of the clear colors, the whitish and grayish background, dominated and succeeding the Baroque style, a new decorative system was appearing. It was the Rococo style with the palette colours included the soft and dull tone pastels, with dominant nuances of pink, grayish, olive, blue sky, beige.

The architectural principles of the Art nouveau combine the personal style of expression where the sinuosity of the drawings harmonized well with the mosaic of the surfaces of contrasted colors. This single synthesis of practical considerations and of an aesthetic nature is characterized by colours from a great richness.

At the time of industrialization, the artists and the architects of the Dutch group "De Stijl" proclaimed a new polychrome design "neo-plastician" who applies sharp and pure colors in their achievements. They intend to propose a theory of the relationship between architecture and painting, like "a place of modern painting in architecture". Théo van Doesburg defined the chromatic surfaces coloured as fundamental elements where the straight lines, the rectangular forms, the principal colors (yellow, red, blue, black and the white) are used to make a unified composition. Le Corbusier, one of the principal actors of the rationalist modern movement, decided to "architecturate" the space devoted to food. His slogan is "Order. Reason. Purity. Truth. Structure. Bleaching", but he also organized and classified the color in the scale of polychromy to create the architectural esthetics.

In Europe in the years 50s and 60s rationalism of the colour design of a restaurant was adapted to its function and construction was based on a certain correlation of the nuances and chromatic tonalities, where the achromatic colors however remained dominant. The "Op" and "Pop" art produces on the spectator a physiological and psychological optical effect. These "Op art" projects were conceived to be integrated into the architecture of the new public pace. The "engineers of plasticity" and the "technicians of visual" as Victor Vasarely, Yvaral and others considered the colour design of as an essential feature of the happiness in the modern city life.

The architectural creativity of Hundertwasser remains before all that of a painter and a graphic designer fighting against the austerity and the monotony of the industrial contemporary architecture. He wants his buildings devoted to food to have "something small" which gives them a structural and polychrome individuality: "ecological" approach, mixture of the techniques, different shapes of the windows, etc.

The tendency in the choice of the colours of neo-rationalism and the neoclassicism in architecture is related to the manner of working on the concrete to give it the effects of matter; it is a tendency of the eighties. The architects have created their own chromatic image and a strong architectural unit which they deployed in several great urban projects.

The changes in European architecture will come from the influence and the popularity growing of the group of New York architects "White and Gray", as well as others. The name of this group will symbolize the abandon of the saturated colors and the use of a pallet with white and grayish. In the architectural projects of this time, the expression of the forms dominates the color composition. The use of a palette of grayed white and metallic and "futuristic" grays dominates the eighties. This design which will be dominating during the eighties will be dominating in the nineties too. The achievements and constructions of this time have had the expressiveness and the dominated voluminous forms.

Today, at this beginning of 21st century, a style close to the minimalism and functionalism as well as the polychromatic restaurant design of interior and outside architecture has a very big importance and it is regarded as one of the centers of interest of the contemporary design. Its elegance, its simplicity and its purity are often considered as references of dynamic in the world of architecture and design.

The international polychrome design is animated by an idea force: "the beauty is also functional and sustainable". From the nineties, we can notice an interest for the environmental quality which gives a particular value to the contributions of the professional designers working on the products for human consumption and the objects daily. Green architecture, organic forms and irregular surfaces are presented in the restaurant polychromatic design using the landscape elements, the polychromy of furniture, and color of the artificial lights for the night life. The aim of colour design of commercial architecture devoted to food is to create a polychromatic environment which corresponds well to natural geographical specificities, with the space characteristics, with the social aspects and cultural roots, but also with the semantic significance of the color historical symbols.

The harmony of colours in the art and design of restaurant architecture is a true colour 3D conception, with its nuances and details, with specific colour combinations, constantly changing in space and time. Our system is built on the balancing of the rational harmony of the real world and the emotional transcription of the "reflected" imaginative world. We can distinguish 4 colour fundamental groups: "Colour", "Value", "Nuance", "Mixed" and 24 complementary intermediate colour groups. They are the colour combinations inside which the different components lose their own characteristics to the profit of a global perception. The colour combinations can be completely transformed by their surroundings, but they can transform as well the environmental design of commercial architecture devoted to food and create psychologically favorable or not favorable atmosphere.

We study the colour harmonies of different food restaurants such as French, Chinese, American, Indian and Japanese etc. foods and its classifications with the Natural Colour System (NCS) through history of art and colour design in different epochs and geographical spaces: brasseries, cafeterias, bars and restaurants, any kind of commercial architecture devoted to consummation, gastronomy and commercializing food products. An environmental approach of colour design in order to create a specific and comfortable background is considered as indispensable for colour conception of exterior and interior design of food commerce buildings.

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Role of color edible films against photo-oxidation of salmon oil: Physico-chemical characterization of films

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ABSTRACT

Edible films of hydroxypropyl methyl cellulose (HPMC) with different colors were tested for their ability to filter light causing oxidation in salmon oil. Fat oxidation was monitored by gas chromatography. The results showed that films with red color have good control of photo-oxidation as compared to the films with blue color. In the second phase, the mechanical (tensile strength, ultimate elongation, Young's modulus) and barrier properties (oxygen and water permeability) of the films with natural red color (NRC) (a blend of Beet Juice and Purple Carrot Extract) were determined to understand the impact of the composition of the film and the nature of the color molecules.

1. INTRODUCTION

Environmental pollution and foods safety have been at the forefront of research concerns in recent years. Research has focused on edible films and active agents into edible film. In terms of active agents, plant extracts have recently received much attention and have a tendency of replacing synthetic agents (Frank et al. 2005).

Recently, several in vitro studies on the antioxidant and antiradical activity of betalains (mainly betanin) from red beet extract (*Beta vulgaris* L.) have been published (Kanner et al. 2002). Anthocyanins play a role in industry as replacer of synthetic food colorants and have health benefits, including reduced risk of cardiovascular disease (Bell and Gochenaur 2006) and decreased risk of cancer (Dai et al. 2007).

As opposed to mixing these compounds directly with food, their incorporation into edible films would localize functional effect at the food surface. Cellulose-based materials are widely used because of their advantages like biocompatibility, edibility, barrier properties, being non-toxic, non-polluting and having low cost (Vasconez et al. 2009). Use of HPMC is attractive because, it is a readily available non-ionic edible plant derivative shown to form transparent, odorless, tasteless, oil-resistant, and water-soluble (Villalobos et al. 2005).

The scientific objective of this study was to select the suitable color incorporated film to filter the light causing oxidation in fat rich products and to understand the impact of the composition of the film and the nature of the color molecules. Another objective was to improve the properties of film by incorporating active molecules and to optimize the storage of oil by incorporating both the color phenomena and composition of the film.

2. MATERIALS AND METHODS

HPMC, containing ~8.8% hydroxylpropoxyl and ~28.18% methyl contents, having viscosity ~15mPas (2% in H_2O. 25 °C) was supplied by Fluka-Biochemika, Japan. Ethanol 96.2% (Pharmaceutics CARLO Erba) was used to improve hydration of HPMC. Colors like blue patent V (E131) and red aqua color (RAC), (pH at 20 °C: 9) were purchased from "Viskase"

(France). Red natural color, a blend of Beet Juice (E162) and Purple Carrot Extract (E163) was obtained from ColorMaker, California, USA.

2.1. Film preparation: Solution was prepared by dissolving 6g of HPMC in 65 ml of distilled water, 35 ml of ethanol and 0.5% color. The film solution was mixed for 40 minutes at 65 °C with a heating magnetic Stirrer (Fisher Bio-block scientific). After mixing, solution was degassed at 50-60 °C by vacuum pump. Films were made by taking 6 g solution in the lids of the Petri-dishes and dried at 20 °C and 50% relative humidity for 24 hours.

2.2. Film thickness and color measurement: Thickness was determined using the standard NF Q 03-016 with a manual micrometer (Messmer, London, England) equipped with a head measuring 5mm in diameter a sensitivity of 2 µm. The color of film was determined by a spectrophotometer Data color International D65/10 (micro-flash® 200d. USA), in space CIELAB (L* a* b*) where (L*) represents the lightness from white to black, (a*) color index from green to blue and (b*) yellow to red.

2.3. Oxygen consumption: Oxygen content was analyzed by Gas Chromatograph equipped with a Thermal Conductivity Detector (TCD) and a fused column 2m × 1/8" molecular sieve 5A (Tnierchim, France). The temperature of column was 50 °C and that of both injector and detector were 120 °C.

2.4. Tensile properties: The mechanical properties of films were evaluated using Lloyd instrument (Hants, United Kingdom) according to ASTM D 882-2002 on 6 samples of each film preconditioned in environmental chamber at 22 ± 2 °C and 50 ± 5% RH for about 48 h. The tests were performed on 60 × 15mm film strips using a force sensor of 5 KN and constant speed of 20 mm/min.

2.5. Oxygen permeability: Film was sealed in a permeation cell containing silica gel. The glass permeation cells with an exposed area of 26.42 cm^2 were placed in a controlled temperature (37 ± 2 °C) and RH (≈100%) chamber. The water vapor transport was determined from the weight gain of the cell. WVP of the films was calculated as follows (Khwaldia et al. 2004).

$$WVP = \Delta M\ A / \Delta p \times 3600 \times X\ (g\ m^{-1}\ s^{-1}\ Pa^{-1}) \quad (1)$$

where ΔM is the change in weight of the cup over time (dm/dt), A is the area of exposed film. Δp is the vapor pressure differential across the film and X is the film thickness.

3. RESULTS

Salmon oil samples were taken in the petri-dishes covered with lids having HPMC film (thickness 40 ± 5 µm) of different colors. Each petri-dish was also covered from the sides with black scotch to avoid from oxygen and light, and was placed under the fluorescent light for eight days. Analyses to study the light-oxidation were done on 2^{nd}, 4^{th} and 8^{th} day at 20 °C.

Table 1. Values of total change in color (ΔE) of films during 21 days of light exposure measure by the equation: $\boldsymbol{\Delta E_{21}} = \sqrt{(\Delta \boldsymbol{L})^2_{0-21}} + (\Delta \boldsymbol{a})^2_{0-21} + (\Delta \boldsymbol{b})^2_{0-21}$.

Film composition	ΔL*	Δa*	Δb*	ΔE
Film transparent	11.21	0.15	-0.18	11.2
0.5 % RAC	0.08	0.05	0.49	0.49
1 % NRC	-0.27	0.55	0.84	1.04
2 % NRC	-0.98	1.61	-0.17	1.89
3 % NRC	-1.07	1.92	0.25	2.21
4 % NRC	-0.85	1.11	-0.6	1.52

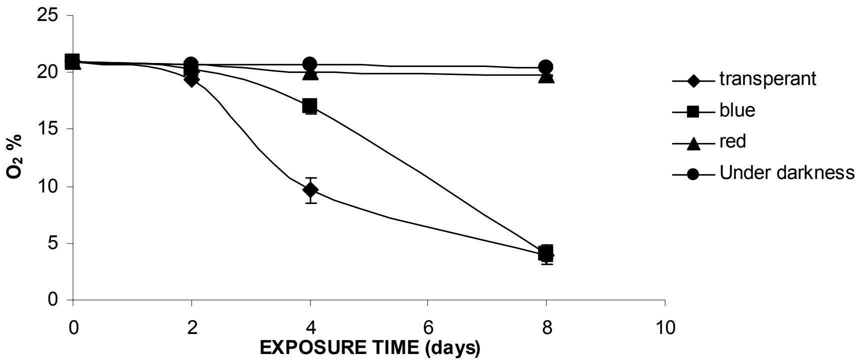
Table 2. Thickness, barrier and mechanical properties of HPMC, flavonoide and color composite films (mean of triplicate analysis).

Film composition	Thickness X (µm)	Oxygen permeability (m^3. m. m^{-2}. s^{-1}. Bar^{-1})	Tensile strength TS (MPa)	Ultimate elongation UE (mm)	Young's modulus Y (MPa)
Film transparent	47.6± 3.7	2.57±0.38	64.50±5.98	4.30±1.03	2492±52
0.5% RAC	40.0±5.0	0.57±0.09	59.24±5.56	2.91±0.57	2471±395
1 % NRC	46.3±5.5	0.74±0.15	55.33±1.12	5.27±0.76	2217±380
2 % NRC	58.1±3.4	0.73±0.23	37.77±3.21	5 .00±1.07	1429±172
3 % NRC	57.5±2.5	0.16±0.08	39.60±2.79	5.26±1.20	1720±158
4 % NRC	51.7±5.1	0.11±0.09	41.90±9.57	7.70±1.66	1106±141

4. DISCUSSION

Previous studies have shown that the light intensity has a considerable influence on light-induced oxidation in food products (Borle et al. 2001). All salmon oil samples showed different pattern of lipid oxidation with HPMC films of different colors over the 8 days of storage. During this period, salmon oil stored in transparent and blue films exhibited a higher degree of lipid oxidation respectively than in the other films (Figure 1). It is obvious that in the transparent and blue packaging the affect of light was more pronounced than in other films. The higher degree of lipid oxidation recorded for the blue film as compared to red film may be attributed to its complimentary color (orange) and the color of the salmon oil (orange) (Chandrasekaran 2001). Results showed that red color has a very good control of photo oxidation.

Figure 1. Effect of light exposure time on the loss of oxygen percentage in salmon oil covered with HPMC films of different colors.



The results given in Table 1 show no significant change in film color from 0 to 21 days of light exposure. In contrast, the value of ΔE is very high for transparent film which means that its transparency has been changed. Results showed that the color of films containing 0.5% red aqua color (RAC) was more stable than that containing NRC. Conversion of CIE L * a * b * to CIE Yxy is required for better understanding of color change using chromaticity diagram. The capacity of HPMC films for preserving the integrity of food stuff was evaluated by measuring the tensile strength (TS), Young's modulus (Y) and ultimate elongation at break. As expected the concentration of color and flavonoids had shown influence on the tensile strength (Table 2). The addition of RAC has decreased TS, ultimate elongation at break and Young's modulus (Y). An increase in ultimate elongation at break and decrease in both, TS and Young's modulus (Y) was shown by the incorporation of NRC. Flavonoides incorporated films appear to have lower oxygen permeabilities than films containing 0.5% red aqua color

(Table 2). The observed behavior could be related to the structural modification of HPMC network. Hydrophilic compounds resulted in less dense film matrix, facilitating movements of polymer chains under stress, hence declining the film resistance.

5. CONCLUSION

Use of HPMC films with suitable colors can control the photo-oxidation of salmon oil. The blue films have very poor performance and provide levels of oxidation of oil similar to those obtained with a transparent film. The red films can get control of the photo-oxidation equivalent to storage under darkness. Controlling pH of film forming solution may enhance the color stability. The use of natural colors has ability to decrease oxygen permeability of films.

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Whiteness, yellowness and browning in food colorimetry – a critical review

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ABSTRACT

In a review of over 200 articles published in over 30 journals dedicated to food science and technology we have found ample references to the application of whiteness, yellowness and browning formulae, most of them related to the description of the change in some kind of technological or process parameter, rather than the perceptual change of the white, yellowish or brownish colour of the product. We have compared these formulae and analysed their application in the most varied fields related to food colorimetry. Whiteness is an important characteristic of many food products from milk and rice to surimi and pasta. In many cases whiteness is desirable, in others it is not. Deviation from whiteness may be perceived as yellowness or browning, and there are hundreds of articles (and some pages in a few textbooks) describing this phenomenon using whiteness, browning and –less frequently– yellowness indices. In many cases, however, the authors use inadequate parameters or other than the best formula for the characterisation of processes, or of colour changes due to processing or storage of food.

1. WHITENESS INDICES

In the food industry the most frequently used whiteness indices are L* (often erroneously called "whiteness" instead of "lightness") and $WI_{JUDD} = 100 - [(100 - L^*)^2 + (a^*)^2 + (b^*)^2]^{1/2}$ (or the equivalents with Hunter coordinates), first suggested by Judd and Wyszecki (1963). In many publications the $WI_{HUNTER} = L^* - 3b^*$ formula (originally proposed by Hunter, 1960, for Hunter L, a, b coordinates) is used, but we found reference only in two cases to WI_{CIE}, the current CIE whiteness formula (CIE 2004). The reason for neglecting the only internationally recognised formula lies in the fact that natural or processed food products are very rarely white enough to fall within the limits of its validity.

2. YELLOWNESS INDICES

The Hunter b or CIELAB b* coordinate is quite often used for the characterisation of yellowness. Yellowness indices are unduly neglected in the publications reviewed, they report only in a few cases the application of the YI_{E313} according to ASTM (2005) or the $YI_{FC} = 142{,}86\ b^*/L^*$ formula often referenced to Francis and Clydesdale (1975).

3. BROWNING INDICES

Browning index in the literature may mean one of two things: a simple indicator of a chemical change (often characterised by the optical density at a given wavelength or the ratio of the reflectance at 570 nm and 650 nm); or the colour change due to oxidation of a freshly cut fruit or vegetable surface, during storage or drying, or the baking of bread. The simplest (and in this case probably least adequate) indicator of the colour change is the L* coordinate (or 100-L* or 100/L*), excitation purity is often used following the suggestion of Buera et al. (1985): BR_{BUERA} = 100 (x_c-0.31) / 0.172 (for C / 2°). For illuminant D65 this takes the form BI_{BUERA} = 100 (x_{D65}-0.32) / 0.162 (Bhattacharya 1985).

4. CASE STUDIES

Illustrating some of the concepts of using whiteness, yellowness and browning indices we have taken colorimetric data from the literature. Where not enough details were given in the published paper the authors have kindly provided them in private communications.

4.1 Sensory characteristics of yoghurt

Vargas et al. (2008) used the WI_{JUDD} formula (D65 / 10°) to characterise the whiteness of yogurts prepared from mixtures of fresh raw caprine and fresh raw bovine milk.

L* and the WI_{JUDD} are very similar in behaviour, they are very little sensitive to the change in milk composition. In this case WI_{HUNTER} or WI_{CIE} shows higher sensitivity, but the colour of the milk mixtures (except for pure goats' milk) is too yellowish, thus WI_{CIE} is not supposed be applied.

The most adequate index would be either YI_{E313} or YI_{FC} (which are in this case strongly correlated, R^2 = 0.9983) or even b*, which in this case behaves very similarly to the two yellowness indices.

4.2 Whiteness of surimi gels

Xiong et al. (2009) investigated the effect of different levels of KGM on the whiteness (WI_{JUDD} – C / 2°) of grass carp surimi gels. As there is very little change in a* and b* (and very low chroma for all samples) the L* and WI_{JUDD} values are very close. Other whiteness indices, however, show a somewhat different tendency. It must be emphasized that the differences between different concentration levels of KGM are very small, at the border of perceptible differences.

4.3 Yellowness of the mashed potatoes

Fernandez et al. (2008) measured the effect of biopolymer concentration and freezing and thawing processes on the colour parameters of fresh and frozen/thawed mashed potatoes and calculated the YI_{CF} (D65 – 10°). For their sample sets the correlation between YC_{FC} and YI_{E313} was R^2 = 0.87, while that between the CIELAB coordinate b* and YI_{E313} was as high as R^2 = 0.97. These correlations are very highly dependent on the sample set in question.

4.4 Drying of onion slices

Arslan and Özcan (2010) studied the effect of sun, oven and microwave drying on quality of onion slices. They measured CIELAB (C / 2^{o}) coordinates, and discussed the colour change in terms of the individual coordinates. If we use one of the well known yellowness or browning indices, interesting further conclusions may be drawn from these data: they rank the colour effect of different drying methods differently than the L* or b* coordinates individually.

There is very high (over 0.99) correlation between the yellowness and browning indices, but very low between them and b*. This goes to show that b* cannot always be used as a yellowness index, depending on the sample set it may or may not correlate well with yellowness/brownness.

4.5 Colour improvement in surimi

Taskaya et al. (2010) investigated the colour improvement by titanium dioxide of proteins recovered from whole fish, and arrived at the conclusion (based on WI_{JUDD} values), that that whiteness of restructured fish products based on proteins recovered from whole fish via isoelectric solubilization/precipitation can be similar to the whiteness of surimi seafood. However, if we look at the WI_{HUNTER}, YI_{FC} or YI_{E313} values we can see that surimi is in fact much whiter than recovered proteins.

4.6 Cheese colour

Sheehan et al. (2009) studied the effect of partial or total substitution of bovine for caprine milk on the colour of semi-hard cheeses. Their data (C / 2^{o}) show that only the b* coordinate changes significantly, there are only very small changes in L* and a*. For such a sample set the YI_{FC} and YI_{E313} are very strongly correlated as are the BR_{BUERA} and b* values.

4.7 Colour evaluation of pasta samples

Švec et al. (2008) evaluated the colour of different pasta samples made of three types of flour: bright M1 as well as semi-bright M2 were milled from common wheat, while M3 from durum wheat. The number of eggs used in the pasta had greater influence on the yellowness for M1 (bright), less for M2 and M3. Adding 2 eggs reverses the yellowness of M1 and M2 pastas as measured by both YI_{E313} and YI_{FC}, but not by b*.

4.8 Colour of fried, battered squid rings

Baixauli et al. (2002) investigated the effect of the addition of corn flour and colorants on the colour of fried, battered squid rings. Increasing the amount of corn flour seems to increase the yellowness indices YI_{FC} and YI_{E313}, primarily due to the increase in the a* coordinate.

The increase in colorant concentration (tartrazine and riboflavin) seems to increase the yellowness indices, but plotting the same data on a CIELAB a*-b* diagram shows a lack of clear tendency in the colour development due to increased colorant concentration.

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Application of non-contact digital imaging for "measuring the un-measurable"

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ABSTRACT

The visual stimulus of food - its colour and visual appearance is considered a predominant influence enticing the consumer to purchase and to maintain loyalty to a brand. Consumer perception of product colour creates a direct correlation between the colour and appearance and the quality and desirability of that product in terms of taste, nutritional value, freshness and safety. The quality control challenge confronting food producers is to ensure the consumer's visual expectations are met and continually maintained in an increasingly competitive and intricate industry with a geographically disparate supply chain. Controlling product colour by visual assessment is difficult and subjective, as the majority of foodstuffs are not simple homogeneously coloured items but are irregularly shaped, multi-coloured and often viscous or semi-viscous liquids. Traditional colour measurement instruments such as colorimeters and spectrophotometers give a satisfactory measurement and good correlation to the visual assessment when the product is a smooth surfaced, uniform, solid structure. However for heterogeneous items, as are the vast majority of food products, the restrictions and limitations of these types of instruments accentuate the need for a method of measuring colour unrestricted by product shape, colour or form.

1. PERCEIVED CONSUMER EXPECTATIONS

Of the various sensory inputs influencing the consumers purchasing decision, sight is undoubtedly one of the main factors across many retail sectors. Within the food sector the visual attributes of food, its colour and overall appearance, are widely acknowledged as one of the most important factors. For a wide range of products, especially fresh produce, colour is one of the key factors which determine if the consumer will buy that product.

Product colour can have very subtle influences on consumer choice. For example, the perceived ideal crust colour of bread may vary from country to country and between different regions within one country. Manufacturers need to be aware of these preferences and adjust their baking processes accordingly to meet these needs. This requires not only effective process control but clear and well defined standards for Quality Control purposes. In this instance high quality digital images and hard copies are ideal. For green vegetables, colour intensity and the retention of the *'greenness'* is essential for conveying *'just picked freshness'*. Monitoring of colour deterioration after harvesting and during storage is essential for the retailer to know how their products will perform during their journey from harvest to store.

Unlike the visual considerations engaged when selecting, for example, an item of clothing, our sense of sight, when selecting products such as meat, fish, bread, cakes, fruit and vegetables all introduce innate, possibly primordial, instincts. Subliminal questions are asked and answered regarding product's colour and overall visual appearance - Is it safe to eat? Will it harm me? Will it be healthy? Will it give my family the nutritional value they need? Colour also determines expectations of flavour - Will it taste sweet or sour? Will it be juicy? Will the texture be hard or soft? Colour is the criteria engaged to satisfy the consumer's current and future needs - Is it mature, ripe and ready for eating now or will it keep until the weekend?

The answers, learned through experience and probable parental advice, have created in the eyes of the consumer, a direct correlation between the product colour and appearance and the product's quality, maturity and the perception of it being 'fit for purpose'. This consumer perception undoubtedly has a significant impact on how food produce and ingredients are quality controlled for colour throughout the supply chain.

2. CONTROLLING THE COLOUR OF FOOD PRODUCTS

The issue for controlling the colour quality of food is the variability of natural products. A product cannot be made to an exact colour tolerance and in some cases this would not be desirable. However, products can be monitored to ensure they fall within an acceptable colour tolerance and investigations can be made regarding why and how the colour can vary from harvest to harvest or from batch to batch. The method of controlling the colour of food products remains a continuing quality control challenge for manufacturers, even more so as the supply chain becomes progressively more complex and globally diverse. It has never been more important to control colour from source to store, from farm to table.

Historically, the prevailing method of controlling the colour and visual characteristics of food and ingredients was by the use of sensory assessors, initially with no control of the ambient light and with inconsistent viewing conditions. The introduction of standardised viewing environments with consistent and reliable illuminant, together with an increased level of colour training and education produced significant advancements in the objectivity of the assessment of colour. In practice however, and notwithstanding the experience or dedication of the assessors or the effectiveness of their training, a degree of subjectivity will always remain. It is this subjectivity that can prove incredibly costly to manufacturers if the retailer and ultimately the consumer deem the product colour to be unacceptable.

Instrumental colour measurement tools, such as spectrophotometers and colorimeters, can measure the reflectance or transmission of a sample product. These instruments have, to date, seen a reasonable uptake in the food manufacturing environment as a first step towards improved accuracy and objectivity in colour quality control. However, these instruments have significant limitations in application, due to the extremely wide range of food produce and general diversity in terms of irregular shape and appearance. Product is often destroyed or modified in some way in order to take a measurement often making the results very tenuous in respect of the observed colour or appearance as seen in store. By using a non-contact measurement the product can usually be measured in the form in which it will be purchase in store by the consumer.

While traditional measurement instruments can provide objective *'pass/fail'* results they can be limited in application as they intrinsically measure only an *'average'* colour, assessing only the limited, and possibly unrepresentative, area exposed to the aperture of the instrument. Crucially the measurement of this isolated and unrepresentative area may not correlate with how the human eye sees the colour and overall appearance of product due to the influence of, for example, simultaneous contrast. Colour measurement of small, isolated and unrepresentative areas of food product is proving to be increasingly inadequate to enable food manufacturers to meet the retailer specifications for quantifiable and reliable colour data.

3. NON-CONTACT DIGITAL COLOUR MEASUREMENT

Non-contact digital imaging technology, designed specifically to address such challenges, is now gaining increasing acceptance by food manufacturers and brand owners. Unique digital imaging based systems using tightly controlled illumination in a totally enclosed cabinet, such as the DigiEye system developed jointly with the Universities of Derby and Leeds and Lighting specialist, VeriVide, are already being used by many international blue chip companies and food research organisations in a wide array of food sectors around the world. The system generates colour accurate images from which colour data can be extracted to allow the consistent control of product colour and appearance.

The design enables non-destructive sample measurement, removing the need for time-consuming sample preparation through detrimental product dissemination such as grinding or sieving. This method of measurement also maintains the integrity of the product sample, avoids potentially prejudicial destruction and allows the product to be assessed as the consumer would view it.

The system has a characterised digital SLR camera, which allows data extraction from any pixel. Product samples are captured within a totally controlled lighting environment which eliminates all ambient light and may be configured to include or eliminate any surface texture or gloss. Diffuse illumination removes the specular reflections of products with glossy, wet or curved surfaces, thereby enabling reliable colour measurement of product such as fruit, soup and yoghurts, meat & poultry and vegetables. Conversely the angled illumination allows the appearance of product with uneven surface structures and texture, such as biscuits and bakery products, to be clearly displayed, measured and evaluated. A calibrated monitor and printer can also provide highly accurate on-screen representation of the product and printed colour accurate authentic representations of the product can be used as master product standards.

The key advantage for image based systems is that it allows colour attributes to be measured in context. Image processing techniques allow specific pixels of interest to be selected and CIELAB data calculated; a process not possible with traditional measurement instruments. As the product can be presented for measurement ‘as seen’ by the consumer, attributes other than colour may also be assessed, such as the distribution of a particular ingredient within the product matrix or the amount or coverage area of one component over another. Crucially not only does imaging provide an ‘in context’ colour measurement it also provides a visual record of the product at the time of measurement.

4. MOVING BOUNDARIES

The boundary which previously determined the limited range of foods for which accurate colour measurements could be obtained is radically moved through the use of non-contact digital colour imaging systems.

Food products which are non-uniform in shape, size or colour can now be consistently controlled and consumer expectations attained. Accurate and reliable colour measurement of for example, dried fruits such as cranberries, is difficult as they are too small to be measured as individual single fruits using a spectrophotometer and too uneven and variable to provide repeatable measurements if measured in quantity. Using digital imaging the same product can be accurately and repeatedly measured either individually within a batch or as a batch. The ‘dark spaces’ between berries can be discounted from the measurement. Automated measurement methods also allow the sample preparation time to be considerably reduced.

Limitations of spectrophotometers and colorimeters are highlighted in attempts to obtain accurate and reliable colour measurement of food products such as a multi-component vegetable soup. However using image sorting functions the different ingredients of the soup can be measured in-situ, negating the requirement to firstly strain out the individual elements. Work carried out by van Dalen, Osman and Don (2010) has already proven that digital imaging methods perform better than conventional instruments for this particular product.

Meat products, which are translucent to some degree, also create a challenge for spectrophotometers and colorimeters. For measurement of bacon, which is a very translucent product, results from a spectrophotometer are affected by slice thickness and the background upon which the bacon is placed. By using the appropriate lighting conditions and backgrounds, repeatable and consistent colour measurements are possible using imaging techniques that measure the surface flesh colour, without distortions of background colour.

For viscous liquids such as cooking sauces or mayonnaise, producing the flat measurement surface required for a spectrophotometer is difficult, probably impossible. Non-contact image processing techniques alleviate this issue providing reliable, repeatable colour measurements.

Digital imaging solutions open up a whole range of new measurement possibilities for product quality control, process and shelf life evaluation and product development. Digital images do not decay with time and produce an accurate record of both the colour and appearance of a foodstuff or ingredient. This wealth of extra data can greatly assist in moving forward product quality and meeting the exacting expectations of the consumer.

5. GLOBAL COMMUNICATION OF IMAGE AND COLORIMETRIC DATA

Digital images are also portable. The ability to communicate images and data electronically facilitates quick and dependable visual product comparisons and opportunities for instant decision making, with the associated opportunities of increased consistency and reliability of food product and ingredients. This, for example, has proved invaluable for research of product shelf life and the colour stability of those food products which are sensitive to rapid deterioration.

The DigiEye system has diverse applications for accurate, efficient automatic colour measurement from raw material to end product. Typical applications include the creation of highly accurate colour photographic standards and specification sheets, post harvest shelf life colour stability analysis, visual inspection and instrumental measurement for quality control and quantifiable and unambiguous tolerance management.

Digital Imaging systems offer significant and tangible benefits in terms of quality control and brand value over traditional instrumentation techniques, due to their wide scope, accuracy, repeatability and flexibility. This capability results in real cost, time and substantial production efficiencies not previously realized by either R&D or commercial enterprises in the food sector.

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Matching target colours in a food system using the Allen colorimetric algorithm

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ABSTRACT

A computer colour matching technique was used to calculate the concentrations of primary food dyes in microwave cake samples needed to match standard ceramic tile colours. This research is a first step in developing novel, multi-coloured, customised foods which can be produced rapidly at point-of-sale. Absorption to scatter (K/S) spectra were determined for the tile targets and blank cake substrate, and unit K/S spectra determined for each dye in the substrate. The concentrations of dyes needed to match the targets were computed by the Allen colorimetric algorithm. To prepare the cake samples computed concentrations were adjusted to range between zero and legal maximum. The results indicate that the ability to match tile colours with cake colours is influenced by the target colour, the combination of dyes used, material differences between the target and matching systems, and the inclusion of tile gloss in the target.

1. INTRODUCTION

Personalised foods is a developing consumer trend which aims to provide customisable health or sensory outcomes for individual consumers or groups. An additional, but currently less explored, manifestation of personalised foods is the concept of being able to customise the visual appearance of any prepared food. An example of this currently under development is the capability to produce multi-coloured, customised foods which can be produced rapidly at point-of-sale. It is envisaged that the consumer would be able to provide a design or image of their choosing which could then be rendered as an identical colour replicate within a food substrate, and through the use of only three or four primary colorants. To achieve effective image transposition in this way will therefore necessitate rapid and accurate colour matching capability.

In the food industry, colour needs are usually met by expert formulators who can produce colour blends using visual matching, using colorants appropriate to the food substrate (Francis 1999). By contrast, computer colour matching techniques used in the paint, ceramic, textile and plastics industries can provide quick solutions to calculating the amounts of dye needed to match colours, and are based on instrumental rather than visual matching.

The aim of this work was to match glazed ceramic tile colour standards with three primary food dyes added to a model food, using computer colour matching techniques. This was a first step towards developing rapid colour matching capability for the new food application. The specific technique applied was colorimetric matching, which can be used when the colorants in the target are unknown. The technique aims to match the X, Y and Z colour coordinates of a target by adjusting the X, Y and Z coordinates of three dyes in a substrate. The concentrations of dyes needed to match the target are computed by the Allen algorithm (Berns 2000). Colour matching requires the absorption to scatter (K/S) spectra of the target, substrate and dyes. These are used to calculate X, Y and Z. For each dye, the K/S spectra of the substrate containing dye at different concentrations are used to derive unit K/S spectra, which is a constant that explains the relationship between concentration and colour.

2. EXPERIMENTAL

The reflectance (360 to 740 nm) of twelve CERAM Series II glazed tile colour standards (CERAM, Staffordshire, UK), a microwave-cooked cake, and cake samples containing synthetic food dyes, was measured under illuminant D65. The specular component was included for the tiles, and excluded for the cake samples. Absorption to scatter (K/S) spectra were determined from reflectance. For the tiles, K/S spectra were calculated from total reflectance, or from internal reflectance using the Saunderson correction. Unit K/S spectra for blue ('Blue'), red ('Red 1' and 'Red 2') and yellow ('Yellow 1' and 'Yellow 2') food dyes were derived from the K/S spectra of cake samples containing dye at different concentrations. These concentrations were within the legal limit for New Zealand and Australia.

The concentrations of Blue, Red 1 and Yellow 1 dyes needed to match each tile colour were computed by the Allen colorimetric algorithm, using Microsoft Excel. Computed concentrations were used to predict L*a*b* colour coordinates (ASTM 2008) for the cake samples. Predictions were made for ΔE^*_{ab}, the difference between tile and cake L*a*b*. To prepare the cake samples some concentrations needed to be adjusted to range between zero and legal maximum. Measured L*a*b* of the cakes were used to calculate the actual ΔE^*_{ab} between tile and cake. To improve matching for some colours, concentrations were computed for new dye combinations in which an alternative dye was substituted for the original dye of the same colour. Cake samples were prepared using selected dye combinations, and new ΔE^*_{ab} calculated for the difference between tile and cake. Hue angles of tiles and of cake samples were also calculated as an additional measure of the degree of matching.

3. RESULTS AND DISCUSSION

The wavelength of maximum unit K/S (λ_{max}) for the blue, red and yellow food dyes are shown in Table 1.

Table 1. Wavelength of maximum unit K/S, λ_{max}, for food dyes in microwave cake.

Dye	λ_{max} (nm)
Blue	630
Red 1	510
Red 2	520
Yellow 1	430
Yellow 2	490

For colour matching, the concentrations of Blue, Red 1 and Yellow 1 dyes computed by the Allen algorithm that were needed to match some of the tile colours were negative, or the totals for the three dyes exceeded allowable levels. This may have been due to the material differences between tile and cake, such as differences in substrate colour. The range of predictions for ΔE^*_{ab}, the colour difference between tile and cake, and ranges for actual ΔE^*_{ab}, after adjustment of dye concentrations to between zero and permitted maximum, are shown in Table 2.

Table 2. Ranges for the predicted and actual colour difference between tile targets and the cake samples prepared to match the tiles. The target colours are also given. Dye concentrations were computed based on total reflectance ('SCI') or internal reflectance ('internal') of the tiles as the targets.

	ΔE^*_{ab} for the difference between tile and predicted cake L*a*b* using original computed concentrations		Actual ΔE^*_{ab} between tile and cake samples prepared using adjusted concentrations	
	SCI	internal	SCI	internal
lowest	1.6 Grey	1.1 Grey	1.4 Grey	3.6 Grey
highest	7.9 Red	12.0 Yellow	19.3 Cyan	25.3 Cyan

Using the original computed concentrations, ΔE^*_{ab} values were less than 3 for around half the number of target colours, indicating the potential suitability of the colorimetric method. A ΔE^*_{ab} of 3 is considered the limit for an acceptable match (Francis and Clydesdale 1975). When the target was total reflectance (SCI), all except one colour had a ΔE^*_{ab} value less than 5. Although internal reflectance would normally be used in colour matching, the result suggests total reflectance of the tiles was a more useful target for matching with cake colours. The effect of adjusting computed concentrations was to increase ΔE^*_{ab} from the predictions. Actual ΔE^*_{ab} values were lower for most colours when the target was total reflectance.

The colour differences between tile and cake when using alternative dyes to improve matching for some colours are shown in Table 3. These colours had actual ΔE^*_{ab} values of more than 5 using the original dyes, when total reflectance was the target. At a minimum, substitution of Red 2 dye for Red 1, and of Yellow 2 for Yellow 1, lowered ΔE^*_{ab}, or reduced the hue angle difference between tile and cake.

Table 3. The change in ΔE^*_{ab} colour difference, and in hue angle difference, between tile and cake when alternative dyes were substituted to improve matching.

Colour	Dye substitution	Change in ΔE^*_{ab} for the difference between tile and actual cake colour (SCI)	Hue angle difference	
			Previous	New
Cyan	Yellow 2 for Yellow1	+3.8	-39.4	+6.0
Deep Blue	Red 2 for Red 1	-2.0	+0.2	-7.9
Orange	Yellow 2 for Yellow1	-8.3	+10.7	+3.0
Red	Red 2 for Red 1	-4.8	-4.9	-3.1

4. CONCLUSIONS

Colorimetric matching could be a useful basis for rapid matching of target colours in this food system. Matching ability however appears to depend on the target colour and dye combination. Material differences between tile and cake (such as background colour) and limitations on the number and level of dyes that can be used, present challenges to matching. Most ΔE^*_{ab} differences between tile and cake are above the threshold of an obvious visual difference, but whether the matches are visually acceptable remains to be determined.

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Color-difference measurements using 9-steps gray scales

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ABSTRACT

The improvement of the CIEDE2000 color-difference formula with respect to CIELAB has been experimentally tested using 10 color pairs which were specifically designed with this goal by Dr. D. H. Alman (CIE TC 1-47, chairman). The merit of these two formulas and the inter-observer experimental variability were measured using the Standardized Residual Sum of Squares (*STRESS*) index. Experiments were performed in two different laboratories, using the 9-steps gray scales for "Color Change" and "Staining" manufactured by the American Association for Testing Chemists and Colorists, and the Society of Dyers and Colourists. Observations were performed under standardized D65 sources by 21 inexperienced observers with non-defective color vision. The results found in both laboratories employing the two 9-steps gray scales were similar, and indicated a clear improvement of CIEDE2000 upon CIELAB, as was expected. The inter-observer variability in our experiments was considerably high, even higher than the predictions made using CIEDE2000. This means that CIEDE2000 (but not CIELAB) predicted our average-observer's results better than individual observers as a group. Current results encourage the use of the CIEDE2000 color-difference formula in industrial and applied colorimetry, including food color research.

1. INTRODUCTION

Color measurement has been defined as "a measurement that relates to what an observer sees" (Berns 2000: 76), emphasizing the importance of visual observations:

> Recent texts on color technology contain a wealth of information about instrumental color measurement yet hardly consider visual color measurement. … Consider this question: Has a costumer who finds a batch of material visually unacceptable ever changed his or her mind after looking at instrumental data? (Berns 2000: 78)

A color-difference formula is a mathematical equation providing a real number (ΔE) from the tristimulus values of two samples (reference and batch), considering also sometimes the specific illuminating and observing conditions for the color pair. The main goal of a color-difference formula is to provide a ΔE value in good agreement with the visual difference (ΔV) perceived by an observer with non-defective color vision for any color pair. In fact, the visual difference between two color samples (ΔV) is the answer of the human visual system, which can be obtained using many different techniques. One of the most popular techniques for the visual assessment of color differences is the use of gray scales (JSDC 1953).

Table 1. CIELAB coordinates for the 10 color pairs produced by Dr. Alman (DuPont, USA) and assessed in our visual experiments (Illuminant D65, CIE 1964 Standard Observer.

Color pair	Reference			Batch		
	L^*_{10}	a^*_{10}	b^*_{10}	L^*_{10}	a^*_{10}	b^*_{10}
1	51.11	0.09	0.96	48.17	0.12	0.77
2	81.92	-0.16	0.83	77.69	0.06	0.80
3	35.95	0.18	0.96	32.38	0.17	0.94
4	37.46	32.88	20.52	37.65	40.18	25.24
5	48.88	6.55	-18.88	49.23	3.81	19.66
6	50.38	-9.24	-16.39	50.81	-6.31	-18.40
7	30.44	0.08	-32.57	30.69	5.86	-36.02
8	29.86	4.15	-33.70	30.10	1.33	-35.96
9	49.27	-1.59	2.17	49.44	-1.49	5.63
10	49.89	-1.22	-2.27	49.90	-3.57	-2.39

Note that using a successful color-difference formula, the subjective visual assessments of color-differences could be reliably replaced by objective instrumental measurements. The last color-difference formula proposed by the International Commission on Illumination (CIE) is CIEDE2000 (CIE 2001), which was found significantly better than the CIELAB color-difference formula from a wide set of 11273 color pairs (Luo et al. 2001). In 2002, Dr. D. H. Alman (DuPont Automotive Products, USA), who was the chairman of the CIE TC 1-47 proposing the CIEDE2000 formula, followed a suggestion from Prof. M. R. Luo (University of Leeds, UK), and produced 10 color pairs to show the advantages of CIEDE2000 upon CIELAB. The goal of this paper is to report on the visual assessments of these color pairs by a group of inexperienced observers with normal color vision, evaluating the performance of CIEDE2000 and CIELAB, as well as the average inter-observer variability.

2. MATERIALS AND METHODS

Table 1 shows the color coordinates for the samples produced by Dr. D. H. Alman, which were highly uniform metallic samples with size 4.5 × 9.0 cm, mounted in direct edge contact on neutral backgrounds ($L^*_{10} = 52.9$; $a^*_{10} = -3.3$; $b^*_{10} = 0.7$) 15 × 20 cm. A total of 21 non-defective inexperienced observers (CIMET Erasmus-Mundus Master students in France and Spain) assessed each one of these 10 color pairs, employing different color-fastness gray scales. All observations were made in commercial color assessment cabinets with D65 source.

Figure 1 shows the measured CIELAB color-differences for the color pairs in the gray scales manufactured by the American Association for Testing Chemists and Colorists (AATCC) and the Society of Dyers and Colourists (SDC). Note that the gray scales from both manufacturers are very similar, the range of color-differences covered by the "Staining" scales being considerably higher than the one covered by the "Color Change" scales. Because of specific temporal constraints, the observers didn't perform replicated assessments on each color pair, and only the gray scales from SDC were employed in the laboratory *L1*.

The *STRESS* index (García et al. 2007) has been employed to evaluate the performance of CIELAB and CIEDE2000 color-difference formulas with respect to the average visual results, as well as to evaluate the average inter-observer variability (i.e. the average of *STRESS* values found considering the visual result from each observer and the average of the group). Lower *STRESS* values (always in the range 0-100) indicate better agreement between visual results and predictions made by color-difference formulas (CIELAB or CIEDE2000), as well as lower inter-observer variability. According to our visual conditions, the parametric factors in the CIEDE2000 formula were kept as k_L=k_C=k_H=1.0.

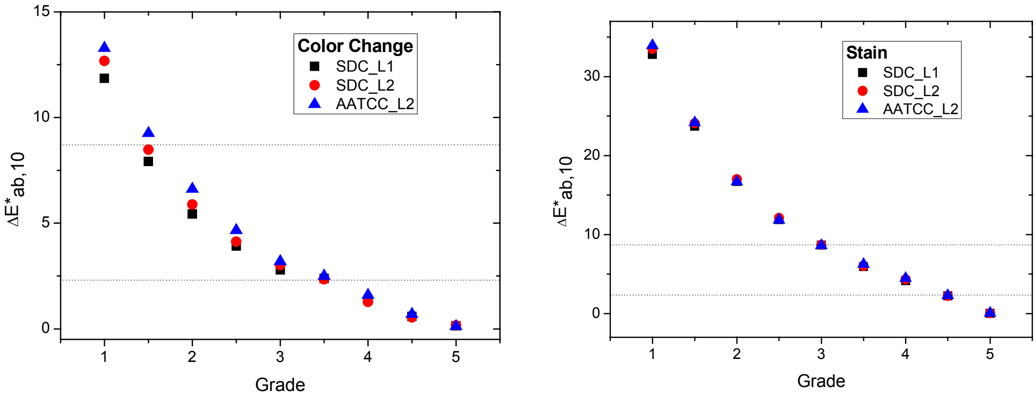

Figure 1. Color-differences for the 9 steps gray scales produced by SDC and AATCC and measured in laboratories L1 and L2. Dot lines show the $\Delta E^*_{ab,10}$ range for the Alman's pairs.

3. RESULTS AND DISCUSSIONS

The results found in our experiment are summarized in Table 2. From this Table, the next points can be addressed:

Table 2. STRESS values found in laboratories L1 and L2 using different 9-step gray scales.

	SDC Change in Color		AATCC Change in Color	SDC Staining		AATCC Staining
Laboratories:	*L1*	*L2*	*L2*	*L1*	*L2*	*L2*
CIELAB	41.8	48.6	43.9	42.2	44.2	55.0
CIEDE2000	27.4	25.8	26.1	33.2	28.2	31.6
Inter-Observer	33.7	36.1	48.0	29.7	35.4	36.5

1) At most the difference between the results from laboratories *L1* and *L2* was 6.8 *STRESS* units. Probably this difference should be even lower using a higher number of observers. Statistical analyses from the results of our different observers reported no outliers.

2) As expected, the CIEDE2000 color-difference formula always performed better (lower *STRESS* values) than the CIELAB one. Specifically, the difference between these two color-difference formulas ranged from 9.0 to 23.4 *STRESS* units. This result agrees with previous findings using datasets with larger number of color pairs (Melgosa et al. 2008). Besides the high improvement achieved by CIEDE2000 upon CIELAB, it must be said that, from the current results, the difference between CIEDE2000 and CIELAB is not statistically significant, as was also expected from the low number of color pairs employed here.

3) With only one exception (*L1*, SDC Staining), the inter-observer variability was always considerably higher than the predictions made by the CIEDE2000 color-difference formula. The same cannot be stated for the CIELAB formula. This means that CIEDE2000 (but not CIELAB) predicts average-observer's results better than individual observers as a group.

Anyway, it must be considered that this result is based on naive observers' answers, whose inter-observer variability may be higher than for experienced observers.

4) Results found in laboratory *L2* from the "Change in Color" and "Staining" scales doesn't report a clear trend: while slightly lower *STRESS* values were found using the SDC "Staining" scale, the same cannot be stated using the AATCC "Staining" scale. Probably, in practice the main difference between the AATCC and SDC gray scales is only the horizontal / vertical orientation of their color pairs. In a previous experiment using 5-step gray scales from a third manufacturer, it was consistently found that for these color pairs the *STRESS* results from the "Staining" scale were lower than those from the "Color Change" scale (Grosman et al. 2010). Analogously, there is no clear trend comparing the *STRESS* results found from the SDC and AATCC "Change in Color" (or "Staining") gray scales.

In conclusion, the 10 color pairs produced in 2002 by Dr. D. H. Alman (DuPont Automotive Products, USA), (Table 1), can be successfully employed to show the improvement of the currently-recommended CIEDE2000 color-difference formula upon CIELAB.

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Relationship between sensory analysis and the instrumental colour and visual texture assessment of deep-fried breaded veal

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ABSTRACT

The aim of this study has been focused on two objectives: (a) to determine the equivalence between sensory evaluation of the appearance of deep-fried breaded veal (DFBV) performed on the real product as well as on a photograph of the same product, (b) to analyze the relationship between sensory analysis and instrumental assessment of visual texture and colour. DFBV were prepared from bovine meat, dipped in egg and covered with bread crumbs. The process of dipping in egg and covering with bread crumbs was performed once or twice. Cooking was in sunflower oil at 180 °C at two different times. A panel of 8 trained assessors measured the appearance profile of the real-life samples and their photographs. General Procrustes analysis showed that both the real-life and photograph configurations were close to the consensus, indicating that overall, both measurement methods provided similar results. Digital images of the DFBV were processed to obtain the chromatic heterogeneity and the average color for the different treatments. It was found that the cooking time induced descents of lightness and hue (darker and reddish samples) while the number of dips increased them (lighter and yellowish samples). These instrumental results were in accordance with the sensorial ones.

1. INTRODUCTION

Deep-fried breaded veal (DFBV) is one of Argentina's most popular food products; it is also consumed in other Latin American countries and Spain. It is prepared by dipping slices of approximately 5 mm thick veal in beaten egg followed by breading and frying. To appreciate its crispy texture it is generally consumed hot. Appearance is a fundamental attribute in consumer's evaluations of DFBV. Factors like degree of cooking, presence of bubbles (bread crumbs not properly stuck to the meat) and degree of meat coverage are all appreciated visually. Serving freshly prepared DFBV to a large number of consumers is relatively complex. The evaluation of a photograph is a lot easier; however for this evaluation to be valid the results have to equivalent to evaluating the real-life product.

Computer machine vision systems (MV) have been developed as an alternative to visual sensory evaluation. Kane et al. (2003) compared instrumental and sensory measurements, both performed on cookie images. O'Sullivan et al. (2003) predicted visual sensory quality of pork from computer vision methods, also using digital images. Balaban et al. (2008) obtained good correlations between MV and a sensory panel evaluating the same digital photographs of non-homogenous agricultural materials. However, in these works there was no comparison between the sensory evaluation of the real-life samples and their corresponding photographs. Once this relation has been established it is possible to validate an MV system.

This study had two main objectives: (a) to determine the equivalence between sensory evaluation of the appearance of DFBV performed on the real-life product as well as on a photograph of the same product, (b) to analyze the relationship between sensory analysis and "instrumental assessment of visual texture and colour" of DFBV.

2. MATERIALS AND METHODS

2.1 Sample preparation and presentation

DFBV were prepared from 5 mm thick semitendinosus bovine meat, dipped in reconstituted egg powder and covered with bread crumbs. The process of dipping in egg and covering with bread crumbs was performed once (egg-bread) or twice (egg-bread-egg-bread). Cooking was in sunflower oil at 180 °C at two different times: 3 min and 6 min. Thus there were two processing factors: number of dips and cooking time, each with two levels; this constituted a 2^2 factorial design with a total of 4 treatments. Eight individual DFBV's corresponding to a single treatment were fried together. Once the frying time was completed they were removed from the pan and drained of excess oil. Digital photographs of the samples were taken with a digital camera (Sony DSC-W55) under controlled illuminating conditions (a closed illumination cabinet with a D65 emulator illuminant). Immediately after being photographed the 8 individual DFBV's corresponding to a single treatment were presented to the 8 trained assessors on a plastic plate, each receiving a single DFBV. Preparation and evaluation was done by duplicate in separate sessions, in each session 4 treatments were evaluated. As there were two evaluation methods: real-life and photograph, each done by duplicate, this meant a total of 4 sessions. Treatments were allocated randomly to sessions, and within each session order of evaluation was also randomized. However, all assessors received the treatments in the same order due to the logistics of the frying procedure.

2.2 Instrumental color measurement

The digital images were processed by DigiFood® software (Heredia et al. 2006). For the image analysis CIELAB color parameters of each pixel of DFBV samples were considered.

2.3 Sensory evaluation

The evaluations were performed by 8 assessors that had been screened and trained in descriptive analysis (DA) following the guidelines of the ISO 8586-1 Standard. Three training sessions were used to develop the vocabulary and agree on a reference sample to calibrate the panel's evaluations. The following appearance descriptors with their corresponding anchors were agreed on: oily (low-high), blisters (few-many), meat coverage (low-high), color of the border (light-dark), overall color (light-dark), bubbles (few-many), thickness (thin-thick), light-colored particles (few-many), overall size (small-big).

Assessors evaluated samples in individual booths provided with standardized daylight-type fluorescent illumination. The real-life product was evaluated on a white plastic plate and the photographs on the PC screen present in each booth as part of the computerized data collection system. Each assessor evaluated the photographs of the same samples used for the real-life evaluation.

2.4 Statistical analysis

Each descriptor was analyzed by analysis of variance (ANOVA) considering assessor as a random effect and dips (one or two), frying time (3 min or 6 min) and evaluation method (real-life and photograph) as fixed effects. General Procrustes analysis (Arnold and Williams 1986) was used to compare the sensory space generated by both evaluation methods.

3. RESULTS AND DISCUSSION

General Procrustes analysis showed that both the real-life and photograph configurations were close to the consensus, indicating that overall both measurement methods provided similar results. However there were differences in some of the descriptors.

Figure 1 (a) shows average scores for the 4 treatments for overall color, where agreement between real-life and photograph evaluations was close. This close agreement was also found for: meat coverage, color of the border, thickness and overall size; and to a lesser degree for blisters and bubbles.

Figure 1 (b) shows the average scores for oily appearance, where for the most oily treatment corresponding to 1 dip - 3 min, the real-life evaluation was higher than for the photograph evaluation. Further adjustments to the gloss of the photograph have to be made in order to evaluate if the agreement can be improved. Another descriptor where there were disagreements was in light-colored particles: for the treatment corresponding to 1 dip- 6 min the average score for the real-life evaluation was significantly higher than for the photograph evaluation. Here also adjustments in the photograph calibration are necessary to obtain closer agreement between evaluation modes.

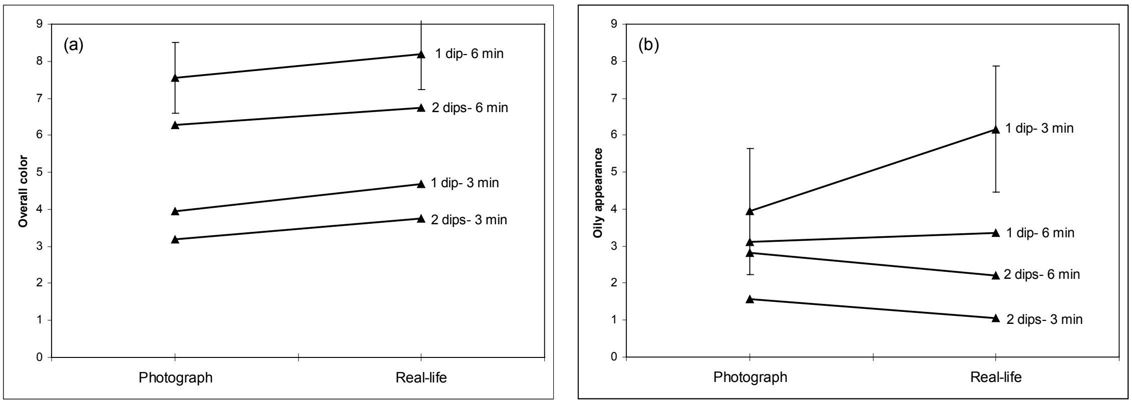

Figure 1. Mean scores for sensory evaluations performed on the real-life products and corresponding photographs: (a) overall color and (b) oily appearance. The bars correspond to ± least significant differences (P < 5%).

Digital images of the DFBV were processed and the average color for the different treatments was obtained (Table 1). It can be observed that, as expected, the cooking time induced descents of lightness (average L*) while the number of dips increased it. There were also differences in hue, being more reddish (lower h_{ab} values) for samples with one-dip and 6-min cooking times.

Taking into account the chromatic heterogeneity as the percentages of number of pixels with different hue or lightness ranges, a clear dependence between the cooking time and the number of "dark" pixels (L* < 50) was found. Also, in a digital image the color variation of the pixels represents the *"chromatic heterogeneity"*. Standard deviations (n=2026 pixels) were considered as an adequate estimation index of this factor. In this sense, the major and minor chromatic heterogeneity correspond to 1 dip-6 min and 2 dip-3 min samples, respectively (Figure 3). As observed, the mean value of each set of points indicates a higher hue value (more yellowish) for the more homogeneous sample.

Table 1. Mean values and standard deviation (n = 2026 pixels) of the CIELAB color parameters for each cooking treatment.

Dips	Time (min)	L*	a*	b*	C^*_{ab}	h_{ab}
1	3	56.73 ± 6.74	16.33 ± 3.43	43.64 ± 5.01	46.72 ± 5.30	69.65 ± 4.13
2	3	63.26 ± 7.31	15.22 ± 3.54	44.30 ± 5.32	46.92 ± 5.78	71.14 ± 3.36
1	6	50.81 ± 7.77	22.72 ± 3.60	44.56 ± 5.96	50.23 ± 5.62	62.86 ± 5.09
2	6	59.45 ± 6.98	17.77 ± 3.98	44.73 ± 5.21	48.23 ± 5.80	68.44 ± 3.69

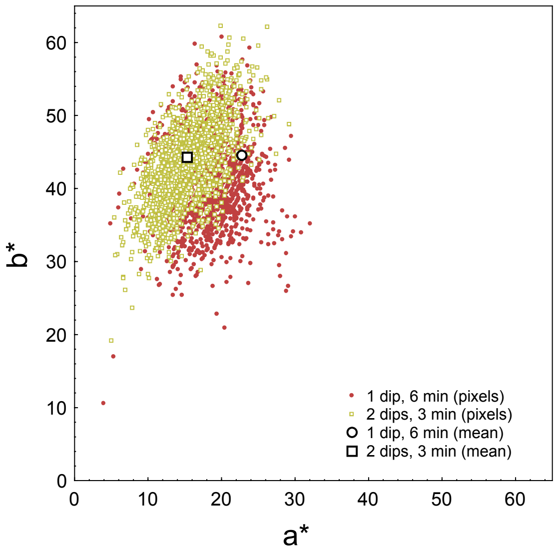

Figure 2. Color distribution of pixels and mean color in the major and minor chromatic heterogeneity DFBV samples.

These instrumental results were in accordance with those given by the sensorial panelists.

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Application of image analysis to the colour-phenolic composition relationships of grape seeds

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ABSTRACT

The chemical characteristics of grape seeds have been correlated with their colour characteristics measured by digital image techniques. The study was carried out on red grape seeds from *Tempranillo* variety. Digital images of the seeds were taken; then colour as well as morphological and colorimetric heterogeneity characteristics were determined from them. The phenolic content of the samples was also determined by High Performance Liquid Chromatography (HPLC). A high positive correlation was found for catechin and a negative correlation for protocatechuic acid.

1. INTRODUCTION

Vitis vinifera grapes have the phenolics compounds mainly in solid parts (seeds and skin), which pass to the wine during fermentation process. Although phenolics are non-coloured components, they influence the final colour of red wine due to copigmentation reactions with anthocyans. Copigmentation phenomena consist of non covalent molecular associations between anthocyanins and other organic compounds such as flavonoids, yielding to changes or increments of the colour intensity. The composition of the seeds changes along the maturation until the grapes reach the ripeness, affecting the sensory properties of wine. Currently, the moment of harvesting is determined based on chemical properties of the grape, and the phenolic maturation of the seeds are not considered. The chemical changes occurred during the phenolic maturation induce changes of appearance of the seeds, modifying their colour (from pale green to dark brown), as well as their shape.

Colorimetry is widely used for evaluating the quality and composition of foods. Digital image analysis appears as a successful complement since it can be determined not only colour but also other characteristics such as shape, texture and homogeneity (Zheng et al. 2006, Savakar et al. 2009). In previous studies we have determined the usefulness of the digital image analysis to assess the phenolic maturation evolution of the seeds in grapes for vinification, reaching industrial interest results. it was also studied morphological differences between varieties with general discriminant analysis models that could classify the grape seeds with high accuracy (Rodríguez-Pulido et al. 2010). This study goes ahead to a deeper knowledge of the phenolic composition of the seeds and the relation with their appearance by applying digitalization techniques.

2. MATERIALS AND METHODS

2.1 Sampling and physical-chemical analysis

A red grape variety (*Tempranillo* cv.) grown in vineyards located in Condado de Huelva (Southwest of Spain) were sampled twice a week from July 20 until the harvest. A gross sample of 2 Kg was divided into two fractions of 1 Kg. One of these fractions was used for physicochemical analysis of the must, which determined average weight and average berry size, pH, sugars and total acidity. In the other fraction a hundred seeds were separated, cleaned, and images were acquired. Once the images were taken, the seeds were kept frozen until the HPLC analysis of phenols.

2.2 Image acquisition and image analysis

The DigiEye® imaging system based upon the digital camera Nikon D80 was used. It includes an illumination box specially designed by VeriVide Ltd. to illuminate the samples consistently in D65 illuminant and a digital camera connected to a computer (Figure 1).

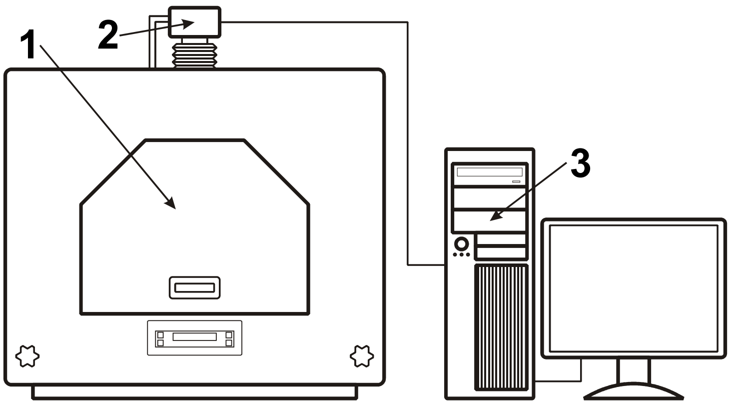

Figure 1. The DigiEye System: (1) illumination box; (2) digital camera; (3) computer.

From image analysis, morphology parameters and appearance were obtained as well as conversion of RGB values to CIELAB coordinates with original software DigiFood® (Heredia et al. 2006). Segmentation criteria were based on HSI (hue / saturation / intensity) colour space and morphological features of seeds, such as restrictions of area and size.

The following parameters were considered:
- Length, width and area.
- Aspect: Ratio between major and minor axis of ellipse equivalent to seed.
- Roundness: (perimeter^2)/(4 × π × area).
- Heterogeneity: Fraction of pixels that deviate more than 10% from the average intensity.
- Browning level: Fraction of pixels having L* value is less than 50 units.
- Mean colour difference from the mean, MCDM (Berns 2000: 75-105):

$$MCDM = \frac{\sum_{i=1}^{N} \left[\left(L_i^* - \overline{L^*}\right)^2 + \left(a_i^* - \overline{a^*}\right)^2 + \left(b_i^* - \overline{b^*}\right)^2 \right]^{1/2}}{N} .$$

2.3 Phenolics analysis

For the HPLC phenolics analysis, a modification of the method proposed by Sandhu and Gu (2010) was applied. 0.5 g of freeze-dried seeds were milled and extracted with 10 mL of acetone / water / acetic acid (70:29.3:0.3 v/v) solvent. Chromatographic analysis was performed on an Agilent 1200 series HPLC system equipped with a diode array detector.

3. RESULTS AND DISCUSSION

Once the images were acquired and the criteria of segmentation were applied, all seeds were recognized by the software (Figure 2).

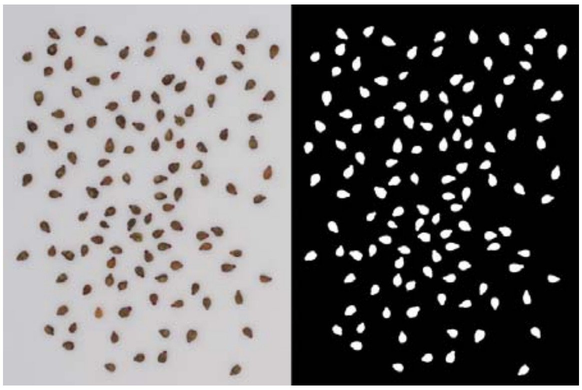

Figure 2. Image of grape seeds and resulting mask after apply segmentation process.

The appearance and colorimetric parameters were measured in grape seeds by image analysis. Table 2 shows the CIELAB colorimetric parameters of each stage of maturation. In the process decreased lightness, chroma and hue, due to the browning of the seed.

Table 2. Colorimetric values for grape seeds during maturation.

Sample	Date	L*	a*	b*	C^*_{ab}	h_{ab}
1	Jul 20	57.97	10.08	29.10	31.09	69.65
2	Jul 23	54.97	10.36	27.33	29.60	67.70
3	Jul 27	55.97	11.24	27.55	29.98	67.25
5	Ago 3	51.49	11.17	23.92	26.60	64.24
6	Ago 6	51.01	11.72	24.05	26.95	62.89
7	Ago 10	50.92	12.02	23.74	26.79	62.26
8	Ago 13	50.15	11.11	21.41	24.31	61.58

The phenolic profile of seeds was analyzed. For identification of these compounds retention times and spectra were compared. The phenolic profile changes during seed maturation. Although other compounds were identified Table 3 shows those which concentration changed.

For the study of relationship between chemical composition and colour in seeds, linear and multiple regression models were applied. As shown in Table 4 not only the quantitative colorimetric variables correlated with some phenolic compounds, but also the hue (h_{ab}), demonstrating their involvement in browning phenomenon from a qualitative point of view.

Table 3. Content of phenolics compounds in grape seeds.

Date	Protocatechuic acid mg/Kg	Catechin mg/Kg
Jul 20	8	867
Jul 23	8	985
Jul 27	12	674
Ago 3	26	504
Ago 6	20	604
Ago 10	38	443
Ago 13	24	491

Table 4. Correlation matrix between colorimetric and chemical values. Results in bold are significant at $p < 0.05$.

	L*	a*	b*	C^*_{ab}	h_{ab}
protocateuchic acid / mg/Kg	**-0.82**	**0.81**	**-0.78**	-0.75	**-0.84**
catechin / mg/Kg	**0.80**	**-0.83**	**0.82**	**0.80**	**0.86**

4. CONCLUSIONS

Image features (i.e., colour, size and shape) can be extensively applied for seeds maturity evaluation. The results suggest that image analysis has good potential to be used for colour and appearance measurements in grape seeds. This technique provides a fast, nondestructive and low-cost alternative in the winery industry to conventional chemical analysis.

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Color classification of veal carcasses: Past, present and future

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ABSTRACT

In The Netherlands, veal carcasses are classified on color, conformation and fatness. In the past 20 years, major efforts have been put into the development of a reliable color classification system. Initially, the color of the *musculus rectus abdominis* was visually matched to a 10-point scale. Later on, the visual classification was replaced by instrumental classification. A handheld tri-stimulus colorimeter measures XYZ values which are converted into a color class on the 10-point scale. The algorithms underlying this conversion were derived from comparison of the measured L*a*b* values with the visually assigned color classes. At present, the quality and stability of the color measurements have been improved by new instruments, by using an additional calibration tile and an improved quality control procedure. Also, a new algorithm was developed to convert XYZ measurements into a color class. This algorithm is based on the conventional ΔE color difference metric and was tuned for optimal performance with respect to historical databases containing visual classifications. In the future, we expect to further benefit from technological breakthroughs in color measurement.

1. INTRODUCTION

In compliance with EC Directives, in Dutch slaughterhouses veal carcasses are classified on the basis of three factors: conformation, fatness and color. Of these factors, color has become an important parameter in the pricing system, involving both farmers and buyers. In the past 20 years, major efforts have been put into the development of a reliable color classification system. Such a system is necessary to guarantee uniform classification results among different slaughterhouses in the Netherlands, but also to provide a sound basis for international trading since the majority of veal meat produced in the Netherlands is exported to other countries. In this field the Netherlands has a leading position in Europe and third countries.

This paper presents the main issues involved in the development of the color classification method, discussing both the historical perspective and current state-of-the-art. We also take a look at future possibilities.

2. PAST: FROM VISUAL TO INSTRUMENTAL COLOR CLASSIFICATION

Initially, the color classification at the different slaughterhouses was performed visually by certified employees of the Central Office for Slaughter Livestock Services (BV CBS). At 45 minutes post mortem, the color of the *musculus rectus abdominis* (muscle tissue) was visually matched to a 10-point scale (Figure 1) ranging from light (1) to dark (10), under prescribed lighting conditions. The colors of the 10-point scale were determined from analysis of the gamut in CIELAB color space encompassed by representative variations in veal meat samples.

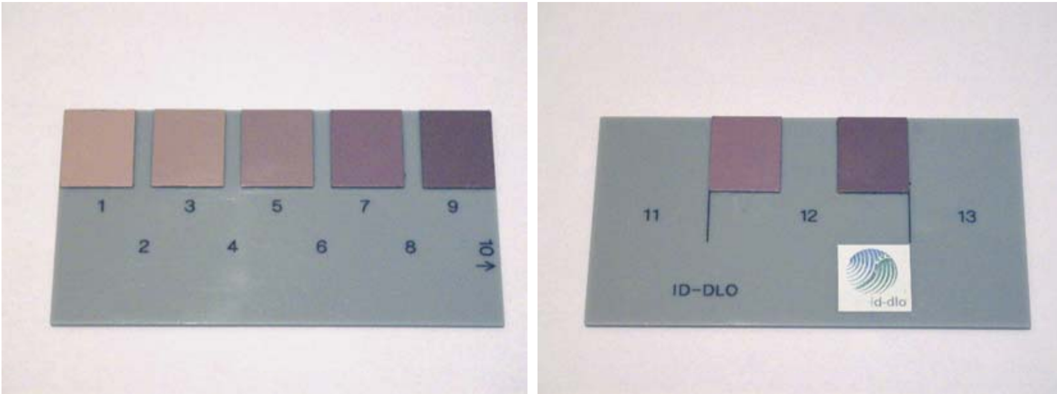

Figure 1. Scales used for visual color classification of white (left) and pink (right) veal meat.

As a logical next step, the subjective visual color classification was replaced by objective instrumental color classification. A handheld tri-stimulus colorimeter (Konica-Minolta CR300), operated by certified personnel, measures XYZ tristimulus values of the same muscle tissue (*musculus rectus abdominis)*, which are then converted into a color class on the 10-point scale. The algorithms underlying this conversion were derived from comparison of the measured L*a*b* values with the visually assigned color classes. Functions derived by discriminant analysis were applied to calculate the most likely color class belonging to the measured L*a*b* values, as described in Hulsegge et al. (2001).

3. PRESENT: IMPROVEMENTS IN HARDWARE AND SOFTWARE

Today, the instrumental classification is still in place, albeit in optimized format. To increase the quality and stability of the color measurements, the instruments have been replaced by newer versions (Konica-Minolta CR400). Before doing so, several options were considered. A switch from a tristimulus meter to a spectrophotometer would allow illuminant metamerism to be considered (Berns 2000), but at the same time it would increase the risk of fouling the integrating sphere of the spectrophotometer. Also, a larger measurement aperture would minimize the effect of spatial variations in the meat tissue being measured. However, in order not to lose the connection with historical databases containing both measurements and visual assessments, and knowing that sufficient accuracy could be reached using a proper calibration procedure, it was decided to stick to the same color measurement technique with a tristimulus colorimeter.

After introduction of the new color instruments in the slaughterhouses, the instrument calibration procedure was improved. Up till then, the daily instrument calibration check involved verification of XYZ values measured on a white calibration tile. Whenever the difference between any of the measured X,Y or Z values with the target values exceeded a given percentage, it was required to inspect the instrument for possible contamination, clean the instrument and calibration tile and re-measure, or even replace the instrument by a spare one, if necessary. In the new procedure, an additional calibration tile having a color representative for veal meat is also measured. This so called *user calibration* not only is a direct verification of the proper functioning of the instrument in the target area of color space, it is also beneficial for maintaining the *Inter Instrument Agreement* (IIA) between different instruments (of the same type) at an acceptable level. Differences between measured and target values are now expressed in the ΔE_{94} color difference metric (CIE 1995), the value of which lies in one of three categories indicating the instrument's operational status. The latter is labeled either code green (instrument OK), code yellow (instrument still OK but may need attention) or code red (instrument not OK: clean and re-measure). After a year of testing in practice, the stability and IIA are considered as excellent. The choice for the relatively simple

ΔE_{94} metric, and not the more recent and complex ΔE_{00} (CIE 2001) was motivated by the fact that the colors of white veal meat are restricted to a limited "reddish" area in CIELAB space (see Figure 2). Application of the ΔE_{00} is said to be most helpful in the blue area of color space and for near-achromatic colors. Also, the equations underlying the computation of ΔE_{00} do not support an easy interpretation of visually perceived differences.

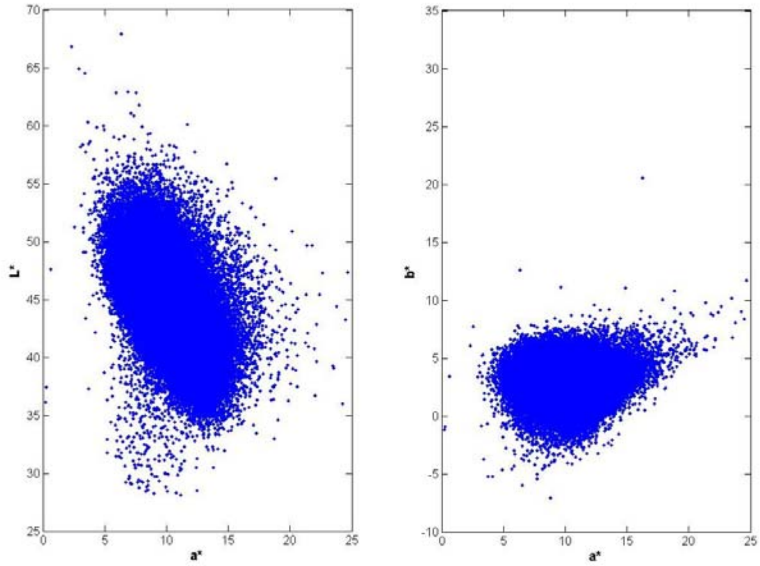

Figure 2. Scatterplots showing the gamut of measured white veal carcass color in CIELAB color space (n = 113,556).

Finally, a new algorithm was developed to convert measured XYZ values into a color class along the 10-point scale. The "old" algorithm, using discriminant functions that disregarded the measured b*-value, did not seem to optimally cover the gamut of veal meat color anymore. The new algorithm incorporates the same metric as used for the instrument calibration check, ΔE_{94}, for which we now optimized the parameters k_L, k_C and k_H. Ten center points were selected in CIELAB space that represent the 10 color classes and have a structured pattern in their mutual spacing. For each color measurement we compute the color difference between the measured L*, a*, b* values with each of the 10 central points. The class associated with the central point having the smallest ΔE_{94} is then assigned as the final color class. The optimization of the parameters k_L, k_C and k_H and the selection of the 10 center points is done with respect to historical databases containing both the classifications of the previous algorithm and visual classifications. As Figure 3 shows, the distribution of assigned color classes of the new algorithm closely resembles that of the old algorithm. This is important from both a technical and a commercial point of view.

4. FUTURE PERSPECTIVE

In the future, we may expect to further benefit from technological breakthroughs in color measurement. Developments in LED technology offer the possibility to use LEDs as the internal light source, which are even more stable, energy efficient and have a longer life-time, and thus may require less calibration efforts.

Operational research can be conducted in the different slaughterhouses to investigate local factors that may cause differences between slaughterhouses. Differences in conditions like temperature, humidity, but also transportation and animal stress may lead to unwanted variations in the measured color, and hence in the assigned color class.

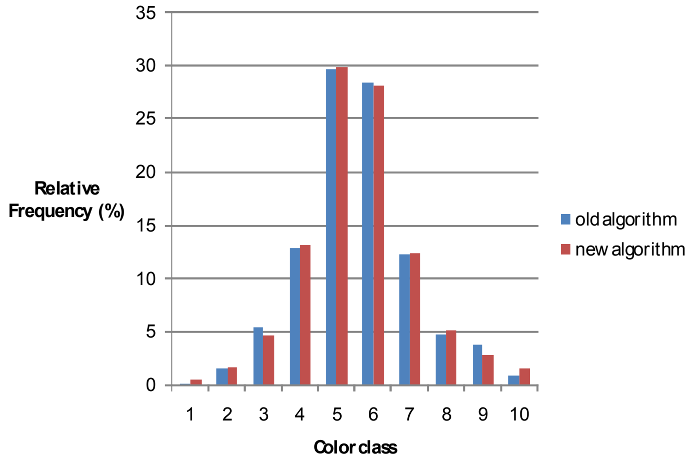

Figure 3. Relative frequency distribution of veal carcass color classes, determined with the old and the new algorithm. The latter is based on the minimum color difference with the centers of the 10 point scale in CIELAB space, being more stable and more easy to comprehend.

With the upcoming possibilities of image processing (Du and Sun 2004), camera based, non-contact color measurement would seem to be the next step. However, this implies that the color of veal meat should be measured on the outside of the carcass. It is questionable whether this correlates well enough with the color of the *musculus rectus abdominis*, which has been previously suggested as the preferred indicator of veal meat color (Denoyelle and Berny 1999). In addition, it would require substantial attention to calibrated lighting conditions in the slaughterhouses. In particular the glossiness of the moist carcasses as well of the fat coverage are difficult hurdles to pass. It is generally known that non-contact color measurement is more suitable to assess differences in color then to determine the absolute color. Perhaps the need for exact (calibrated) lighting may be relaxed by using smart portions of the wavelength area (Aporta et al. 1996) or by smart calibrations to known color references (Connolly et al. 1996, Pointer 2000).

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Is the colour measured in food the colour that we see?

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ABSTRACT

The foundations of Colorimetry establish that the measured colours must correspond to the colour seen by observers. If the correspondence is not good, the response of observers is the correct one, and the experimental conditions of colour measurement must be revised. Since I have been measuring food colours, for the last 30 years, I have had a doubt: are food colours well-measured? Or rather: Do the colour coordinates that have been found in the laboratory correspond to the food colours seen by customers (or experts)? On numerous occasions, I have found that the answer is negative.

There are four groups of problems responsible for this. Firstly, official methods to measure the colour of certain foods are not related to the actual observation methods of expert colour assessment. Secondly, some authors (and, consequently, referees) do not know the significance of colour coordinates. On other occasions, authors make a statistical study of each colour coordinate separately to ascertain the acceptability of results, instead of the three coordinates together and/or the colour differences. Thirdly, authors use measuring instruments which are not suitable for the optical properties of the food to be measured, producing unacceptable results. Finally, if the foods whose colours are to be determined are not homogeneous (mainly fruits with red and green or orange areas), the methods of measurement used (one measure of each colour) cannot agree with the results of the panel of experts. It is necessary to change the measurement method.

1. INTRODUCTION

The foundations of Colorimetry establish that the measured colours must correspond to the colour seen by observers. If the correspondence is not good, the response of observers is the correct one, and the experimental conditions of colour measurement must be revised.

Since I have been measuring food colours, for the last 30 years, I have had a doubt: are food colours well-measured? Or rather: Do the colour coordinates that have been found in the laboratory correspond to the food colours seen by customers (or experts)? On numerous occasions, I have found that the answer is negative and I have found four groups of problems responsible for this.

This talk will discuss these problems, based on, firstly, the cases I have found in the different kinds of foods whose colour I have measured and, secondly, on those in the literature I have had to study and discuss with experts in other areas of food technology rather than in the knowledge of colour and colorimetry.

In this talk, I shall give priority to wine and fruit as I have worked most and have found the most important problems with them.

2. FIRST GROUP

Official methods to measure the colour of certain foods are not related to the actual observation methods of expert colour assessment.

The sensory evaluation of wine is performed in standardised glasses. If we observe the colour of a red wine in this glass, it is black with reddish tints at the edges. This is why the expert tilts the glass to observe the colour of different thicknesses of wine, where the blue tones of young wines can be appreciated. If we perform spectrophotometric measurements of the light transmitted, we will see that the blue zone of the spectrum disappears as the pathlength of the cell increases. This disappearance of light transmitted in the blue zone indicates changes in the colour of the wine. In one example with a Beaujolais Nouveau red wine which does not have much colour, these colour changes can be appreciated and, after 15 mm of wine thickness, it has values of $L^* \leq 21$ CIELAB units, colours which are seen as black by the naked eye.

If the wine has more colour, the blue tones disappear at 10 mm thickness and the measurement does not correspond to the colour which is observed by the wine-tasters.

The new official method for determining the wine colour (OIV 2006) establishes that the wine colour must refer to a 10 mm pathlength cell. My work group suggested that the colour should refer to a 2 mm pathlength cell, due to the violet tones of dark young red wines. But the proposal was not accepted by some wine experts as they preferred to maintain the same norm as before because of “tradition”.

However, we decided to keep the 2 mm path length cell for determining the colour of red and rosé wines in our MSCV program (Simplified Method for Wine Colour), which is available as freeware on the web (Ayala et al. 2001).

For white wines, we have kept the measurements in 10 mm pathlength cell since at 2 mm they would be practically colourless.

3. SECOND GROUP

Some authors (and, consequently, referees) do not know the significance of CIELAB colour coordinates. These coordinates correspond to related colours, and they are always expressed in function of the reference white (CEI and CIE 1987).

For example, the L* coordinate, that some authors call “luminosity” instead of “lightness” which is its correct name, and it is defined as: “the brightness of an area judged relative to the brightness of a similar illuminated area that appears to be white or highly transmitting”.

Some authors misinterpret the a* and b* coordinates as the magnitude of colour red or green and yellow or blue, respectively, of any colour. This implies that the colour is a phenomenon of four stimuli (or five, if we included the brightness) rather than three stimuli as in reality. They don’t bear in mind that the h_{ab} coordinate is a function of the quotient of both, b^* / a^* and is related to the colour hue. Furthermore, they don’t take into consideration that axis + a* ($h_{ab} = 0º$) corresponds to a red-purple colour, and not to a spectral red colour.

Finally, many authors do not use C* and h_{ab} coordinates, without bearing in mind that these two coordinates, together with L*, are those which correspond to the visual perception of related colours: C* coordinate is related to the perceived chroma, which is “the colourfulness of an area judged relative to the brightness of a similar illuminated area that appears to be white or highly transmitting”.

The h_{ab} coordinate is related to the perceived hue: red, yellow, green, blue or combinations of two of these consecutive colours. The spectral reds commence with values of $h_{ab} \approx 30º$ and the spectral blues end at $h_{ab} \approx 270º$, the rest of the circle being taken up by the purple hues.

If we want to compare colorimetric results, we must use the colour differences between the colours measured, such as the first CIELAB colour difference: ΔE^*_{ab}, or one of the later colour differences derived from this colour space, such as the last CIEDE2000 difference, recommended by the CIE (CIE 2004).

This lack of knowledge concerning the meaning of the CIELAB colour coordinates and colour differences led to a problem when performing a comparative study of spectrophotometric measurements of the colour of wine by the OIV (Office Internationale de la Vigne et du Vin), in which several laboratories took part.

The colour of a series of red, rosé and white wines was measured and the results were sent to the coordinating laboratory of the study where the statistical analysis was performed of each coordinate separately. This analysis showed that all the measurements were within acceptable deviation if the measurements were made in 10 mm pathlength cells. However, when I carried out the study of colour differences between the coordinates of samples and their statistical mean values, there were some colour differences $\Delta E^* > 3$ CIELAB units, which indicated that they would be distinguished by an observer (Martínez et al. 2001).

I warned the group in charge of the comparative study about this, but they just withdrew the samples from the study and work continued as before. According to the old adage: "Any experiment is successful if no more than 50% of the experimental data have to be rejected for the result to fit the researcher's favourite theory".

I should mention that the "bad" samples were of dark red wines. After thinking about this for a long time, I have reached the conclusion (which I cannot prove) that the problem was that the spectrophotometric measurements referred to 10 mm pathlength cells are not good in the blue zones, where the absorbances of the samples is greater.

These measurement errors, together with the different calibration of the instruments cause the small deviation in each coordinate which, added together when calculating the colour differences, lead to their being distinguishable to the naked eye. This did not occur with wines which were not dark (or if the colour of wine was referred to 2 mm pathlength cell).

Finally, I should like to recommend that, when data are analysed, no conclusions should be made about each coordinate separately when comparing results. What is important are the colour differences, above all if they are visible to the naked eye.

It is highly likely that in these cases we should value more than ever what a colleague of mine once said, "There are truths, lies and statistics".

4. THIRD GROUP

Authors use measuring instruments which are not suitable for the optical properties of the food to be measured, producing unacceptable results.

According to the classical and the Kubelka-Munk theories (Judd and Wyszecki 1975), when white light incides from medium 1 on a body (medium 2), various processes may occur.

a) Partial reflection of the light in all wavelengths of the visible spectrum on the first surface, owing to the change of refraction index between the two media.
b) Transmission of the remaining light to medium 2.
c) Partial absorption of the light in those wavelengths characteristic of the material of medium 2.
d) If the body is not transparent, the non-absorbed light undergoes scattering inside the body until it reaches the second surface of the body.
e) Partial reflection on the second surface, analogous to that produced on the first surface due to refraction index change.

f) Transmission of the remaining light outside the body (medium 3).
g) The light reflected on the second surface returns inside the body, undergoing the same processes of absorption and scattering as in sections c) and d).
h) Partial reflection on the first surface, analogous to sections a) and e).
i) Transmission to medium 1 of the remaining light in the wavelengths which produce the characteristic colour of the body. This colour is similar to that corresponding to the transmitted light in section f). For example, a leaf is green because of transmission and reflection, even though these may not be the same green.

If the illuminated body is perfectly opaque, there is no light transmitted (lost) on the second surface and, therefore, the quantity of light which returns to medium 1 is greater than in the previous case. If the body is not perfectly opaque but is sufficiently thick, light is not transmitted to medium 3, either. The reflectance of this body is called “reflectivity”. In normal conditions of natural or artificial illumination, most foods are opaque, and the light which indicates their colour has no losses on the second surface.

This process is similar to the vision of the colour of paintings or other opaque objects and most colour measuring instruments are designed to measure opaque objects.

Many colour measuring instruments, such as portable colorimeters and spectro-colorimeters, use a flash as a system of illumination, which compensates the short period of illumination with the high power of light emitted. Those of us who have worked with these devices know that, each time we take measurements, it is necessary to calibrate them with a perfectly opaque white reference surface. This indicates to the device the maximum quantity of light it is going to receive and must interpret as white colour.

The problem of this illumination is that it has sufficient power to go through nearly all samples and loses part of its light through the second surface. The first time I observed this phenomenon was when I was measuring the colour of veal with a thickness of 2.5 cm. I was on the computer and my colleague was managing the portable colorimeter with one hand, while holding the recipient containing the sample with the other. I saw the light of the flash after it had gone through the sample and the white recipient. The same thing has happened with other, vegetable, foods.

Obviously, this affects colour measurements since the instrument receives less light than it should if the food to be measured were opaque as the instrument “supposes” in its calibration. Consequently, the measurement corresponds to a darker object than what the tested food really is.

In the case of greens, where the green colour of the leaves or thin stalks is measured, measurements may give L* values lower than 30, or even 20, units, which means that these “green” colours are practically “black”.

I have also observed the same problem in the colour measurement of flower (carnations), where the coordinates measured were much lower that those of the photographs which accompanied the text.

On other occasions, I find it very difficult to understand the results presented as colour measurements. The most extraordinary case I have found so far is the colour measurement of different varieties of peach. One member of my team, a food technologist, showed me this paper when we were measuring the colour of another variety of peach. He told me that the measurements did not agree with ours. I looked at the paper and the measurements and I told him to find me those peaches of blue-white colour, some of which have L* values higher than 100.

I believe that, behind these results, there are two problems:

a) A poorly calibrated instrument.
b) Corroborating the previous section, the most absolute ignorance of the authors and referees of the paper regarding the meaning of the CIELAB colour coordinates.

5. FOURTH GROUP

Finally, I should like to talk about the colour measurement of fruits without a homogeneous colour, mainly because of the ripening process. As is well known, a fruit changes colour while ripening and this change is usually from green to yellow and then to a lighter or darker red. The area of the fruit which first turns red is that which is directly facing the sun. When they are picked, these fruits usually have green and red areas, such as some apples, or yellow and red, like some peaches.

Some authors (Drake and Elfving 1999, Benavides et al. 2002, Echevarría et al. 2002) study the post-harvest colour of these fruits by measuring the colour of both areas separately, but it is clear that the panel of experts who evaluate these fruits cannot appreciate them separately since they have to give their colour evaluation as a single parameter.

We faced this problem when we had to measure the colour of Fuji apples which have alternating stripes of red and green. We decided to set up the equipment in such a way that the apple was spinning while a spectroradiometer measured the reflectance spectrum of one band all the way round the apple for one complete turn, integrating the result. The spectra obtained should differ according to the fruits' areas of red and green.

To verify these results we measured the reflectance spectrum of a completely green area and that of a completely red area and we calculated the spectra that would be obtained by adding both spectra in different proportions: 0.9 ∗ red + 0.1 ∗ green; 0.8 ∗ red + 0.2 ∗ green, successively. The results show that they are similar to the measured spectra of some apples. This confirmed that the spectra measured on the fruits were a sum of the spectra of the red and green areas weighted with the areas occupied by each colour.

When we compared our results with the experts' response we saw that there was a good correlation between the a* coordinate obtained from the reflectance spectra measured and the panel's evaluation of the level of ripeness of the apples (Marquina et al. 2004).

It seems that the panel of experts evaluated the quantity of the red area of the fruit to establish its level of ripeness and the method of spinning the fruit in front of the spectroradiometer did something similar.

In the case of measuring fruits of different colours, I would recommend this method, but I realise that it is impossible with a portable instrument. The use of digital photography to establish its colour might be able to use this idea, although it should be taken into account that the image of the fruit will be of just one part and not of the whole fruit.

To end this talk, I would like to suggest that, when they are measuring the CIELAB coordinates of a food, researchers should use some computer program which is able to reconstruct the colour on the screen. They should have a clear idea that the colour they are going to see will only be similar to that indicated by their colour coordinates, unless they have correctly calibrated the screen response, which is not normal. However, if the colour they see on the screen is not similar to the one they see on the fruit, something is wrong with the measurement method and should be corrected: the colour measured by the device should be the one we observe in the food.

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From Arcimboldo to Mondongo: Food and color in painting

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ABSTRACT

Food represents one of the ways in which a vital activity shared by all animal species (feeding) is processed and culturally codified, becoming a ritual, and exceeding the status of natural satisfaction. The own sensualities, the communicational interchanges and the aesthetic values acquire meaning in front of food, all this being integrated in cultural expressions, particularly philosophical and artistic ones.

For instance, *The banquet* of Plato is not ingenuous in taking the rituals of shared food as a frame for deep thoughts about beauty, power, love, and the human soul. And the *Last supper* by Leonardo da Vinci expresses in a pictorial way the integration of shared food into a religious fact.

But other modes of expression have been proposed through food, which are interesting because food becomes the matter by means of which reality is represented. We take two cases located in two different historical times: the case of Arcimboldo in the 16th Century and the Mondongo Group in the 21st Century.

1. BRIEF DESCRIPTON OF THE ARTWORKS OF ARCIMBOLDO AND THE MONDONGO GROUP

Arcimboldo paints sculptural images created with different food stuff making their parts, and keeping the referential colors of the food. Fruits, vegetables, meats, and other elements build creatively the figures of human faces, meaning perhaps that we are constituted by the food we ingest. He paints compositions of fruit vegetables and meats located and arranged so that human forms appear to be observed, see Figures 1 and 2.

Figure 1. Arcimboldo's autumn.

Figure 2. Arcimboldo's summer.

Among its notable pictorial modes of artistic creation, the Mondongo Group make concrete color images with different amazing materials, including food. Especially interesting are the faces and bodies created with colored cookies and candies. This group of artists produce significant erotic scenes on themes of cultural criticism through concrete compositions using food, see Figures 3, 4 and 5.

Figure 3. Mondongo's black series issue.

Figure 4. Mondongo's black series issue.

Figure 5. Mondongo's black series issue.

2. VISUAL METAPHORIC / METONYMIC LINK

In the authors mentioned the food composition images are similar to a human body image or to images of parts of them. This significant effect, in the context of the present paper, is considered a visual metaphor. It is based on a iconic similarity between the artworks images and the images of reference. Body shapes are the significant references in these pictorial expressions.

The metonymic relationship between the human body and food is based on the fact that the biological development requires food for its realization. This relation is established through the change of antecedent by consequent, that is to say, the food that precedes the biological development is placed as a substance that constitutes the developed body.

The affirmation "we are what we eat" represents the link between both metaphoric and metonymic significant effects.

3. SIGNIFICANT CULTURAL CRITICISMS

In the artwork of the Mondongo Group (specifically in the *black series*) they perform hard erotic paintings with cookies used as material of the concrete compositions.

In Spanish, the word "mondongo" (the trip) refers to an organ cut of the cow from the abdominal zone, with which people cook a food that has the same name, and this word, because of its sonorous inflexion, has connotations related to the abdominal zone as a sign of sensuality.

The meaning of these works are related to the instincts, because these artworks are about instincts and their reciprocal connections, since sexuality implies an imaginary "food" to be eaten by the lovers. The alimentary flavor is culturally united to the sexual taste and sexual flavor.

Other works of the Mondongo Group express social criticism with other materials, for example, a face made of pearls to express money and prestige.

4. CLASSIC AND CONCRETE ARTISTIC ASPECTS

The works of Arcimboldo belong to classical art because in them, a food composition is organized as a perspective representation, produced by means of traditional pictorial pigments.

In Arcimboldo and in the Mondongo Group the function of food as expressive substance is different. In Arcimboldo, food is the reference to be represented by the painting technique, while in the Mondongo Group, food itself is the substance of the technical concrete expression.

The works of the Mondongo Group can be considered as belonging to the trend of concrete art, since the expressive technical materials are involved in the production of pictorial sense. The material expressive elements of their work (cookies, candies, etc.) are related to the meaning (sense) of the work, unlike classical art where the only unique material expressive elements are the pictorial pigments for any expressed sense. But there is a difference with the conventional concrete art of the 20th Century, because in that art the material expressive substance is the pictorial paste, and there are no naturalistic reference scenes.

5. MATERIAL CONCRETE COLORED FOOD PALETTES

The concrete aspects of the artworks of the Mondongo Group make it possible to consider "colored food palettes" that replace the colored pictorial paste of the conventional pictorial art. These palettes would consist of series of colored foods such as fruits, vegetables, grains, seafood, fish, meats, spices, ice cream, chocolate, etc., see Figures 6 and 7.

The form of the pictorial paste spots (stains) on the canvas is not predetermined, unlike the basic forms of the food palette, the composition in this case would be placing predetermined forms. In Arcimboldo's paints there are represented food stuffs forming sculptures, while in the Mondongo Group artworks there are concrete preexisting forms attached or glued to the plane of expression.

6. COMPARISON WITH POINTILLISM

In the pointillism technique, the expressed forms are produced by heterogeneous and scattered colored little spots or colored points. This type of art works need to be seen from a certain distance, but the works of our authors require this condition too, and thus we can consider them similar, only in this aspect, to pointillism.

7. SOME DESIGNS WITH THE SAME OR SIMILAR IDEAS

In the following figures there are examples of editorial design and advertising where similar ideas to those presented in this paper are expressed, see Figures 8 and 9.

Figure 6. Fruits palette.

Figure 7. Spices palette.

Figure 8. Editorial design: "we are what we eat".

Figure 9. Advertising design.

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The *Last supper* of Leonardo da Vinci, analisys and interpretation

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ABSTRACT

This study on the *Last supper* by Leonardo da Vinci provides a summary of the causes of deterioration of its pigments, a summary of its latest restoration, the description of its current state and the chromatic analysis and composition of the painting. More than 500 years after its completion, a lot of this Renaissance masterpiece has been lost forever. Despite this, the *Last supper* by Leonardo da Vinci is still under study and worship and still arises controversy among historians and critics. At the same time of the *Last supper*, Leonardo was also doing the monumental equestrian sculpture for Francesco Sforza, father of Ludovico Sforza, the governor of Milan; another great work of art that would have a more tragic end that the *Last supper*, since the plaster model was destroyed and today there are not more than a few preparatory sketches. Apart from that Leonardo had also been commissioned to organize parties and banquets at the court of Ludovico, which the most famous was called The Paradise's Feast. The show date and time chosen by the astrologer of the court, required the participation of hundreds of designers, painters, actors and workers. The celebration began with a dance and costume parade continued with a banquet for which Leonardo himself wrote and designed the menu and the kitchen itself, with ovens and cleaning systems. Based on the last restoration of the work, carried out by Dr. Brambilla, it is known that Leonardo tested for this painting a variety of pigments and binding experiments. The colors that have survived until today are not the same as 500 years ago, as the work has suffered successive restorations and repaintings in the course of time, certainly have lost many of its physical and visual properties. There have been written records of the realization of the painting by Leonardo himself and by his contemporaries too. There is a record by the convent prior accusing Leonardo and his assistants not to terminate the work and to empty the warehouses and cellars of the convent in search of food appropriate for the subject. Finally Leonardo's choice for food was arranged on the tablecloth by other austere: eels, bread, oranges and wine, all painted in warm, neutral tones. As in all the plastic work of Leonardo, there is nothing by chance in the composition, and the way all its elements are interrelated. We can also find some riddles hidden in this composition, some have already been revealed and some are still darkened.

One of Leonardo's manuscripts in the *Madrid Codex*, lists his personal library, and mentions a cookbook named the *De honesta voluptate et valetudine* written by Plotinus, which recipes were taken mostly from the *Libro di arte coquinaria* by Maestro Martino di Como, both books written in the 15th century.

We really don't know why Leonardo had this cookery book, but this fact suggests that at least he was once interested in culinary arts. Maybe, when he was commisioned by Ludovico

Sforza, governor of Milano, to organize the Paradise party in honor of Gian Galeano Sforza, Ludovico's nephew.

In 1494, Ludovico the Moor commissioned Leonardo, who had just been named Engineer Ducal of the court, to materialize two major works: the equestrian monument to his father Francesco Sforza and a version of the *Last supper* in the refectory of the convent Santa Maria delle Grazie. Both of them would be extremely important in Leonardo's life, although he heard about their degradation.

It is assumed that Leonardo finished the *Last supper* in 1498, because Luca Pacioli, describes the work as completed in the preface of his *De Divina proportione* (1509).

Traditionally, the *Last supper* used to be painted in *fresco* in the refectories of the convents of those times, but the speed that these technique required was not appropriate to the aesthetics interests of Leonardo, who wanted to model colors, lights and shadows without a time limit.

Since the restoration was done by Dr. Pinin Brambilla, from 1978 to 1999, we know that Leonardo used a variety of experimental pigments and binders in this work.

The wall, on which the work was performed, has a thickness of 35 cm at the top and 40 cm at the bottom. The mortar was made with crashed rock. Leonardo applied a gypsum plaster on this mortar, which was still fresh when he applied a coat of lead white. Once it was dried Leonardo could model the pigments to his taste and time.

It is not exactly known what was wrong in the use of the technique, if any, but the story of the deterioration of this work, which is one of the top of high Renaissance, is particularly ruthless and it seems incredible that today it still keeps something of its old magnificence.

The physical study of the wall began in 1970 by order of Franco Russolo, supervisor of fine arts of Milano, the management was continued by Carlo Bertelli (1983) and the restoration was done by Dr. Pinin Brambilla.

The first step was to describe the painting and its environment in precise scientific terms. For the restoration a relief map of the wall was created with estereophotogrametry, cartographic technique used for aerial topographic mapping.

Ultrasound was used to know the thickness of the painting at about 200,000 different points, it could solve the thickness to one tenth of a millimeter, this allowed finding small craters and small places where the layers of paint began to chip away.

Hygrometers and infrared cameras could detail the contours and temperatures of humidity zones. Ultraviolet rays were applied to identify the mineral pigments used by Leonardo and to differentiate them from those used by olds restorers.

After these studies, in 1978, Dr. Brambilla began with the cleaning and removal of all previous restorations.

Despite the restoration, the colors in the painting, are not the same as they were in those times. Due to it has certainly lost a lot of surface color and much of its original qualities, we could try a pictorial color analysis only in general terms.

We can appreciate the painting maintains the traditional Leonardian structural color, which organizes the image into three areas or planes which defines the perspectivic space: a background or plane of greater luminosity, an intermediate plane in dark brown tone and a first plane or foreground in saturated colors. Leonardo scenes always had the same chromatic structure: light, darkness and saturated colors.

But in the case of the *Last supper* he added other chromatic's variable to the foreground, to be discussed later.

Chiaroscuro illuminates the wall to the right of the room where the apostles are settled, while the wall to the left is in shadow, this modeling has its reason in the natural lighting of the refectory, which windows are on the left wall. This chiaroscuro modeling, coupled with the naturalism of the figures and the linear perspective of the work, would provide the sensation of eating in the same room of the legendary dinner to the former monks of the monastery. The composition is held in the foreground, by the horizontal chromatic white tablecloth, which is covering the table, with food disposed on it.

This white tablecloth has a decorative design, with self-replicates figures, today visibly damaged, combining geometric and naturalistic image at the same time, in cobalt blue saturated on the right and desaturated on the left, corresponding to the general chiaroscuro of the composition.

On closer examination of the painting, it can be seen that the image is composed of blue zigzag lines, diamonds, frets, flowers and faced birds couples.

The arrangement on the tablecloth is made of pewter plates, glasses cups and jars, painted in white and gray achromatic.

There is no cutlery on the table. There is only the masterly hand wielding a dagger between Peter and Judas, which is discussed by historians. It is not a cutlery, but the symbol, the sign and the menace near someone of a violent death.

There are some memorable renditions, perhaps apocryphal, but which are relevant, about Leonardo's delay to finish the painting, like the famous letter from the prior of the monastery in which he complains to Ludovico “the moor”, for the delay of Leonardo to complete the work, basically because he, along with his assistants and servants, were emptying the holds and the kitchen of the convent with the excuse of searching for suitable food and wine to paint over the table of the painting.

After a year he and his aides had been trying all kind of food and wine, twice a day and there was not a single line drawn on the wall. Leonardo was certainly looking for shapes and colors for the food on the table.

Due to severe deterioration of the image, there are different interpretations of the kind of food he finally placed on it. It seems to have had mussels, eels, bread, oranges or lemons (the yellow pigment may have been obscured) and other fruits that could be pomegranates (or others) and red wine.

If we take the set of colors of the food disposed on the table, we can see it keeps warm colours orange, red, brown and earth, in contrast to the blue design of the tablecloth.

According to Varriano, the dish under the figure of Santiago the major is an eel, a common dish of the Italian Renaissance and mentioned in the recipes of Plotina cookbook, which Leonardo possessed.

In the foreground, above the horizontal white tablecloth, the cloths of the guests form a chromatic succession of cold and warm.

Looking across the picture from left to right: Bartholomew at the end of the table, wears a blue tunic with a green toga; James the Minor an orange-vermilion tunic, Andrew has an ocher tunic and a green mantle on his shoulders, Peter has a blue tunic and a orange-yellow toga around his waist, Judas wears a red tunic and on his left a blue mantle and on the side of Jesus a green mantle and John wears a blue tunic on his left and a light pink mantle on the side of Jesus.

Jesus is in the center with a red tunic on his left and blue toga on his right. On the left side of Jesus (our right) is Simon at the end of the table, he wears a light blue tunic with a light pink mantle on his left side and a white mantle on his right side;

Thaddeus wears an orange-yellow tunic and a green mantle, Matthew has a blue tunic, and Philip blue garments under a vermilion toga, James the Mayor wears a green tunic and the hand of Thomas seems to be dressed in blue.

Then, from left to right of succession it would be:

Bartholomew	blue and green
James the Minor	orange-vermilion
Andrew	green, ocher and green
Peter	orange-yellow and blue
Judas	blue, red and green
John	blue and light pink
Jesus	red and blue
Thomas	blue
James the Mayor	green
Philip	blue and red
Matthew	blue
Thaddeus	orange-yellow and green
Simon	white, yellow and light pink

To understand this chromatic sequence we can represent it through squares modules: 8 blue, 5 green, 3 red, 2 light pink, 2 orange-yellow, 1 orange-vermilion, 1 yellow, 1 white and 1 ocher. 24 colors in all. Then if we name the colors from left to right and put the squares sequence on a neutral background, we have: blue, green, orange-vermilion, green, ocher, orange-yellow, blue, blue, red, green, blue, light pink, red, blue, blue, green, blue, red, blue, orange-yellow, green, white, yellow and light pink. Light pink on the far right side of both sequences of twelve colors.

The relationship between the series of twelve colors and the number of apostles is not subject to this study and therefore I am not going to deal with this topic. The series are directed from light to dark; from the light pink at the end of the right side to the dark blue on the left, the same way as the natural lighting of the legendary room, the left wall is darker than the right one. With the addition of all the intermediate colors, the sequence maintains this sense of chiaroscuro, the left half is darker than the right half.

Turning to the color structure of Leonardo's *Last supper*, we can see that it is organized on the following way: The last plane, which includes the countryside, the hills and the sky, is in shades of high value light, with a dominant cold. The intermediate layer shows the walls and the ceiling of the room in neutral tones. The foreground is organized by the polychrome present in the clothes of the apostles, in contrast with the gray achromia of the dishes and the white achromia of the tablecloth. Its bindings in cobalt blue contrast not only with the warm color of the food, but also with the warm and dark plane under the table, which completes the chromatic dynamic of the painting.

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Between mysterious and sin: Red in pomegranate and apple

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ABSTRACT

The color red is observed in many plants, flowers and fruit in nature. Among this variety, pomegranate and apple have especially drawn our attention for a semiotic analysis since both fruit have common characteristics as being names of places and representative of plenty. As the forbidden fruit of Adam and Eve, apple is considered a sign of reproduction in many beliefs. The representation of these fruits in art is observed since early periods. Today, the traditional *nature morte* is considered an out-dated approach in terms of artistic development. Throughout the development of nature morte, the artist first acted as the imitator of nature, then the creator and finally the selector of the object. With selections from the paintings and miniatures including apple and pomegranate figures used as visuals in accordance with the main theme of the conference.

1. POMEGRANATE AS AN ATTRIBUTION IN ART THROUGH THE AGES

The color red is observed in many plants, flowers and fruits in nature. Among this variety, pomegranate and apple have especially drawn our attention for an analysis since both fruit have common characteristics as being names of places and representative of plenty. Pomegranate originated Eastern Iran and it had been brought by the cult of mother Goddess Kybele to Anatolia. The name pomegranate derives from Latin “pomum” apple and “granatus” seeded and it is the common name for pomegranate in many European languages. Although it is known as granate, means garnet, but it is still confused with the Granada of Spain. The Genus name Punica named for the Phoenicians. It is the mythological story about Phoenics who was sent by his father Agenor to seek his kidnapped sister Europe. Phoenics settled in Phoenicia and established Sidon town (Erhat 2000: 247). The word of Side, means pomegranate in Greek language and the name of legendary woman in Greek mythology also the Side town in Pamphylia named after her. There must have been a connection between these two mythological stories (Erhat 2000: 271). The word “Nar” (Turkish equivalent of pomegranate) is identical with the district of Side. This particular town is named as pomegranate in ancient Anatolian languages symbolically represents the fertility of this fruit as a fruitful region.

The representation of fruits in art is observed since early periods. They are reflected on Ancient Greek art and Roman murals as popular subjects of humanity. It is termed “kore” for woman sculpture in Greek time. Well-preserved piece from Attica dating back 575 BC must have stood over a tomb. The body is awkwardly rendered under the dress, with typical broad Attic shoulders. One hand thought of extended, holding an offering a pomegranate the other to the breast in a manner derived from Near Eastern figurines of the goddess Astarte (Boardman 1993: 56), (Figure 1).








Figure 1 Figure 2 Figure 3 Figure 4 Figure 5 Figure 6 Figure 7 Figure 8

The great picture of Telephus in Arkadia, a fresco copy from a public building in Herculaneum. it is clear that the original was a royal commission of the third to second centuries BC. The subject is Heracles' finding of his son Telephus, the hero whom the Attalids adopted as the founder of Pergamon. This narrative composition has been interspersed with some purely symbolic adjuncts of kingship. Such as a basket overflowing with fruit is the symbol of royal plenty (Boardman 1993: 177), (Figure 2). We can see pomegranate figure on the mosaic floor in Dorset. Central figure is portrayed as a fair haired, clean-shaven man with dark, rather penetrating eyes. It thought to be the earliest representation of Christ. There are pomegranates each side of him as symbol of immortality (Caygill 1999: 146), (Figure 3).

The picture of Paris Bordone represents the victory of peaceful virtue of love over the force of arms. It is dated 1500s now in the Kunsthistorisches Museum of Vienna. There is the pomegranate tree in the allegory picture including Mars, Venus, Victory and Cupid. It is a erotic scene before eating the forbidden fruit (Prohaska 2004: 26), (Figure 4). In the Greek mythology, Persephone who was kidnapped by Hades, prominently features the pomegranate. Persephone had no food, but Hades tricked her into eating six pomegranate seeds while she was still his prisoner and so, because of this, she was condemned to spend six months in the underworld every year. Pre-Raphaelite painter Dante Gabriel Rosetti painted Persephone holding a pomegranate in her hand (Figure 5).

The paintings defined as "nature morte / still life" has significance in European Art. The arrangement of various fruit in a jar does not only associate the sophisticated eating tastes but also include further meanings. Especially in Dutch painting (Figure 6**)**, these objects had become an excellent field of experimentation. In this way, the harmony as well as the conflict of colors was analyzed. The nature morte paintings which particularly take food as their subjects are called *bodegon* in Spain. Nature morte paintings emerge as new forms in different movements in European painting. From their interpretation in Cubism to Chirico and Pop Art, it is possible to view this transformation (Eczacıbaşı 1997: 1406). Enar Parsian name of pomegranate is one of the subjects in Shahname as a fruit offered to the Shah. This is a scene that illuminated in the book (Figure 7).

Today, the traditional nature morte is considered an out-dated approach in terms of artistic development. Throughout the development of nature morte, the artist first acted as the imitator of nature (mimesis), then the creator (poesis) and finally the selector of the object. Examples of the perfect selection can be seen at the photographs of Antonio Díaz who can be called as the post-bodegon (Figure 8). His photographs are not only still-life but also represent symbolic means.

2. APPLE: FROM OBJECT OF DESIRE TO THE OBJECT OF SIN

Apple is originated in Central Asia. Turkish name of the apple is "elma" and similarly "alma" in Hungarian and other Turcic languages. The name "alma" is connected with the city called Alma-Ata which is the capital city of Kazakstan. In the Latin name "pomum-pomaceous" fruit of the apple tree species Malus domestica in the (rose family). In Latin, the words for apple and for evil are similar in the singular (malus-apple, malum-evil) and identical in the plural (mala). This may also have influenced the apple becoming interpreted as the biblical "forbidden fruit". The center of diversity of the genus Malus is eastern Turkey. It must have been the earliest tree to be cultivated. We know the Neolithic revolution was occurred firstly in this region. Apples' fruits have been improved through selection over thousands of years. Alexander the Great brought dwarfed apples from Asia Minor to Macedonia. Since then it has been an important food for Europeans for Asians as it was. They stored the apples picking in late Autumn for Winter. Colonists brought the apples to America and Argentina. They were spread and desired so also were stored.

Michael Pollan, who examines sweetness as a biological desire, explores the history of sweetness' role in society as once noble, now cheap and artificial. He also explains that fruiting plants exploit the mammalian sweet tooth by encapsulating their mature seeds in the sugary flesh of fruit, so that we animals transportation to the seeds. We and the plants have evolved to use one another (Pollan 2008: 3). We know the food storage is the solution for the maintenance of human being. The fruits and vegetables stored in the underground chambers through the ages in Anatolia (Figure 9). Goreme valley is located in the central Anatolian plains.

Apple is known as a mystical or forbidden fruit in many beliefs. The Book of Genesis is not identify apple as forbidden fruit. But in Christian tradition apple is accepted as a forbidden fruit which Eve seduced Adam by sharing it (Figure 10). As a result of this, most of the Renaissance painters used Greek mythology; sometimes replacing the apple with a pomegranate, in their biblical scenes. In this way the mythological story of golden apples in the Garden of Hesperides named the unnamed fruit of Eden; the fall of man into sin, as an "apple" .The Greek goddess Eris, tossed a golden apple inscribed for the most beautiful one, into the wedding party which Paris of Troy was appointed to select the most beautiful among Hera, Athena and Aphrodite. He awarded the apple to Aphrodite causing the Trojan war (Erhat 2000: 43). Herakles is famous mythological hero of his twelve labours; one of them is to travel to the Garden of the Hesperides and pick the apples of the life tree growing at its center.

Italy was the center of humanist and idealistic art for the Nederlandish and Flemish artists. Though many painters went to Italy Hugo van der Goes the melancholic master who worked in Ghent; he created in 1475-1476. As well as the luminous coloring it was the first and foremost his ability to make visible individual experience. The two-part domestic altar with the fall typologically the representation of Salvation through the sacrificial death of Christ. The apples are pictured as naturalistic style of Northern art (Figure 11).


Figure 9


Figure 10


Figure11


Figure 12


Figure 13


Figure 14


Figure 15

Caravaggio painted apple and the other variety of fruits in the basket, a simple faded leave among other objects indicates vanishing and perishing beauty (Figure 12). In the picture of *Last supper at Emmaus* of Philippe de Champaigne includes apples beside bread and vine on the table. Nature mort subjects of Vanitas paintings has the same deep symbolic meanings (Figure 13). Still-life pictures were very popular among the rich people in 17th century in Netherlands. Fruits, flowers, already serviced table, crystal glasses are the reflections of wealth. In the picture named *Cookmaid*, a mild pornography of food can be seen. Nathaniel Bacon's painting whose ample melon evoking cleavage is contrasted with a variety of fruits to convey a traditional sense of sexual temptation. Fertility and plentitude. Such subject matter its origins in mid-sixteenth century paintings; viewing through a door or window, with a foreground dominated by an arrangement of food on the table. it must have painted in the 1620s. It is clear that it is contemporary Eve figure in front of a paradisial East Anglian landscape (Humpreys 2001: 40), (Figure 14). Thanks to Simeon Chardin who added the term of "nature morte" in French art at the end of 18th century (Figure 15). The technique creating the emptiness at the back of the picture were realized Chardin firstly and then were used by Cezanne and the cubists painters frequently (Akbulut 2006: 299).

3.CONCLUSION

The examples that apple and pomegranate as attributed as a symbol of forbidden and mysterious. In addition to these examples still-life pictures are important for artists in studying color experience. They date back as the 5th century BC, according to Pliny in his *Naturalis historia*. The pictures of Zeuxis and Parhassios were highly developed for that ages. They imitated the nature perfectly: This is mimesis. The Renaissance painters made the pictures in the same way. After later they questioned the color and examined the changing of colors with light. Apples' color is not always red in nature but it represented with the color red in the art. It symbolizes eroticism, forbidden and sin while the color of pomegranate symbolizes innocence and mysterious. Moreover the cover of pomegranate has dark spots on degrading coral color the seeds are garnet color. It is the duality of between innocence and sin: Coral color is represents mysterious and innocence, the color of seed with dark red-scarlet represents sin-forbidden.

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Color communication: Pieces of culture from photographs of food

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ABSTRACT

Cooking recipes from many cultures are found in sites about food in the internet. Along with these recipes, we can find illustrations in photographic images from ready dishes. The presences of color in these photographs are communication channels from culture where the dishes, the recipes, the sites are from. The objective of this work is to evidence constructed meanings in Brazil and United States through color analysis in photographic images that illustrates dishes in sites about cooking recipes. The dishes are selected from named "comfort food" that represents different dishes in different countries.

1. COLOR AND COMMUNICATION

Studying the perception of color is to experience relationships from several different areas. The perception of color is related to the physics, materials and pigments, using techniques, spatial organization, physiology, art and philosophy. However, investigating the symbolic social construction of color is to consider, in an interdisciplinary way, all areas mentioned. Color can be materialized in various medias. As language, each of these medias has different specifications, which interferes in the color perception.

The objective of this work is to evidence the construction of meanings in Brazil and the United States through the analysis of color in photographic images that illustrate dishes on websites about cooking recipes. The analysis of color in the photographic image will be based on three steps: the meanings of colors, the materialization of color in photography and the possible psychological effects.

2. PHOTOS AND WEBSITES ABOUT FOOD

Currently it has become common to search for cooking recipes on specific websites as the "foodnetwork.com" to the United States or "maisvoce.com" to Brazil. These websites are connected to television channels, where chefs teach how to prepare usual and sophisticated dishes. The cooking recipes are often associated with photographic images of ready meals.

The photographic image is one of the possible media for the materialization of color. The photography ontology presents specifications on the relationship between image and referent. This relationship can be mimetic, deconstructive or indexical (Silveira 2006), which interfere significantly in the symbolic construction of color meanings.

To consider the materialized color in the photographic images, this work will follow the thought of Philippe Dubois (1998), regarding the photographic image within the indexical semiotics classification of Charles Sanders Peirce (1978). The indexical photograph is seen as a trace of reality, a middle way between mimesis and deconstruction. Through this concept, the inevitable sense of reality in front of the photographic image and the existence of a physical contiguity between the photograph and its referent are recognized.

The images associated with the recipes will be considered not only as illustrations of the dishes described, but also showing the specific characteristics of the presentation of each dish, interfering in this selection of the best recipe.

3. IMAGES OF THE CONCEPT OF COMFORT FOOD

We chose the boundaries of the concept of "comfort food" to analyze differences or similarities between Brazilian and American cultures.

Form the concept of "comfort food" dishes that evoke nostalgic memories of meetings in the comfort of family, contributing to a sense of well-being, tranquility and satisfaction. The dishes that define this concept are made in house from fresh ingredients, salty and sweet (Panlilio 2003). As a cultural construction, the dishes of the concept of "comfort food" have a collective definition, but may vary individually. This work will consider only the dishes defined collectively.

In the United States, the dishes that define the concept of comfort food are: brownies, tomato soup, mac and cheese and bacon and eggs. For Brazilians, the dishes within the same concept are: rice, beans, steak, fries and tomato salad, bean soup, fried egg and hot chocolate.

The websites chosen to analyze the color in the photographs are, for the United States (www.foodnetwork.com and www.myrecipes.com) and Brazil (www.tudogostoso.uol.com.br; cybercook.terra.com.br; maisvoce.globo.com and panelinha.ig.com.br).

The collected images corresponding to the dishes in the two countries are, for the United States, Figure 1 and Figure 2. Figure 1 depicts a brownie on left and a tomato soup on right.

Figure 1. Delicious brownies and hot tomato soup (www.foodnetwork.com).

Mac and cheese is depicted in Figure 2, on left. The eggs and bacon are in Figure 2, on right.

Figure 2. Mac and cheese (www.foodnetwork.com) and bacon and eggs (www.myrecipes.com).

For Brazil, the images collected from the dishes within the concept of comfort food are in Figure 3 and 4. Figure 3 shows traditional composition of rice and beans. For this culture, this dish is the essence of food (DaMatta 2005). The same Figure 3 also brings a delicious cup of hot chocolate pictured on right.

Figure 3. Rice, beans, steak and eggs (maisvoce.globo.com) and hot chocolate (cybercook.terra.com.br).

Figure 4 depicts the bean soup and the fried egg. The soup is prepared for a quiet and restful night. The fried egg is a kind of food for every time, every day, at lunch or dinner.

Figure 4. Bean soup (tudogostoso.uol.com.br) and fried egg (panelinha.ig.com.com.br).

4. COLOR, PHOTO, COMFORT FOOD, BRAZIL AND THE UNITED STATES

To analyze the color in photographic images on websites about cooking recipes from Brazil and the United States, in order to extract information about these different cultures, we will go through three stages:

a) Symbolic social construction of color meaning in occidental cultures, where analysis will occur in two moments: identification of what colors are present in photographic images and then the meaning of those colors.
b) The materialization of colors in photographic images, where analysis will be in the context of that media.
c) Possible psychological effects, where analysis will be done through the use of meaning of each previously identified color.

Are four main colors that appear in those photographic images (Figure 1, 2, 3 and 4): brown, yellow, red and white. As we can see, the colors are the same for the photographic images of dishes in websites in Brazil and the United States. The colors meaning for the both countries are also the same. Brown has the meaning of tradition, weight, support, security, tree trunk. To the yellow, we have the meanings of light, warmth, wealth, prosperity, joy, energy. The red has the meaning of beauty, sign, mark, love, celebration, creativity, communication, fire, luxury, blood. Finally, white has the meaning of peace and knowledge.

For the second step, we will think the photographic image in the indexical form, by complementing and interfering with the perception of colors simultaneously. As we noted in Figure 1, the brownie is in perfect shape, carefully cut, tender and appetizing. The clipping of the photographic image reinforces a great sense of texture. The image of tomato soup shows a detail clipping, revealing a perfectly uniform texture.

In Figure 2, mac and cheese shown in the photographic image is bright, creamy and seemingly so easy to eat. The image of bacon and eggs shows a situation free of fat, which is false.

Hot chocolate depicted in Figure 3 seems really hot, tasty, bringing warmth and security. The image captures the careful preparation done at home. For Brazilians, the rice, beans, fried egg and steak dish is the synonym of all that is the essence of life. This image does not match the immense sense of warmth that this dish brings.

Figure 4 shows a fried egg on right, which shows a kitchen perfectly free from all fat spreads in the act of frying an egg. The bean soup pictured is extremely creamy, shiny, sophisticated.

The third step in the analysis of the presence of color in photographic images taken of the food as "comfort food" in Brazil and the United States is a brief assessment of possible psychological effects from the identification of colors used in the dishes, the meanings of these colors and which is shown in the images. In this context, brown can cause a feeling of safety, comfort, family, structure. The yellow can cause the feeling of getting a lot of energy. Red can cause attraction to food, fill up with more power, more beauty. White can cause the feeling of extreme calm, almost boring.

5. CONCLUSIONS

Based on the principle that the human-being participates in the symbolic construction of the color meanings through interaction with other human-beings in society, using the colored objects in their daily lives, changing colored objects as gifts on special occasions, using color in clothes or even eating colorful foods (Eco 1985), we can draw some initial conclusions.

The first comes from information that the colors on the dishes under the concept of comfort food in both countries are similar. The same colors, used for the same purpose, can cause similar effects of nostalgic comfort and safety of family meetings in both cultures.

Although the dishes are different, the concept of comfort is similar, when linked to security coming from brown, the tranquility coming from white, the energy from yellow and joy and appetite from red. Through the meanings of these colors, the dishes bring a sense of comfort and security of family meetings.

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It's nice… can it be tasty?

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ABSTRACT

The speech introduces the conclusions of an exploratory research on consumers as the target. This research set as basic objectives to investigate, at first term, the impact of color on the perception of food by the consumers and, in second term, the importance of color in the evaluation of that food. This assessment was considered related to the transmission of the following values: health/nature (fresh connotations, ingredients quality, production processes, etc.), appetizing (drivers to intake connected to color) and aesthetics (way in which food color integrates to daily-life esthetics). The investigation was made over three spaces of color impact: the food itself, packaging and advertising communications. Moreover, it considered food at the buying time and the consuming moment (distinguishing between daily consume and the gourmet, at restaurants). The research is registered within the theoretical-methodological framework connected to a sociosemiotic perspective. This involves the articulation of an investigation from the focus group technique with the intervention of discursive focus on the group production's analysis.

1. ANALYTIC PERSPECTIVE

For sure, color perception leads to sensations, feelings, sense assignment and associations that are connected strongly with the individual's personal history, because of its close relationship with the territory of the primary emotion. But if we detach from this perspective, only to be studied, in our view, from a psychoanalytic methodology (although the subject's personal history will never cease being present, since unconscious instances always emerge at the conscious level) we find out that this perception leagues strongly to cultural and social appreciations (like any other perception). So, this research has been set out from the beginning as an inquiry directed to understand cultural and social meanings of color, in this particular case, the color in foods.

It is relevant to point out that crystallized meanings that throughout history have been assigned to colors are rejected. Even considering only western cultures, the individual has used and perceived color differently thorough societies and periods of time (Pastoureau 2006). But even by doing a time and space cut, stable meanings can't be assigned to color without regarding the context in which they are found. We believe that this context is a discursive context, and is from the perspective of the social discourse that this study has been undertaken.

Summarizing this approach, we will say that the processes of social semiosis (the production of meaning in all orders) acquires the form of a social discourse, where continuously exists discourse production and reception. These discourses are sustained by very different supports (oral or written language, images, gestures, music, etc.) and its constituency allows the analysis. An analysis of discourse has the objective of a unitary discourse production, space-time cut of the endless social semiosis (Peirce 1988: 161-165), but it is important to remark that this cut does not forget that all discourses are connected to previous discourses and they affect the production of specific sense of the new discourse. Also, when a discourse reads another there is a certain perspective on that reading, which is also socio-cultural and can be found in discourses that have influenced the receptor discourse (Verón 1987).

We assume that color in food can only be perceived in discourses: a meal (as it produces a meaning for the one who is eating or seeing it, it's a discourse, a fragment of the socio-cultural semiosis), a photograph, advertising or a pack. This is the analytical approach that has been adopted and will be developed in section 2.

2. RESEARCH OBJECTIVES AND METHODOLOGY

The research aimed to detect appreciations and evaluations of food color in consumer profiles. This involved detecting meanings associated with color significances and, if possible, within the modest conditions of the study (with decided exploratory character), define constants in those associations.

The methodology adopted was of a socio-semiotic cut, regarding that: 1) an investigation was conducted in focus groups on public, but the group production was analyzed from a semiotic perspective and also used this approach to the preliminary analysis of material which acted as a stimulus, 2) it was used, globally, a semiotic perspective which responds to the discourse analysis approach, which, as raised in section 1, always considers socio-cultural phenomenon inscription. The research was organized in three parts:

In the first one, respondents were questioned over sensations, feelings, insights and reflections arising from the perception of color in food. Here, connections were spontaneous and by free association. Moreover, these reactions were discriminated related to different instances of the vision of food: in the point of sale, on a dish that is prepared, in a restaurant, in the communication of products. Also memories were solicited and stories connected with the topic.

In the second part, there were presented stimulation consisting of several series of photographs of food and drinks. Some food advertising was also included.

In the third phase, photos of different packs were tested among various food categories. Consequently, the research has privileged color appreciation build on their representation. This decision obeyed the context in which the study was inserted and where the sponsoring company operates: the one of communication for consumption. From this decision, it is important to note that the color becomes part of the photographic sign, with its own characters: iconicity and indexicality (Peirce 1988: 142-161, Schaeffer 1990). Since this addition, the food tested is integrated to a "connoted system" (Barthes 1997), whose level of expression is a "denoted system", given by the *real* dish, from the perception analogy as the first system of significance present in the photograph (Metz 2002). This *real* dish is interwoven by a second meaning production, typical for the photographic record, where all resources of this language take place: form definition, composition, lighting values, etc.

The inscription of food photography in advertising adds, surely, a new complexity to perception because it presents a new space of connotation. Therefore, the research established limits to people exposure to this stimulation, as the main interest was color perception of food at meals.

In the assessments made by interviewed people over color, it was addressed primarily the emergence of socio-cultural conditioning at the reading, meaning the "recognition grammar" (Verón 1987: 129) which took place in the moment of significance adjudication over the color of a dish of food.

We take up at this point what was said related to the rejection of stereotypical meanings assigned to colors (e.g. red/ passion, green/ hope). If we do not agree on obtaining these generalizations as an objective of a study, it is true that they socially circulates, as a part of the global discourse, mainly through media and can therefore integrate the "recognition conditions" (Verón 1987: 127) from which a color is associated to a meaning. In fact, this has happened in this investigation, although its intervention has been limited.

3. SOME CONCLUSIONS

Due to the presentation conditionings, we will only present some of the findings over the perception of color in the meals, leaving the ones referred to beverage appreciation, packaging and food in advertising:

Color evaluation was performed from an ideology which privileges the value of nature in food. The colors that are attributed to positive qualities in one way or another are generally the ones associated with natural colors. However, this nature is related to a *cultural nature,* meaning here a vision of nature in the discourse of culture that talk about food. Thus, while nature provides highly varied chromatics, colors that talks more about it are green and red. In third place, yellow and its derivatives (cream tones). The mentioned colors are the most closely associated with foods and drinks that represents the ideal of current consumption in terms of *duty*, such as: the salads, the fruit juices.

But the colors are perceived in forms in which it is very difficult to separate. In food, when a color is highly associated with a form, the break of this partnership creates distance, and also rejection (even if it is, at first, a *well-conceptualized* color). This is one of the ways in which this report showed the relationship between expectations of appetite or health and cultural culinary knowledge.

Colors are also associated to consistencies and textures, and this can be connected many times with more or less appeal. These belong to an association that can't easily be rationalized; sometimes it may be stated to refuse a color but with a deeper inquiry arises that the rejection is over *that color expressed in that texture.*

Color is also appreciated in relation with other colors that appear on the dish. People like more than one color, monochrome meals are less attractive. Although it's recognized that daily meals are eaten with this feature, they are far from the ideal of a well served dish. Over the two most regular color combinations, it is preferred the one that is by contrast. Tones combination within a color cast tends to be associated to a hybrid meal. The belief that different colors not only make a dish more attractive but also more nutritious, it's also expressed. This assessment is often connected with a vague knowledge on nutrients associated to color in salad ingredients; by displacement, it is applied beyond vegetables. But then, when colors are too many, the dish is not appealing. Lots of colors make them start to superimpose and chromatic excess is a new cause of distance. It's expected that a color is confined to a form but when forms evanescence and colors superimpose, there starts the rejection. In foods, a color contained in a form may reassure people but when it expands without limits it can generate worry.

Other aspects of importance in the evaluation are the degrees of saturation and lighting. Saturation has a peak, typically between the middle and the top (tolerance varies according to people). Mistrust and rejection toward the dish increase as the color saturation reaches black color. In contrast, when it drops below the optimal intensity, they tend to ascribe weak flavor (bland). Tolerance to saturation that exceeds average level decreases in a notorious way in not familiar dishes. Also, in terms of brightness, there is an optimum; everything below that level transmits tastelessness and excess of brightness does not seem to fit the representation of food: the presence of brightness refers to artificiality, but in addition, if the light is excessive and blurs the outlines, that is another cause for the loss of a food form and slurring of colors, both reasons for refusal.

During the inquiry two attitudinal profiles were revealed. While it was noted that all respondents confer importance to color in foods, there was a profile that had already become aware of their perception and offered a more or less articulate discourse on the subject. This profile, when cooking or serving food, tries to make it chromatically attractive. Also, evaluates with the same criteria a meal that is presented, for example, when eating in a restaurant. On other side, the second profile has expressed not having repaired on the relationship between food and color. While there was a greater presence in the first profile of respondents more connected by their lifestyle and/ or their profession with universes of aesthetics in general,[1] this relationship wasn't exclusive; also appeared emergent people without connection to these universes and still paid attention to color in the presentation of the food. But it is also true that although this last group's lifestyle wasn't connected with the aesthetic space, they still were sensitive to their values (e.g. in their houses decoration or in the appreciation of the natural world). The opposite trend was also presented: profiles whose lifestyle or profession universes were connected with aesthetics, but did not associate food to those territories.

Finally, even there was a previous articulated discourse or not, it became clear that the color in the presentation of meals was an issue that, for all, spoke of the values of the dish.

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[1] In recruitment conditions, there were considered variables connected to personal style and lifestyle detected from a previous questionnaire, as well as age level and genre.

The colour of food and its relationship to appetite appeal

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ABSTRACT

How important is the visual appeal of food we prepare for ourselves? Perhaps when our health is good the visual appearance of home-prepared meals is of little consequence, as long as the food tastes good and satisfies our hunger. But if we're not well, then food not only nourishes our body, but also benefits our state of mind by encouraging us to eat. Does strong and varied colour equal perceived flavour, and monotone or lack of colour a lack of flavour? The study addressed the hypotheses that the most visually appetising meals would approximate complementary or triadic colour schemes, and the least appetising meals would relate to monotone or analogous colour schemes. To test this postulation selected students undertook investigations into the colour of meals they prepared. The results confirmed the importance of colour in appetite appeal, but also defined the specifics of colour in relation to culture, and whether the meal was breakfast, lunch or dinner. It seems our expectations vary in this respect. The value of analogous colours *plus* a complementary colour was recognised while too much colour was seen to be as unappetising as too little colour. A follow-up expanded study reassessed the link between colour and visually appealing meals. The earlier findings were confirmed.

1. INTRODUCTION

It is well established that we "eat with our eyes" before placing food in our mouth to taste it. This fact is important when the selection of food involves a choice between several or many observable options. A question therefore arises as to the importance of the visual appeal of food we prepare for ourselves. Does it matter if home cooking has appetite appeal or not?

It is thus important to examine the role colour theory might play in relation to the visual (appetite) appeal of a meal, prior to consumption. While professionals in the food industry are aware of the importance of colour to appetite appeal, I propose that the majority of people preparing a meal for themselves or their family do not fully realise this significance. (It is interesting to note that the cookery books I researched do not appear to place any relevance on the colour composition of presented food.).

Further, I propose that the most visually appetising meals approximate complementary or triadic colour schemes, and the least appetising approximate monotone or analogous colour schemes. To examine the foundation of this hypothesis, selected students from my Colour in Context elective course (Queensland College of Art, Griffith University, Australia) were asked to describe a meal and photograph it prior to eating. They were also asked to rank the degree of hunger they felt, the appetite appeal (based on the colour/s of their meal), and the actual taste (when finished eating) on a scale of one to five, where one represented "not very" hungry, appealing or tasty, and five represented "extremely" hungry, appealing or tasty. Three study outcomes were chosen as a focus, as they represented data from both genders and varied cultural backgrounds –Australian, Mexican, and Taiwanese. In addition, other images and responses were included in the survey that followed.

2. CONTEXT

Foods represent all colours of the spectrum / colour wheel, although some colours are more common than others. Research shows that eating a "Rainbow Diet", a diet rich in colour, is important for good health and wellbeing.[1] Indeed, complementary colours add vibrancy and intensity to each other and so "look visually appealing on the plate" (Dalrymple 2010). The complements of red and green, however, are more prevalent in food than are blue and orange, or yellow and purple. Similarly, an analogous colour meal unifies the various foods, however it lacks visual vibrancy. While a mono-colour meal may taste good, it is very unappealing as there is no visual variation. In 1997 the Colour Society of Australia included a seminar lunch that consisted of only white foods for soup, main course and dessert.

> Many diners felt uncomfortable while eating because the choice between food identification and conversation had to be made. Although there was a wide variety of foods available some diners found the occasion 'boring' and Chef John O'Connor stated it was the most depressing meal he had ever created. (Hutchings 2003: 143)

Thus according to Dalrymple (2010), "a range of colours breaks the meal up". Nevertheless, what makes an exciting or eye-catching colour combination, in a design sense, may not evoke the same response on a dinner plate, such as a triadic combination of orange egg yolks, green spinach, and purple potatoes. For this reason "foods need to meet preconceptions of what is normal … the preconception of taste affects the taste buds".

Further, food colour affects appetite, prepares the palette for the tastes to follow, and enhances the enjoyment of food. Studies demonstrate that the addition of an artificial sweetener to orange juice can remain undetected, whilst food colouring that slightly darkens the juice is perceived as a taste change (Alba and Hoegg 2007). As Dalrymple (2010) observed, "colour gave perceived taste change – actual taste change was unregistered".

3. INITIAL OBSERVATIONS

Just as colour is an integral part of our life so is food. For this reason Dalrymple explored the connection to determine "whether colour combinations of foods effect the visual appeal of the overall meal." He produced a series of personal accounts on the colour combinations of meals he ate over the course of two weeks, recording the food and ingredients, time of day, visual appeal, actual taste, and colour observations.

Importantly Dalrymple observed that for "dishes containing complementary colour combinations, the general visual appeal of these meals were high. The meals looked fresh and healthy and vibrant." He noted that analogous coloured meals had "fairly good visual appeal", only slightly less than complementary colour combinations, and that the meals were unified but lacked visual vibrancy. The colours sat comfortably together on the plate, but "nothing jumped out or demanded attention". Such meals, therefore, had visual appeal, but this appeal was less than the complementary coloured meal combinations.

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[1] Dr. Eric Braverman conducted research while at Harvard Medical School into the nutritional value of plants based on their colour, and so devised the Rainbow Diet.

Dalrymple found monotone-coloured meals to be least appealing as they were "visually boring and unattractive", with no contrast and nothing to catch "the eye of the viewer".

In another study, Garcia Lopez (2010) photographed all meals for one week. He briefly described the ingredients, degree of hunger, degree of visual appetite appeal, and the taste of each meal. At the end of this period he surveyed thirty people, asking them to choose between the photographed meals based only on colour appeal. He noticed that Asian and Latino responses provided similar results, mainly the preference for bright food colours like red and green, compared to Europeans / Australians who mostly preferred pale colours, beiges and browns. All cultures agreed that yellow was the least favoured as a food colour.

Following this initial survey, Garcia Lopez adjusted his methodology to survey ten Asians, tens Latinos and ten Europeans. The results indentified a preference among all three nationalities for meals that contained three colours, and the least preference for meals with only minor colour variation. (He also observed that food colour preference is related to personal history for example whether or not food was scarce in their youth, or whether a particular food brought back fond memories or not.)

Dalrymple (2010) identified that,

> Based on judging meals on a singular element, such as the colour combinations, the complementary coloured dishes performed the best, however, the most visually appealing meals contained both complementary colours and analogous colour combinations ... The single coloured meals were dull and least interesting of the group.
>
> The taste of a meal could not be completely determined by the visual appeal of a meal, a dull monotone meal could taste better than a brightly coloured dish. It is difficult to determine explicitly that visual appeal is linked with taste, although expectations of taste are higher with a visually appealing meal.

4. SURVEY AND FINDINGS

In the follow up study, ten colour photographs, for each of a variety of breakfasts, lunches, and dinners were shown to thirty participants (mainly staff at Griffith University, Gold Coast Campus). The participants were asked to rank each meal within the group from the most visually appetising to the least. The most preferred breakfast contained a warm analogous and tonally varied colour mix, whilst the least preferred contained a monotone, single scheme.

The most popular lunch image contained a greater tonal range of warm and cool colours (neutral, analogous and complementary), whilst the least popular comprised a warm neutral colour scheme. The most preferred dinner meal contained a complementary warm and cool colour scheme in a tonal range of the most variation. Neutral colours in a limited tonal range again were the least popular image. Interestingly, there appears to be a preference trend towards stronger coloured meals as the day progresses; however, relatively colourless dishes are unappealing at any time of day.

The findings support the supposition that colour and the appeal of various foods are closely related. Just the sight of food fires the neurons in the hypothalamus (Goldstein 2002). For the sighted, the eyes are the first sense that must be convinced before a food is even tried. The visual appeal of a food is determined by the preconceptions of what is considered (culturally) "normal". Regardless of the final taste of a meal, the consumer has formed an opinion about the meal before it even reaches their taste buds.

5. CONCLUSIONS

Generally it can be stated that whether we are eating out or at home, the visual appeal of food is important. These outcomes are confirmed by the results from both the student investigations and the survey of meal group images. Further, we appear to prefer and enjoy more colour in our meals, especially as the day progresses. Could this visual aspect be linked to a physiological need? In addition, the findings strongly indicate that the most visually appealing meals contain analogous coloured foods, plus at least one complementary or contrasting coloured food. This outcome directly supports the findings from a class activity I undertake with my students to find the most appealing colour trios. The most popular, as voted by each class, are always two related colours plus one contrasting. Thus, it appears that our visual appreciation of colour is constant, regardless of the context.

The findings of the two studies suggest that further research is required to identify the importance of the visual appearance of food to healthy and unwell people. Perhaps, when we are not well, colourful meals could encourage us to eat, just as children are encouraged to eat with colour. This data may be of interest and benefit to groups, such as social welfare organisations (that support life skills training), hospitals and old people's homes where nourishing the body can sometimes be a difficult task as the unwell often don't feel like eating. I assert that if a meal meets the preconceptions of colours for each food type, then a dish containing both complementary colours and analogous colours is most visually appealing. Finally, there is a link between colour and visually appealing meals, wherever they are eaten and from whichever kitchen they are produced.

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Colour evaluation of green tea drinks by Thai observers

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ABSTRACT

This study aimed at investigating colours of green tea drinks in terms of observers' preference and their associations with tastes. Twenty-three liquid coloured samples were generated using food colourants, covering the range of colours of green tea drinks available in the market. The experimental samples contained in 250 ml PET bottles were presented in a light booth illuminated with D65. Visual experiments were carried out in a darkened room by 40 Thai observer, whereby observers' tasks were to regard the samples as green tea drinks and make their judgements on acceptability and preference using a 1 (the least) - 5 (the most) integer scale. Observers were also asked to provide their expectations of tastes. The colours of green tea drinks available in the market were noticeably different and ranged from yellowish to brownish. Observer accepted colours within this range as green tea drinks due to familiarity. It was found that the most preferred colour of green tea drinks was light brown and it was associated with tasteless.

1. INTRODUCTION

It is well known that appearance properties of food products have an effect on the perception of food quality (Francis 1995, Jaros et al. 2000). No food would be accepted without the acceptable appearance. Studies on consumer response to food and sensory evaluation have thus become of great interest and the number of published papers has increased over the past decades (Tuorila and Monteleone 2009). Previous studies showed that colour played an important role in consumers' preference for beverages (Tang et al. 2001, Duangmal et al. 2008). Consumers have expectations of taste based on the colour of beverages.

Recently, green tea has become one of the most popular drinks in Thailand, as it has been claimed for health benefits to regular green tea drinkers. Commercial green tea drinks are usually contained in a clear bottle. The colour of green tea drinks is thus one of the major attributes that affect consumers' impression on the product. This study investigated a range of colours of green tea drinks in Thailand and their association with consumers' expectation and preference.

2. EXPERIMENTAL METHOD

To investigate the colour range of green tea drinks, a number of green tea drinks from four major brands, namely, Fuji, Kirin, Oishi and Unif, were randomly sampled from various places, and their colours were measured in terms of CIELAB values using a HunterLab ColorQuest XT spectrophotometer with a 50-mm path length cell. Not much variation was found within the same brands; however, the colours from different brands were distinctly different, ranging from yellowish to brownish colours. Figure 1 shows the average CIELAB values of the green tea drinks obtained from the four brands.

Twenty-three liquid coloured samples were generated with a mixture of water and food colourants, i.e. Tartrazine, Sunset Yellow FCF, Brilliant Blue FCF, Caramel, and Ponceau 4R. These 23 experimental samples were created in a way that they perceptually provided a good coverage to the colours of green tea drinks available in the market. The distributions of sample colours in the CIELAB space are shown in Figure 1.

In visual experiments, the experimental samples contained in a 250-ml PET bottle, as illustrated in Figure 2, were placed in the middle of a light booth under D65 illumination. The experiments were conducted in a darkened room. Observers assessed the samples one at a time and the order of samples was randomised for each observer. Observers were instructed to regard the samples as green tea drinks and rate their acceptability and preference using a 1 (the least) -5 (the most) integer scale. Note that in the case of acceptability observers were also informed that a score of 3 was considered an acceptable level. Observers then provided their expectation of taste in association with the sample colours.

Forty Thai observers, including 20 males and 20 females, ranging in age between 18-25 years old, participated in the visual experiments. All observers had normal colour vision.

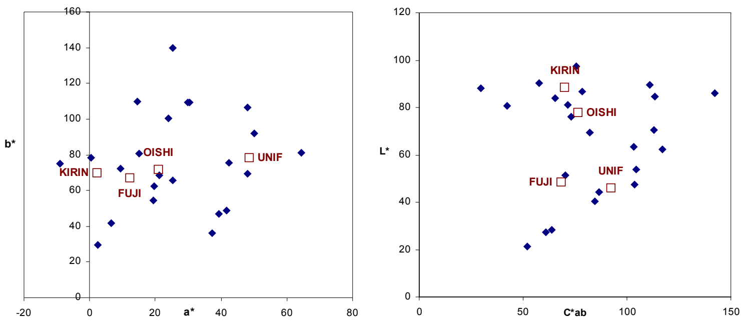

Figure 1. The distributions of samples in a- b* plane, and L*- C^*_{ab} plane.*

Figure 2. An experimental sample.

3. RESULTS AND DISCUSSIONS

3.1 Acceptability

The visual scores obtained from all observers were averaged, in which samples with an average score of 3 or above were considered acceptable as the colours of green tea drinks. The results are shown in Figure 3. The acceptable samples scattered around the colours of the four brands. This is possibly due to the fact that observers are familiar with these colours and do not accept any other colours that fall outside the familiar range, which is ranging from yellowish to brownish colours.

Figure 4 shows the relationship between visual scores of preference and acceptability. The results showed that below the acceptability level, preference scores were lower than acceptability scores and both aspects were highly correlated with an r-squared of 0.9861. This reveals that observers would accept the colours as green tea drinks only when they liked the colours and these two aspects can hardly separate from each other.

Figure 4 shows the relationship between visual scores of preference and acceptability. The results showed that below the acceptability level, preference scores were lower than acceptability scores and both aspects were highly correlated with an r-squared of 0.9861. This

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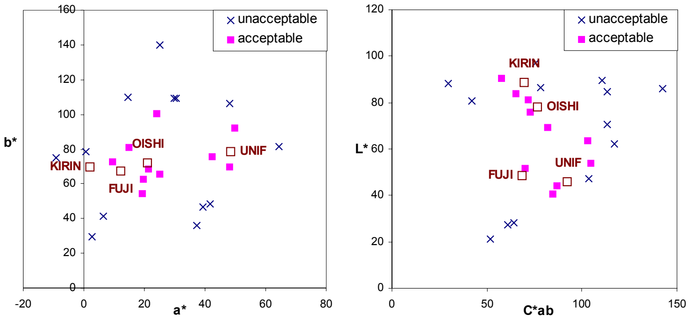


Figure 3. The acceptability of colours in a-b* plane, and L*-C*$_{ab}$ plane.*

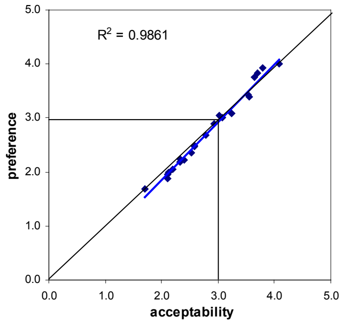


Figure 4. Agreement between acceptability and preference.

3.2 Preference

Figure 5 shows colour preference for each sample, whereby the size of each dot represents the magnitude of preference. The data were grouped according to tastes that majority of observers associated with the samples. It was found that observers tended to prefer samples having similar colours to green tea drinks of the four brands. The most preferred colour was light brown (L*, a*, b* of 80.96, 21.28, 68.4, respectively) with a visual score of 4.0, and majority of observers associated it with tasteless. Nevertheless, most highly preferred colours were associated with sweetness. This results agrees with the finding of Tang et al. (2001), who revealed that sweetness was a strong promoter of overall pleasantness of soft drinks.

The expectation of taste with respect to colour could be observed: yellowish was associated with sweetness, high lightness with tasteless, and low lightness with bitterness. Observers' experience with the tastes of green tea drinks of the four brands could also influence the results. The further investigation regarding taste association is given in the following section.

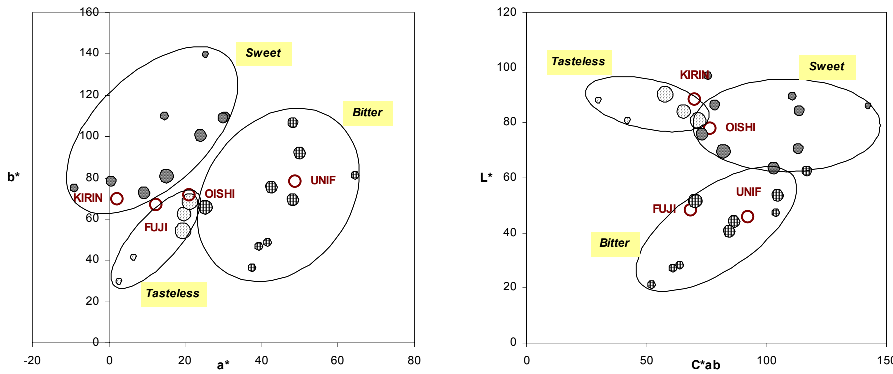
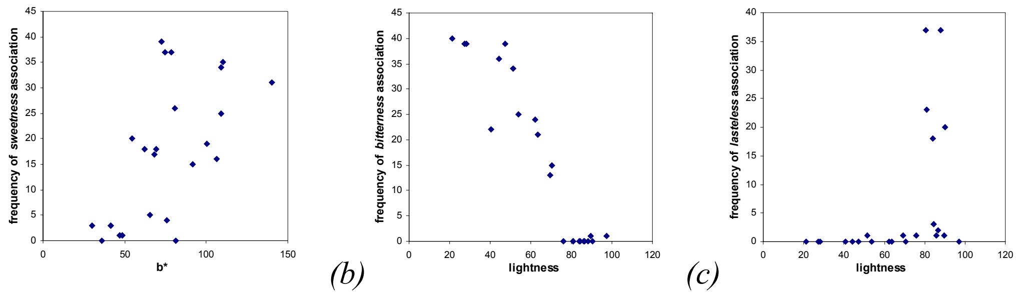


Figure 5. The magitude of colour preference in a-b* plane, and L*-C*$_{ab}$ plane.*

3.3 Association with taste

In the visual assessments, observers provided the expectation of tastes in association with colour of the samples and four tastes, i.e. sweet, bitter, tasteless and sour, were collected. No other tastes were reported and only few observers answered sour. This is possibly because the three tastes (sweet, bitter and tasteless) are common for tea. To reveal the correlation between the expectation of tastes and colours of green tea drinks, response frequencies of tastes were plotted against colorimetric values. Figure 6 (a), (b), and (c) show the major findings for sweetness, bitterness, and tasteless, respectively. It was found that a number of observers associated the samples with sweetness tended to increase with the increasing b* value, implying that intensity of yellowness is related to sweetness.



(a) (b) (c)

Figure 6. Associations between tastes and colorimetric values: (a) sweetness-b, (b) bitterness-L*, and (c) tasteless-L*.*

In the case of bitterness, the results clearly showed the tendency of bitterness with the decreasing lightness of the samples, i.e. a number of observers responding that the samples were bitter increased when the L* value decreased. On the contrary, samples with high lightness were associated with tasteless, as can be seen in Figure 6 (c).

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Color determination in dehydrated fruits: Image analysis and photocolorimetry

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ABSTRACT

Dehydrated fruits are prone to suffer discoloration during storage, which diminishes its quality and consumer acceptance. Many natural pigments are unstable in dried media, and also brown pigments can be formed. The objective of this work was to evaluate the kinetics of color changes in freeze-dried pear, melon and strawberry slices. Color changes were determined using a computer vision system (Briones and Aguilera 2005, Acevedo et al. 2008) and a photocolorimeter. Pear and melon presented homogeneous color distribution. Due to browning during storage, a* and b* values increased and L* values decreased. Strawberries presented heterogeneous color distribution, then for the image analysis the slices were divided in 4 different zones according to their a* values. The heat treatment also caused browning and anthocyanin destruction. The color changes in strawberry were better represented by the a* variable, showing a decrease along storage time because the heat treatment caused anthocyanin pigment destruction. Before storage at 45 ºC the a* values were distributed in different sections. As increasing storage time a reduction in the a* values is observed. Also, at the highest RH analyzed the strawberry slices became homogeneous. Computer vision analysis is a useful tool to assess optical properties and allows the analysis of heterogeneous materials.

1. INTRODUCTION

Foods containing reducing sugars and proteins are particularly sensitive to browning reactions. Solubility decrease, color development and the loss of nutritional value are the most important causes of deterioration associated with browning in foods (Buera et al. 1987). Dehydrated fruits are considered to be highly stable. However, they are prone to suffer discoloration during storage. Many natural pigments are unstable in dried media, and also brown pigments can be formed. These color changes cause deleterious changes in food appearance and organoleptic quality, and may be an indication of the decreased nutritional and functional properties of foods. Food discoloration can occur homogeneously, but most of the times heterogeneous distribution of color is observed. The objective of this work was to evaluate the kinetics of color changes in different dehydrated fruits as a function of relative humidity.

2. MATERIALS AND METHODS

Strawberry, pear and melon were cut into discs (2.0 cm diameter and 0.5 cm thickness), frozen with liquid nitrogen and freeze-dried. The freeze drier was operated at –84 ºC, at a chamber pressure of 0.04 mbar, and the process lasted 48 h. To determine browning, discs were equilibrated in a range of 11-93% RH for 14 days at 20 ºC (Greenspan 1977). Then, samples were located in rubber o-rings between two glass plates hermetically sealed (to avoid water loss), and placed in an oven at 45 ± 1 ºC. Color changes were determined using a computer vision system (for strawberry) and a photocolorimeter (for melon and pear). Images were taken in a standardized black box using a D65 illuminant and a digital camera, a Power Shot A70 (Canon Inc., Tokyo, Japan) was used. Color images were digitized into pixels of 24 bits containing levels of the three primary colors: red, green and blue. Then RGB values were converted to the CIELAB coordinates L^*, a^*, b^* using mathematical formulas described previously Papadakis et al. (2000). The photocolorimeter measurements were performed at 2º observer and D65 illuminant.

3. RESULT AND DISCUSSIONS

Figure 1 shows the changes of the color functions observed for melon and pear upon humidification at 20 ºC and storage at 45 ºC. Both fruits presented homogeneous color distribution.

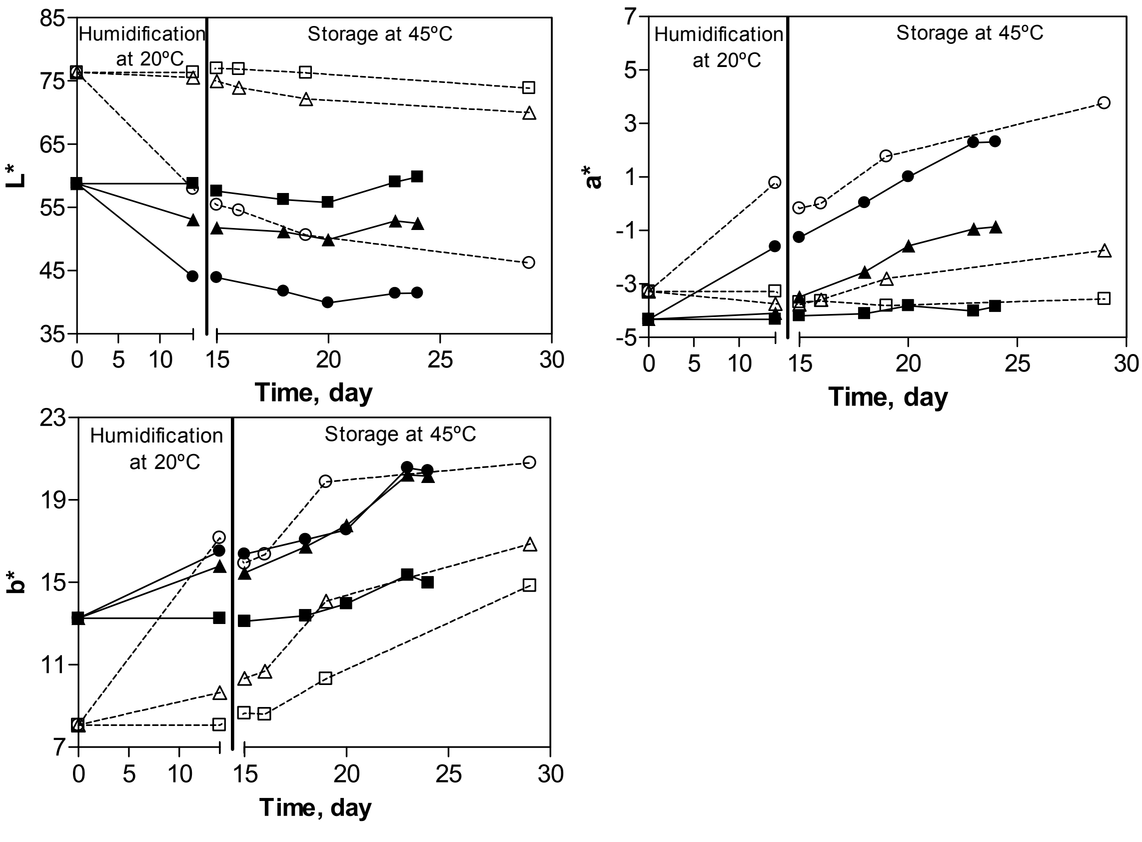

Figure 1. L, a* and b* changes as a function of time for melon (black symbols, solid lines) and pear (open symbols, dashed lines) at 11 (■, □), 43 (▲,△) and 84 (●,○) % RH.*

During storage at 45 °C and due to browning reactions a* and b* values increased and L* values decreased causing a change from the original clear color to different browning degrees. These changes were more important with the increase of relative humidity (RH).

Strawberry samples presented heterogeneous color distribution. Therefore, image analysis was performed. Since in this case the color changes were better represented by the a* variable, the images of the strawberry slices were divided in 4 different zones, according to their a* value (Figure 2). In all systems L* values decreased with storage time and RH increase (not shown). Also, a* values decreased with storage time at 45 ºC because the heat treatment caused anthocyanin pigment destruction. At the highest RH analyzed the strawberry slices became homogeneous.

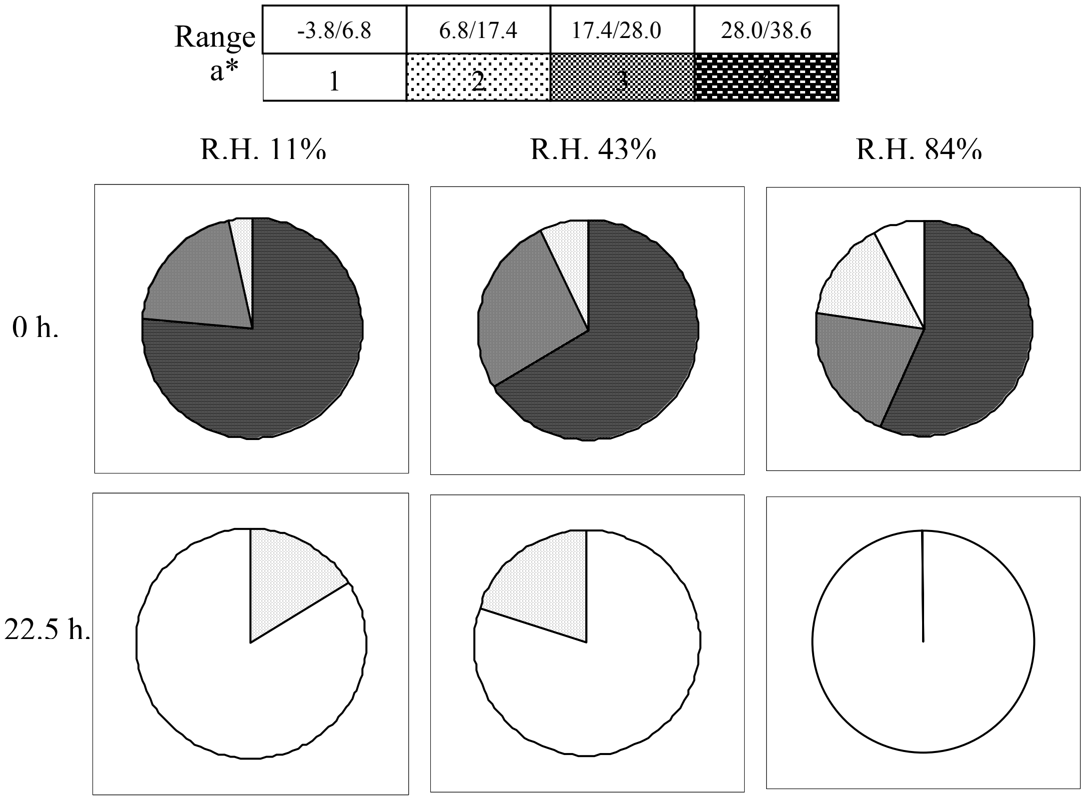

Figure 2. Percentage of pixels corresponding to different sections of a values for 0 and 22.5 hours of storage at 45 ºC at 11, 43 and 84% RH.*

4. CONCLUSIONS

Photocolorimetry is a simple and easy technique to evaluate color changes, but it shows a limitation for the analysis of small areas or of heterogeneous samples. Computer vision analysis is a useful tool to assess optical properties of fruits with heterogeneous color distribution, based on its simplicity. It also allows the quantification of areas with different chromatic characteristics.

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Color study at storage of lyophilized carrot systems

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ABSTRACT

Foods derived from fruit and vegetables provide not only water, fiber, vitamins and minerals, but also phytochemicals. There is evidence that phytochemicals are highly beneficial, because they counteract the oxidative stress induced by free radicals, which is involved in the etiology of a wide range of chronic diseases. Hence, there is a need of antioxidants consumption. It is therefore proposed as an objective of this work, to study the stability of β-carotene in its natural matrix, encapsulated with different molecular weight maltodextrins. Freeze-dried systems were stored in atmospheres of different water activity. The effects of storage stability and wall materials in carotenoides degradation kinetics were investigated. Encapsulation process followed by freeze-drying was evaluated by spectrophotometric quantification and analysis of color. The source choice of β-carotene, carrots, has responded not only to the excellent composition of the raw material, but also to its high availability throughout the year. In freeze-dried carrots systems, the color study through the relation b * / a * was useful, while the luminosity is highly dependent on the systems composition and it is heavily influenced by the presence of water. The presence of maltose or maltodextrins, generates much less change in color. The worst storage situation corresponds to the highest water activity, 0.75. The preservative effect of maltodextrin systems was evident. Among the different encapsulating materials, the best effect was provided by the MD150 maltodextrin. Both the optical and electronic microscopy have proven excellent tools to verify the excellent coverage of maltodextrins. The gained knowledge of the deterioration phenomena of carotenoid pigments in their natural matrix, can be implemented on the development of innovative functional foods, beneficial to the population health.

1. INTRODUCTION

Beneficial effects in prevention of many chronic and degeneratives diseases are attributed to vegetal pigments, mainly through theirs antioxidant properties. Particularly β-carotene and lycopene stand out by their antioxidant action. Carrot is the most important source of first, whereas tomato and watermelon are of the second.

The isolated pigments of natural raw material and laboratory synthesized analogs do not present the beneficial properties with equal intensity to that found in vegetal matter studies. This can attribute to different stability and absorption of phytochemical or other substances absence that accompany the pigment in their natural state and are necessary for its physiological action. Nevertheless, the fresh raw material is perishable and seasonal and with a variable pigment concentration against the pure pigment preparations. The encapsulation by freeze-drying is an excellent tool to preserve these compounds. It is therefore proposed as objective of this work, to study the stability of β-carotene in its natural matrix, carrot pulps, encapsulated with different molecular weight maltodextrins, in different storage conditions.

2. MATERIALS AND METHODS

Carrots were washed, peeled, cut in pieces, steam blanched and ground. The obtained juice/pulp mixtures were treated with pectinase and hemicellulase enzymes, mixed either with Calcium Chloride (MCa), maltose (M) or maltodextrins of different molecular weights (MD40 and MD150) and then freeze-dried. Freeze-dried samples were equilibrated at three different water activities (a_w = 0.11, 0.44 and 0.75) and submitted to accelerated stability tests (55 °C) during different time intervals. Enzymatic treatment enhances tissue disruption and pigment extraction. The surface color of the samples was measured with a Minolta integrating sphere spectrophotometer and CIELAB L*, a*and b* coordinates obtained. Control samples were made of unblanched (C) or blanched (CE) carrots without enzymatic treatment nor any other substance added.

3. RESULTS AND DISCUSSION

Figure 1 shows the storage behavior of controls and MD40 maltodextrin added samples equilibrated at different water activities. The b*/a* ratio was selected as a good indicator of vegetable color changes in the red-orange hue (Little 1975). As the red pigments decomposes b*/a* noticeably increases. As expected the most remarkable change took place with the unblanched control samples. Another color function which could correlate with the food appearance is the luminosity, L*.

Figure 2 shows L* values as a function of storage time of several different samples. L* differences during storage are not significant. Nevertheless their initial values were very different according to the composition of the samples. The initial L* value was affected both by blanching, enzymatic treatment and the matrix structure. Samples with added calcium have higher L* and also those with less water (low water activity).

The most wet samples have a darker appearance due to a transparency effect caused by water on the structural biopolymers of vegetables (Agudelo-Laverde 2008). Tang and Chen (2000) encapsulated β-carotene in sucrose and gelatin matrices and showed that there was a small decrease of luminosity throughout the storage to 45 °C, whereas the parameters a* and b* were not indicative of deterioration. Luminosity is highly dependent of superficial phenomena, such as porosity, topography, and superficial humidity (Prado et al. 2006). Figure 3 depicts different freeze-dried carrot samples after 21 days of storage. At aw = 0.11 can be seen clearly the dilution or coverage effect of color in samples with maltose and maltodextrin. On the other hand the deterioration is greater at high water activities.

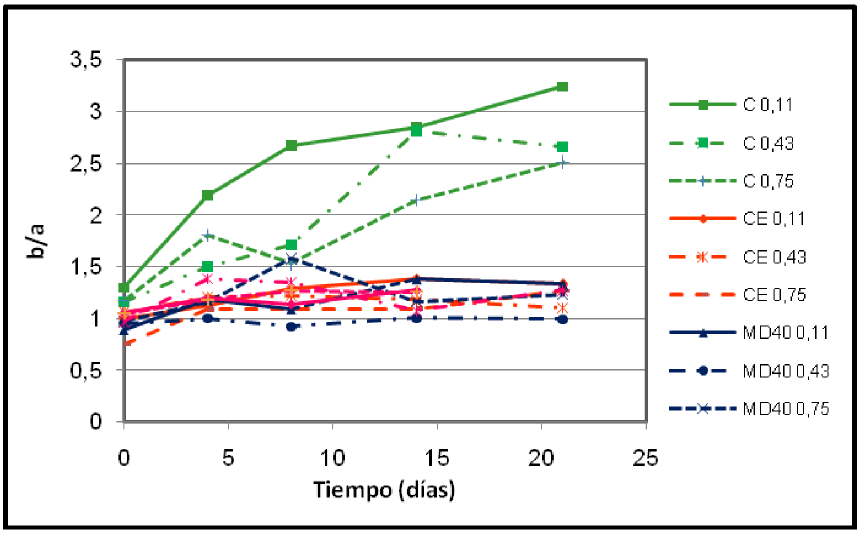

Figure 1. b/a* in dehydrated carrot samples during storage.*

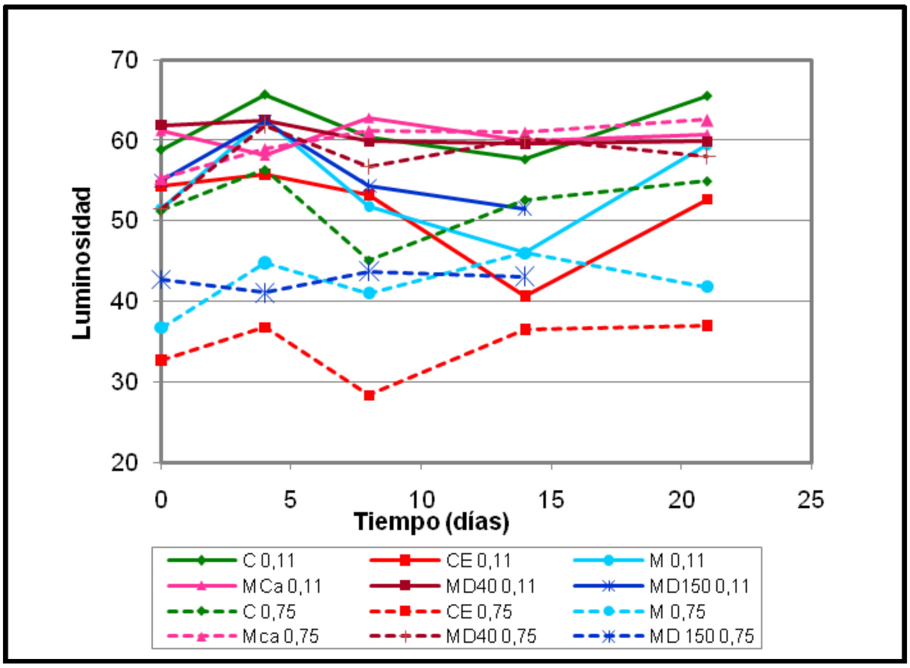

Figure 2. L behavior in dehydrated carrot samples during storage.*

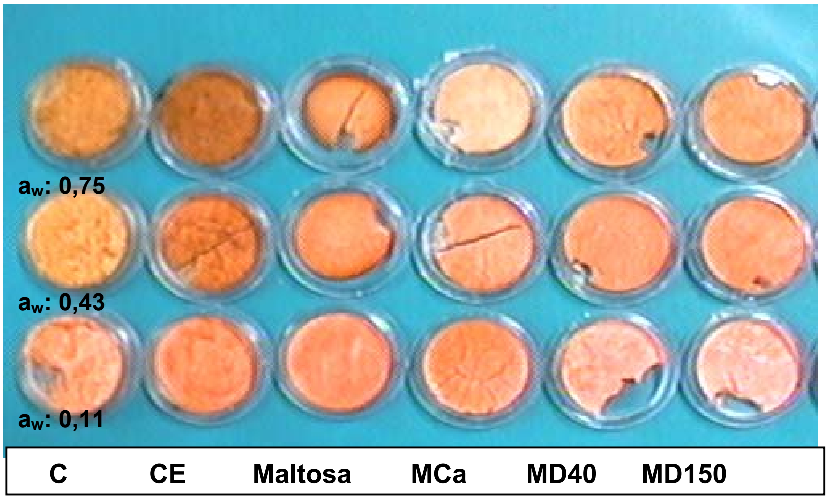

Figure 3. Dehydrated systems of carrot in different matrices during 21 days of storage from aw: 0,11, 0.43 and 0,75.

4. CONCLUSIONS

The lyophilized carrot systems described are more concentrated β-carotene sources than the raw vegetables. The β-carotene losses during processing and storage could be related to the b*/a* ratio. Instead, the luminosity values are highly dependent on systems' composition and on the surface characteristics of samples. While the appearance seems little related to the pigment concentration, it is highly influenced by the water content. The more unfavorable storage situation corresponds to the greatest water activity studied, 0.75. In the freeze-dried carrot systems of intermediate and high water content (aw = 0.43 and 0.75) the encapsulation with MD150 is the one allowing more pigment retention during storage. The protecting action of maltodextrins was also evidenced by structural studies made with electronic microscopy. The encapsulation process herein described which combines natural biopolymers and pigments of known antioxidant activity could be a useful tool in the development of innovative functional foods, of adequate appearance and health-promoting properties.

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Spectral signatures: A way to identify species and conditions of vegetables

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ABSTRACT

This work shows the results obtained by the application of suitable techniques for the acquisition and processing of spectral absorbance data of several vegetable species, allowing its identification –assignment of each spectral signature to one specific plant- which in turn allows the control of origin of products (foodstuffs or not) and their characteristics. Spectral measurements of absorbance were performed on samples of two sugarcane varieties and four citrus types (orange, lemon, tangerine and grapefruit) taken periodically from a controlled crop, using a spectrophotometer FOSS-NIR 6500 in the range of 400-2500 nm by 2 nm. The measured samples were about 240 in the case of sugarcane and 160 in the case of citrus. A Principal Component Analysis was applied to the data by means of STATA 9 software and the results were interpreted in that PCA context. This procedure allowed us not only to clearly identify which variety of sugarcane corresponds to each spectral absorbance function, but also to determine which wavelength or wavebands have significant relevance for that identification. Similarly, this technique allows us to identify and classify the spectral functions coming from different types of citrus. The main conclusion is that the proposed technique is capable to precisely identifying the species each sample comes from; besides, this technique would allow us to determine the nutritional or health condition of them at the moment of the analysis, as could be seen from the obtained results.

1. INTRODUCTION

When the optical radiation reaches the surface of any of the numerous components of the environment is subject to one or more of the following processes: it can be reflected, transmitted or absorbed, according to energy conservation laws. The characteristics and intensity of this behaviour depend on the material and surface quality the radiation impinging on. The particular combination of elements making up the material staff, their proportions, quantity, size and form will determine the characteristics of the interaction, setting which aspects of the incident radiation will be modify and in what extent.

The energy of the electromagnetic wave is related to its wavelength in such a way that the smaller the wavelength, the more energy a given wave contains. When this energy reaches the surface of a body it is either reflected from, absorbed by or transmitted by it. The degree and intensity of each process being determined by the wavelength and the physical and chemical properties of that body (Scotford and Miller 2005).

The spectral reflectance in plants is influenced, besides the absorption of their elements, by the structure of the surface and the cells in the leaves (Zwiggelaar 1998). Leaf optical properties are a function of leaf components and structure, water content and the concentration of biochemicals (Asner 1998). According to numerous research works and scientists, spectral reflectance in the visible and near infrared region (400-2500 nm) is a powerful and fruitful tool to evaluate properties and situations of plants and crops. Consequently, most agricultural studies use measurements in the visible (400-700 nm) and near infrared (700-2500 nm) region of the spectrum. Many studies performed in the last few decades sustain that optical properties in this region can potentially detect physiological and biological functions of plants and crops, offering potential for applications in agriculture (Scotford and Miller 2005). Some researchers proposed a set of wavelength in which the reflectance values are capable to offer much valuable information about the status and functionality of the plant (Gausman and Allen 1973). Particularly, they pointed out to 550 nm (green reflectance peak), 650 nm (chlorophyll absorption band), 850 nm (on infrared reflectance plateau), 1450 nm (water absorption band), 1650 nm (reflectance peak following water absorption band at 1450 nm), 1950 nm (water absorption band), and 2200 nm (reflectance peak following water absorption band at 1950 nm). All of these suggest that if the body under consideration is a plant and we can measure carefully the characteristics of one or more of these processes, from that data we could infer useful information about conditions and functionality of the plant. To start with this proposal, we try to discriminate and recognize different plant species by means of the analysis of their reflectance or absorbance functions.

Among the characteristics of the interaction determined by the matter structure, we are particularly concerned in reflection and absorption. Those, expressed by means of spectral reflectance or absorbance functions of materials, especially of vegetables and named here as “spectral signatures”, allows us to obtain information about constitution and condition of the material analysed: measuring the spectral signature with enough precision will allow, under specific conditions and by means of an adequate treatment of data, identifying not only the specie to which the signature corresponds to, but also its phenology and nutritional condition as well as the presence or absence of diseases, affections and scarcities of the plant from which the sample comes from.

2. MATERIALS AND METHODS

In order to compare and identify the specie a leaf belongs to, several samples of leaves of different plants are collected and their spectral reflectance and/or absorbance (spectral signatures) were measured. The species considered in this study were 2 varieties of sugarcane (labelled 742 and 384) and 4 types of citrus: tangerine, grapefruit, orange and lemon.

In the case of sugarcane, about 240 samples were measured, half of each variety, including two forms to prepare the samples to be measured: finely minced and coarse chopped. In the case of citrus, the samples measured were about 160, both sides of leaves (front and back) being measured. Samples subsets were collected every fortnight during four months and measured within the following 24 hours.

Spectral signatures were measured between 400 nm and 2500 nm, at 2 nm intervals, by means of a NIR System 6500 scanning monochromator (Foss NIR Systems, Silver Spring, MD, USA). The spectral data obtained were processed and analysed statistically with STATA 9.0, applying Principal Component Analysis to suitable grouped subsets of data.

3. RESULTS

Some results from the measurements in the case of sugarcane are shown in Figure 1, which displays spectral signatures, plotted between 400 nm and 820 nm, for the two varieties analyzed.

Visual inspection of the figure indicates that is fairly hard to discriminate if one particular sample belongs to one or another of the varieties considered.

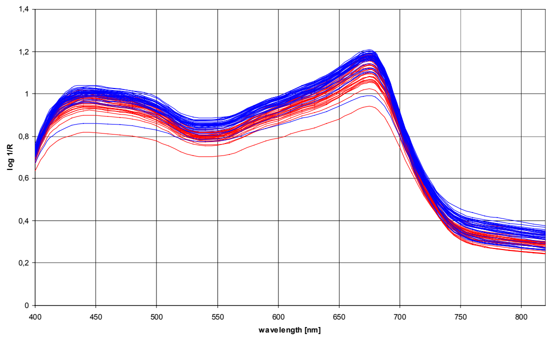

Figure 1. Spectral signatures for sugarcane samples (—— 384; —— 742).

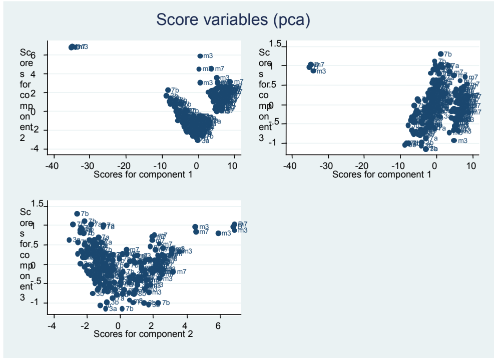

Figure 2. Scores for two sugarcane samples.

Doing this requires the spectral signatures to be analyzed statistically. To perform that analysis we applied a PCA initially to the complete set of data. Figure 2 shows PCA scores for the three main components, corresponding to 121 measurements of "384" and 122 of "742", considered between 400 nm and 820 nm (as in the case of Figure 1).

From Fig. 2, we can't decide which group represents each variety. In the upper left graph there can be seen three clouds but the only clearly differentiated from the rest is the small one on the upper left corner, which represent the scores for the measurements of a white reference disc included in the measurements.

In the representation, different types of treated samples are included together: minced and chopped leaves, front and back sides. The last are grouped in the central cloud, whilst the minced ones are gathered in the upper right cloud. The situation doesn't change substantially if we analyze just data corresponding to minced samples, as shown in Figure 3.

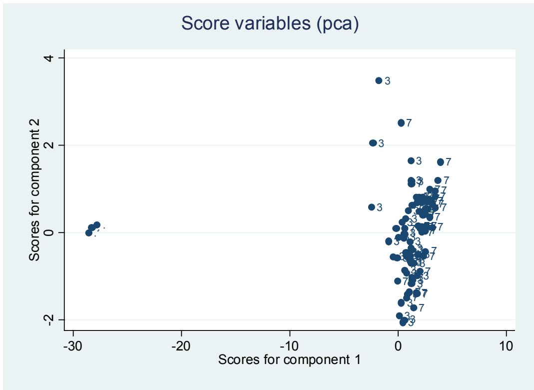

Figure 3. Scores for two sugarcane minced samples.

If we work now on the same type of sample (minced) but considering 79 measurements in different spectral range (in this case 400-500 plus 700-820 nm instead of 400-820 nm), the results from the PCA are rather different. Those are showed in Fig. 4. This tells us that is very important the conditioning (characteristics, spec-tral range, quantity) of the samples to be treated.

Figure 5 displays the PCA scores for data of minced samples considered between 400 and 1200 nm. The set comprises 21 spectral signatures, 10 of each variety plus one additional that correspond to variety "742", which is easily identified closest to the Component 1 axis.

Analogous procedure was applied to the comparison of 4 citrus, considered between 800 and 1100 nm. Figure 6 shows scores for all citrus samples without any special preparation. Despite that, is possible to separate samples of orange and tangerin (N and M) from lemon and grapefruit (L and P). When we applied the method to leaves of lemon (L) and orange (N) in the same condition, the identification of each type is very evident, as shows Figure 7.

4. CONCLUSION

The results obtained in this work show that a careful selection and suitable preparation of samples together with a precise collection of spectral signature data and the application of an adequate statistical analysis like Principal Component Analysis conform a powerful and reliable technique to recognize and classify plants, allowing us to identify the origin of a given vegetable sample. That technique could be considerably improved by developing of a database of standardized spectral signatures of the main crops in each stage and status. This could be the basis for higher level of plants and crops analysis, allowing us the prediction, diagnostic and solution of different health and phenologic affections of plants.

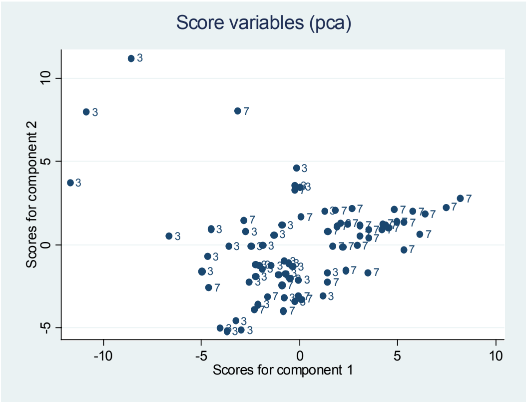

Figure 4. Scores for minced samples. Different spectral range.

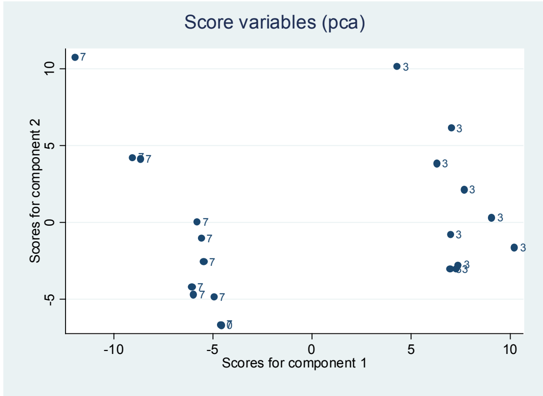

Figure 5. Scores for minced samples. Spectral range: 400 to 1200 nm.

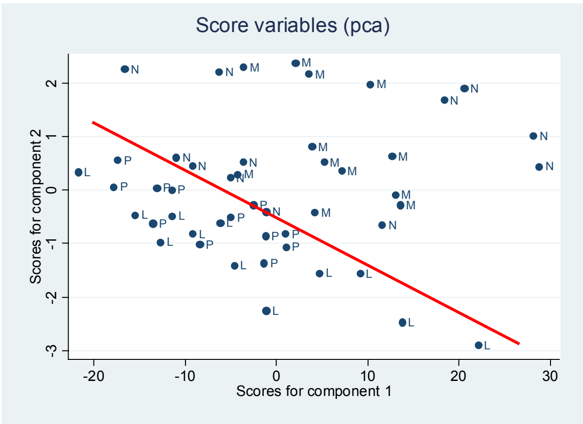

Figure 6. Scores for 4 citrus samples.

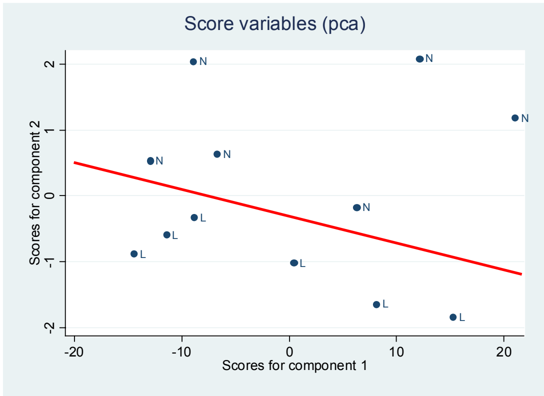

Figure 7. Scores for 2 citrus. Samples in the same condition.

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Food, colors and urban places

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ABSTRACT

The clear trend towards a global city, a virtual city of flows and *no-places* invites us to observe carefully the image of the urban man and his insertion in the present urban condition. In this way some issues are developed: the perception of urban environments, the chromatic treatment of its components and the resulting importance of color in the promotion of city and urban life experience. We witness a rapid change of urban territories and places related to great technological revolutions which have brought about the prevalence of flows over places. In view of the miracles of the virtual and the numeric revolution, many predicted the idea of *an end of life in the city and its places*. According to Mongin (2005 [2006: 275]), exactly the opposite is taking place: a re-configuration of the city, the rescue of urban places and appreciation of urban environments to reinforce an identity. This paper states the value of food sale in outdoor urban markets because of the expressive and communicative functions of the language of color and the promotion of enjoyable experiences that collaborate with the construction of urban places.

1. COLOR AND THE RETURN TO URBAN PLACES

The *place* is related to the concept of existential space (Bollnow 1963), which means that a space becomes a place when man makes it meaningful by inhabiting it, really experiencing its qualities and potentials. This space is the result of an interaction between man and the environment that surrounds him where it is impossible to dissociate the organization of the perceived universe from the activity itself that takes place there.

Therefore, the space is a necessary part of the structure of existence, which involves an abstract topological or geometrical aspect described by Piaget (1957) and the reception of concrete surrounding elements that qualify it.

Norberg Schulz (1975) exemplifies it stating that man does not simply roam without objectives but that he acts in relation to known centers, directions and areas (Figure1). The simplest model of that existential space is therefore a horizontal plane with a vertical axis that goes through it symbolizing the center, the radial lines representing the ways or paths in infinite directions where more or less known domains or areas are formed within these paths.

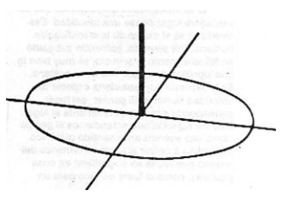

Figure 1. Existential space diagram.

When these diagrams become concrete in the city with the experience of surrounding elements, qualified by the expression and meaning of themselves, man feels in his center, oriented, willing to experiment, identify and evoke these urban environments.

The globalized present city poses contradictions: we move from a first paradox of the urban, a limited space that allows unlimited practices, to a second paradox: an unlimited space, the virtual one, which permits limited and segmented practices. Within the context of this urban condition which the human condition is not exempt from, different sociologists propose the return to the heideggerian *place* (Heidegger 1951). The perceptive space is essential for his identity as an individual and the existential space makes him belong to a cultural and social whole (Bollnow 1963).

In that context, the expressive power of color, being polysemic and multi-sensorial, becomes a powerful communication tool: its versatility is related to the manifestation of its variables and its capacity to assimilate into certain impressions verified by other senses: hearing, taste, touch, smell. Color is also connected with feelings and states of mind in which it seems to provide expressive-symbolic summaries in the chromatic synesthesias and in visual appearance signs, such as reflection, brightness, opacity and translucence among others.

2. URBAN PLACE AND COLOR IN FOOD STREET MARKETS

According to Canter (1977), *place* is a very rich concept which allows the connection of different disciplines so as to understand the way the inhabitant uses and interprets his city; besides, it makes us notice the structure of the cognitive systems related to the environment. That is why an urban place is constructed in close relation to the user's possibility to participate actively with all its components.

A street is not only a direction but a living environment when this turns into a giant urban window that encourages urban life (Figure 2). The food sale in street markets encourages multiple psycho-social experiences, promotes attitudes, conducts, behaviors and actions which are linked to communicative and expressive functions of color and the food in question.

Figure 2. Street in Puebla, Mexico.

Color, being easily recognized, is a perceptive element to catch attention, distinguish and identify food within an image; it's also used to structure a space and show itineraries. It is used as a sign or mark to highlight functional elements or codify street information.

It reliably describes what food is like, its expressive and meaningful qualities. That is to say, color gives information about food condition. Fully saturated colors easily remind us of the food in question because of its chroma or hue. When colors are desaturated, they are more easily remembered because of their luminosity.

The color of food displayed in street markets creates certain environments: warm, cold, luminous, dark, vibrant, loud, dynamic or stimulating ones among others.

At the same time, color establishes associations by acting as a code; the symbolically associated color is recognized by anyone and allows the recognition of ripe fruit, fresh vegetable or appetizing fresh food; it also enables us to distinguish between hot or cold or crispy or stale.

Being used as a component of space, color harmonizes or contrasts the food of the image in question, it can blend it in or divide it, unite or fragment it. The chromatic rhythm can speed up or slow down the reading of an image, providing order, regularity and control and structuring the image in an expressive, communicative way.

Thus, the color of food in street markets establishes certain organizational principles in space so as to configure it and make the urban environment meaningful by expressing messages. If we consider the organizational principles of color such as focality, unity, balance, proportion and hierarchy and we add up the expressive and communicative possibilities of chromatic language, such as the contrast of pure colors, chiaroscuro, temperature, the optical contrast of complementary colors and the tendency to transformation or visual synesthesias, all applied to food, we can notice this is a subtle instrument of promotion of conducts and behaviors in the urban inhabitant as regards how he uses the space.

On the other hand, color influences the nervous system because of its aesthetic value and the way it affects feelings. There are no impressions or emotions that cannot be represented by color. The two principles established by the Ancient Greek, *melos* and *pathos,* can be the base to create a whole expressive scale (Pérez Dolz 1980: 127). We can express the algedonic, painful, sad, tragic, pitiful or terrible and the related emotions are pathetic and disastrous. On the contrary, the melodic concept of color is based on the *hedonic,* pleasant, sweet, agreeable, cheerful, happy and tender. Any emotion related to this is *melodic*, lyrical. Between these two opposite ends there is a large scale of possibilities that color is able to channel, even in the food displayed for sale (Figure 3).

Figure 3. Square in Las Rosas, Córdoba, Argentina.

All this exceeds the simple layout of goods displayed in the urban environment in question to become a driving fact of urban life by putting emphasis on the environmental cognitive processes (Ittelson 1973:13-15) that lead man to participate actively in the construction of urban environments.

3. FINAL CONSIDERATIONS

Color, with its iconic-linguistic potential, comes up as a leading factor in the insertion of human practices and experiences by means of the sale of food in street markets; it also contributes to define the urban place that Heidegger claimed as essential for the intrinsic definition of man and his living environment.

The multiplicity of opportunities to express the language of color by means of the street exhibition of food for sale allows the construction of that urban place where man finds his Center and can fully enjoy experiences. Those are environments to be enjoyed, to be experienced with pleasure and great delight expressing a referential identity where the sense of the local, opposed to the global, is re-conquered giving or rescuing identities in the real city.

Thus, places come up as symbols of resistance to the virtual city. If globalization establishes its *no-places*, the language of color and the conducts it promotes can possibly take up the challenge to return to urban places.

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The daily quotes that transforms the city into a festival of colours: River Market Valdivia

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ABSTRACT

The river market (Feria Fluvial) in the City of Valdivia, located in the very centre of the city, has historically been developed as a trading place for different products within a frame of cultural diversity, where colour plays a significant role; it is present both in food being traded there and in the spatial conditions framed by this fair. This work focuses on the presence of colour throughout history and at present, exposing its relevance in the daily ritual carried out in this place.

1. RIVER MARKET VALDIVIA: AN URBAN SPACE IN HISTORICAL PERSPECTIVE

The River Market constitutes one of the spots in the City of Valdivia that, operating as a nucleus of technological and cultural transference, ascribes to the notion of a crossbred landscape (Fernández 2004). This, from the perspective in that it is open to the simultaneous presence of a diversity of human groups, including differentiated cultural traditions and practices. Particularly concerning the River Market, this openness is enriched by the incorporation of local land and sea products, together with the progressive interaction with a coastal and river fauna. A very ancient trading spot, this market is possible to be dated back to the Conquering Period chronicles. Indeed, this historical deeprootedness consolidates its crossbred condition, given the permanence of the contact, growingly unequal, among Huilliche groups, Spanish, Chilean and German settlers, thus establishing a cultural landscape holding organic character (Pizano and Cortés 2002). By this, we mean a space acquiring its quality of referential area in the surroundings through its continuous productive relationships, rather than by the existence of strengths (Augé 1998).

This contact is documented since the early arrival of Spaniards, when, in 1544, Jerónimo de Alderete outstands the existence "…at its mouth (the river's) a great pueblo called Ainil"; while Mariño de Lovera describes how canoes entered into the very houses, thus being the east bank of Ainil River the first arriving point (Mariño de Lovera, in Guarda 2001). In spite of the accidental development of the city in the subsequent years,[1] the River Market is still the arrival point for the local vessels, as it was emphasized by Gabriel Guarda for the times when the colonial settlement is still in force: "…further north (…) coinciding with the situation of the present River Market, the indigenous boats had their arrival place" (Guarda 2001: 32).

[1] We mention reiterative destructions, including the indigenous revolt inside the frame of the colonial settlements (1599), and multiple posterior natural disasters.

These situations are still sustained in the republican period. Presently, though there has been a diminishing in number of vessels directly linked to the coastal area and river-side localities, producers-sellers belonging to these communities continue arriving, together with, of course, their products, manufactures and narrations.

1.1 The products

The vast diversity of products related to the River Market has varied throughout time, anyway keeping the land and sea confluence. Early chroniclers remark the preponderance of coastal products: "The city is plentiful of fish; and no less of seafood, retrieved by the Indians sinking twelve strokes under the water" (Mariño de Lovera 1865: 139). Centuries after, with the arrival of the railway as key landmark, a diminishing in vessels number and the incorporation of products coming from other regions of the country could be observed. After the big earthquake of 1960, mediating the institutionalization of this space,[2] the configuration of the space where the fair is located has been changed; regulating the stands distribution, hence explaining the arrival journey of the products. This way, stands located bordering the river offer fish, seafood and, to a lower extent, flowers or preserved food, coming from the coast and riverside settlements. Stands located towards the urban nucleus (orient) offer those products brought by carts and later by pickups; being greens, fruit, legumes, cheese and smoked products the predominant merchandise.

2. COLOURS

We can analyze the chromatic situation of the fair as permanent colours and aleatory colours (Lenclos 1999). Permanent colours refer to the urban scenario sheltering the fair, where the ground, awnings, the city facade and the river can be distinguished. Aleatory colours refer to products, vehicles, public and light; this last aspect has been deepened by us.

2.1 Products order and their colours

As this is an open fair, when walking through it, the stands play the roles of actors on a background stage. Concerning fruit stands, the background is composed by the city façade and parking cars (multicolour); and regarding fish stands, Valdivia River (blue, pale-blue or grey). This stresses the chromatic division of both stands stripes; notwithstanding that, aided by the awnings and the propinquity, the fair keeps its unit.

Land products include all shades of colours in small sections of multiple and contrasting colours, where many complementary pairs of saturated and bright colours meet without problem (Figure 1). Sea products are ordered in bigger plots, despite being very bright, their colours are mainly achromatic (black-white) with bluish shades. The salmon, a product whose massive trading started with the *boom* of the salmon industry in Chile (90's), has contributed from not long ago to the cold bluish shade of the area, a new and warm colour. Some seafood also constitute an exception to the cold nuances as they are similar to fruits by having basic and clean colours such as red, orange and purple.

[2] In the frame of the city reconstruction and, specially, the creation of the present promenade.

Figure 1. Land products include all shades of colours in small sections.

2.2 Awnings and their colours

Since 2007, the fair has been covered by permanent five-colour-awnings: red, orange, yellow, white and blue; because they are not enough protection against rain or sun, the tenants spread their own canvas, mostly oranges, producing an effect of artificial illumination over the products (Figure 2). The land traders prefer them because "the white ones let too much heat trough and the blue ones make the products look ill". Concerning fish, this gives them an orange-like brightness, different from their natural colour. This could seem advantageous for some traders as this makes fish look fresher, since "the gulls of those fish over there, under the orange awnings, look redder than the ones of these" according to trader Mrs. Cifuentes. Nonetheless, summer favours fish traders under the white and blue awnings as they let less sun and heat run through.

Figure 2. Permanent awnings and traders canvas at the River Market Valdivia.

2.3 All colours

Illuminated by artificial light, over the dark pavement, at 6 o'clock in the morning, the first stands receiving their supplies from pickups and carts begin to be installed. Slowly products start painting the area with colours. The first clients appear either by walking or by their cars, appearing also sea-lions, cormorants, seagulls, terns, pelicans and dogs. At mid-day, especially at weekends, people start crowding, thus adding to the products colours, the colour of their clothes in movement, bags, and cars jamming, looking for a place to park. The visual colourfulness is acerbated by the variety of textures brightness, traders shouting, animal sounds, smells, and buying-selling talks and those sounds of encounters with the usual acquaintances, in this concurred and popular place. The fair goes slowly breaking up from 3 in the afternoon, with the disassembling of the stands and the transporting of the left over products to the pickups and hand carts. Municipality workers, dressed in orange, mingle in this disassembling with their hoses and brushes, eliminating any trace of colour from the ground, leaving the place clean and grey to be walked over by citizens or tourists, waiting for the next day like a white paper; the daily pulse that has convoked hundreds of Valdivians to this place for centuries and gives identity to its inhabitants.

3. CONCLUSIONS

According to Lenclos (1999), aleatory colours "in the everyday setting, offer an important counterpoint to the static character of an architectural space", we can go further and say that the soul of the River Market Valdivia lies on these impermanent colors. This River Market is presented as an urban and architectural place, strategic in its location and historical burden, making it into a meaningful space for the inhabitants of the city. It is not only a trading area, rather, it is an ancestral daily ritual celebrating diversity in an intercultural and inter-species landscape (Poblete and Eggers 2009), where colour is a fundamental part of this complex multiplicity of codes going further than the simple products exchange. Colour, which we are not aware of as it is part of the daily landscape in which we are immersed, may give us clues about how to build a parallel reading that, in the transdiscipline, can guide us to understand individual cases. Even though this work outlines in a general way the aspects where colour is present, we know that a deeper study will be able to reveal its relationships, not only spatial, but historical and social as well.

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The colour of food: Last layer on the palimpsest of St. Caterina market in Barcelona

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ABSTRACT

This research aims to understand in depth the colour composition of a contemporary building, the St. Caterina Market (Barcelona 2004) by architect Benedetta Tagliabue, who develops a poetic reinterpretation of the colours of a food stall. The physical reality of the colour, the design process and intentions expressed by the architect are studied. The result is a market as a kind of palimpsest, which allows the reading of the different layers of history and re-presents virtually chromatic experiences that are developed in the inner space. A kind of transparency, as a tele-reality, which is consistent with the contemporary perception, and blurs the boundaries between reality and fiction.

Figure 1. Overall photograph of St. Caterina Market in Barcelona, by EMBT architects.

1. INTRODUCTION

Throughout history, food has been an outstanding artistic inspiration source for many artistic disciplines, used as an argument to train with colour. The presence of food as a decorative element in architecture goes beyond a simple functional relationship with the use of space and is a helpful tool for organizing colour composition. Examples include coloured cornucopias of classical architecture, Biblical food in medieval fresco paintings (grape, bread, fish, etc.), painted still life in illustrated housing, glazed ceramics in modernist markets, etc.

Benedetta Tagliabue recovers and reinterprets this tradition of representing food at market buildings. She takes up again both the decorative motifs and the tiles, but abstracted and manipulated in a transversal proposal, which in one hand is strongly contemporary, and at the same time restores aspects of the past. This building links different historical levels, and it reverbs the echoes from previous architectures, in a plot that previously was a convent, square and market (Figure 1).

2. DESCRIPTION OF CHROMATIC FEATURES

The roof of the market is an undulated wooden structure with a glazed ceramic tile at the top. The colour treatment covers the entire surface of the market and projects onto the street shaping a small pergola. Therefore, the cover is a continuous surface, independent of other parts of the building. The chromatic layout is not claimed to integrate the building in the surroundings but to make it different, to recognize it. The colour ranges are the consequence of a distant referent: the market activity, instead of its immediate architectural landscape.

Hexagonal spot coloured pieces are used to make up a large-scale drawing; a mosaic consisted of little coloured tiles (Figures 2, 3). Red and orange shades dominated over a large pool of green ranges, resorting to the simultaneous contrasts of complementary colours to give intensity to the whole. Blue hues are practically nonexistent, although purple shades are arranged in the darker parts. Everything finished on a gloss surface that slightly reflects sunlight.

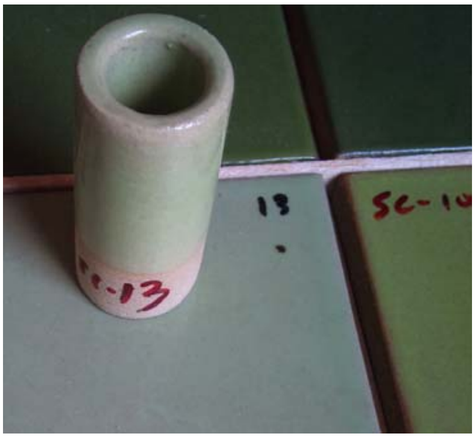

Figure 2. Small samples of colored glass tiles, showing the 64 shades selected.
Figure 3. Detail of one of them.

3. DESIGNING PROCESS

As Benedetta herself insures, the main plastic strategy is "trying to give the same importance to the trace of the monastery than the trace of a time when everything was destroyed, or the moment of a road that went through the middle [of the plot] as if everything could be such an important question" (Miralles and Tagliabue 2000). In this way, the trace that fits with nowadays is this kind of virtual image of the vegetables available underneath, in previous layers.

The colour composition on the roof has been reached starting with the photograph of a food stall (Figure 4). This first picture is touched up with specific software in order to reduce its amount of chromatic information. This abstraction process reduces the color ranges to just 64, and makes it possible the tiles supply and its industrial production (Figure 5). It was necessary a work with ceramist Toni Cumella, to adapt the computer colours to appropriate pigments for ceramic tiles. In opposition to ancient mosaics, built with small tile pieces or *tesela*, Tagliabue's mosaic incorporates new technology to help in the color decision process, the module size fitting and the industrial production of material.

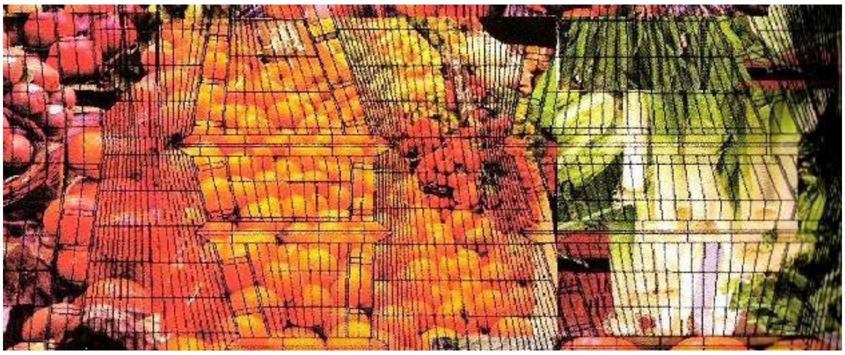

Figure 4. Starting photograph of a food stall (Tagliabue 2010).

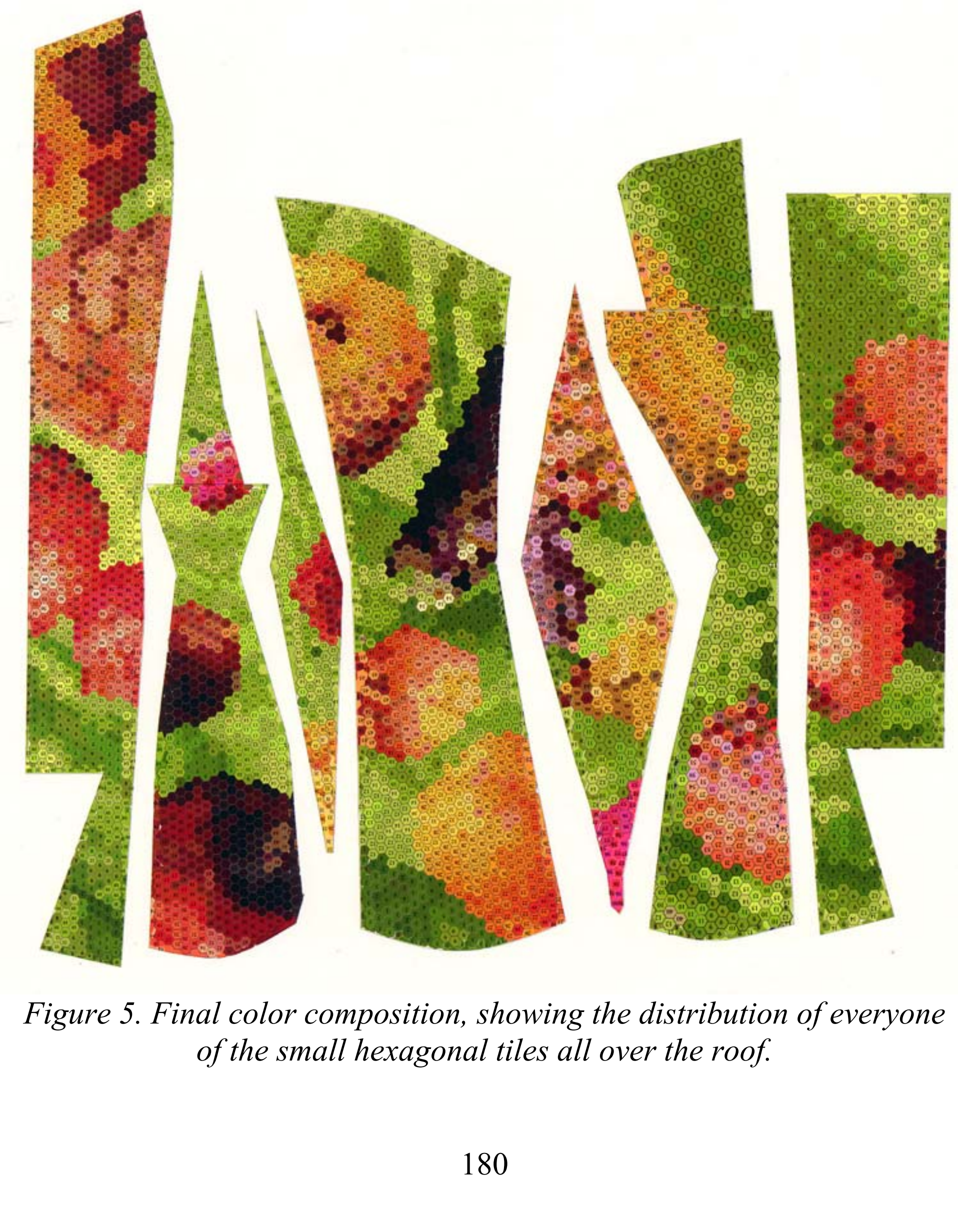

Figure 5. Final color composition, showing the distribution of everyone of the small hexagonal tiles all over the roof.

4. INTENTIONS

This roof can be interpreted as a large awning that protects from sun and rain, and under which the activity market is developed. Like a big patterned fabric, generates the necessary protection enable to trade outdoor, as has been done during the times.

This is, doubtless, another layer which has been putted on top on this plot, where was the convent, plaza, market, etc. The project of EMBT, as if it were a palimpsest, can be search for the lines of the different historical moments and the colourful cover is a stratum more that does not respond formally to the logic of what is below but what it represents, its use as the market recovered. As the author says:

> There would be another reading of this basic project, which would be the ability of producing documents that make explicit the superimposition of different moments of a place, building on the ruins of it. Surely, in this work have influenced public spaces and watch how essential is the coexistence between architecture, design and the need to destroy society. (...) You need to have some kind of document in which the time on this site is condensed. But not to consider your project as a step further, not that if it had a linear idea behind, but almost as if time -I like to think in this way - instead of having it back, you had it before you ... (Miralles and Tagliabue 2000).

5. CONCLUSIONS

The result is a building understood as a palimpsest, which shows the accumulation of the various historical facts as strata. The substrate corresponding to the contemporaneousness is the roof, which plays virtually the chromatic experiences that take place underneath, and stages the lower level. The colour of a market that is transparent, thanks to technology, to express a final image, as a tele-reality. An interesting thought about contemporary perception that blurs the boundaries between reality and fiction.

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Color preference for dining space and its imagery

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ABSTRACT

Are there correlations between demographic factors and color preferences for dining space? An electronic survey was conducted to examine color preferences and color imageries of dining space. 382 undergraduate students of the Chinese Culture University in Taipei chose from 11 pre-selected colors based on the Natural Color System (NCS). A color imageries study with semantic differential scale was conducted, using five bipolar word-pairs (beautiful-ugly, soft-hard, warm-cool, elegant-vulgar, and loud-discreet). White turned out to be the most and black the least favored color for a dining room. Color preferences are subject to demographic factors on a limited scale: like age, gender and habitat. Data mining allows for creating a color preference prediction model based on certain demographic characteristics.

1. INTRODUCTION

The color of living space may affect its use frequency and economical value, and it may also be associated with individual well-being, especially in case of a dining room. Color as a research topic has been examined in many fields, like psychology, physics, chemistry, optics, engineering, visual arts graphic design, urban studies, architecture, and others. Previous research has investigated color preferences by color chips and in certain settings, but little is still known about people's color preference for their direct living space. Earlier studies confirm color is promoting positive or negative emotions like pleasure or distress (Miller 1997). Color causes people to stay or to leave, and they respond differently to public and private space with regard to their perception of intimacy (Nissen et al. 1994). Age, gender and individual background can influence color preference (Manav 2006), and professional education on color and its use can have a different effect on people's color preference (Cubukcu and Kahraman 2007). It is assumed that there might be a disposition for color preference of dining rooms by age, gender, personality, and education, for generating color preference prediction models by applying eight characteristic basic demographic variables - gender, habitat, educational background of color studies, studies of environmental design (or not), personality, leisure time activities, blood type, and age.

2. METHOD

Survey

Subjects: Three hundred and eighty-four undergraduate students from the Chinese Culture University took part in the study, 382 sets of the questionnaire have been completed. Among them were 156 male and 226 female, 253 of the participants had an educational background of color studies. The majority's habitat was northern Taiwan, though many of the students came from different home towns all over Taiwan.

Semantic scale: A semantic differential scale consisting of 5 bipolar word-pairs which were "beautiful-ugly, soft-hard, warm-cool, elegant-vulgar and loud-discreet" has been used to let subjects rate the living spaces one-by-one with a 7-step Likert scale to understand subjects' color preferences for dining rooms and their individual perception.

Color stimuli: Based on the Natural Color System (NCS, Scandinavian Colour Institute), four primary colors, plus four intermediate colors, and 3 neutral colors - black, gray and white, a total of 11 colors were selected from the NCS color circle to cover the walls of living spaces for color preference surveys.

Table 1. List of experimental colors (Y: cd/m^2).

No.	NCS Color Notation	Color Chip	Name	RGB	CIE1931 Yxy value (estimated by sRGB translation)
1	S 0580-Y		Yellow	(253,202,0)	63.12, 0.461, 0.472
2	S 0585-Y50R		Orange	(243,117,40)	31.93, 0.536, 0.392
3	S 1080-R		Red	(184,57,74)	13.6, 0.511, 0.309
4	S 3055-R50B		Purple	(131,84,145)	13.2, 0.298, 0.223
5	S 1565-B		Blue	(1,150,192)	25.6, 0.205, 0.257
6	S 2060-B50G		Blue Green	(0,122,153)	16.2, 0.207, 0.264
7	S 1565-G		Green	(8,165,109)	28.1, 0.257, 0.443
8	S 1075-G50Y		Yellow Green	(163,180,40)	40.6, 0.395, 0.504
9	S 0500-N		White	(244,244,244)	90.5, 0.313, 0.329
10	S 5000-N		Gray	(133,133,133)	23.5, 0.313, 0.329
11	S 9000-N		Black	(20,20,20)	0.7, 0.313, 0.329

The selected NCS colors were picked up from the NCS palette 2.1 software application, and the RGB values of each color were found and then translated into CIE 1931 Yxy values with the EasyRGB-PC software. Images of a dining room were projected on a 120" wide metallic screen with a Mitsubishi XD200U DLP projector. All images had a standard 4:3 aspect ratio and a 1024 × 768 spatial resolution, with a viewing distance 2.5 meter, and the visual angles for the width of display was 50.6 degree. The projector was calibrated to fit the sRGB standard with an X-rite XT colorimeter suite. All images were viewed in an experimental lab room which was totally dark.

Procedure: All participants were screened for color deficiencies by using the Ishihara Color Vision Test. Subjects first received a brief written and verbal instruction about the task. Then they provided information about their demographic background.

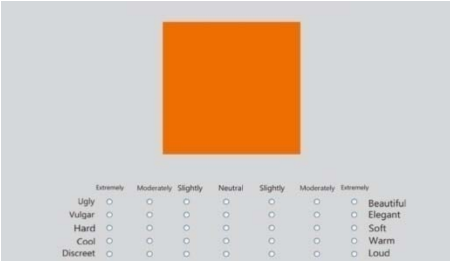

Figure 1a. Color chip used for experimental space of the survey.

Subjects were shown projections of colors and they picked their favorite dining space color. Indicating their feelings, subjects then rated the color according to semantic scale. The process was repeated by letting subjects indicate their least favorite colors and related impressions. Finally, most and least favorite colors were chosen from color chips.

Figure 1b. Projection model of experimental space.

Figure 1c. Projection model of experimental space.

3. RESULTS

Preference: Figure 2 shows color preferences for dining rooms with white, blue and red as the most preferred colors. The lowest grade has been given to blue-green. The first three most disliked colors for dining rooms colors are black, yellow, and yellow-green. Generally speaking, yellow, yellow-green, red and purple are less popular than other colors for dining space. It is interesting to notice that blue-green was rated least among the most favorite colors, but the highest rates for the least favorite colors were black, yellow, and yellow-green.

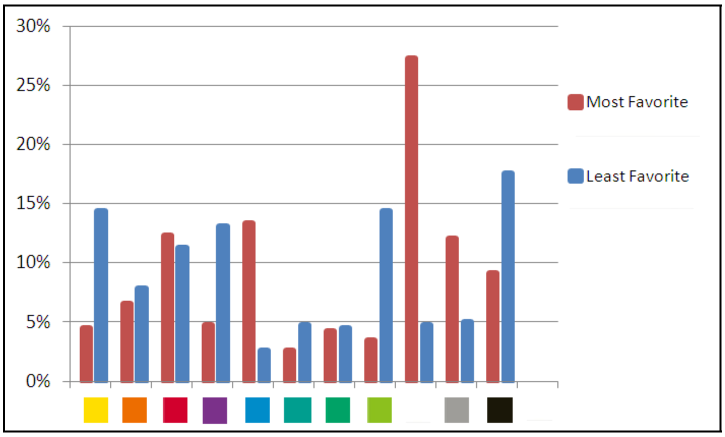

Figure 2. Most favorite and disliked color preferences for dining room space.

Semantic domain: Figures 3a-c show the most / least favorite colors for dining room by semantic scale. Regarding overall choices, red has been perceived as very beautiful, closely followed by white, blue, orange, green, and purple when considered as most favorite colors. Yellow, purple and leaf-green were chosen as most ugly when considered least favorite colors. Yellow, orange, and red appeared generally softer than all other colors.

The evaluation gap between most and least favorite colors can be explained with a tendency of giving higher rates to favorite colors. Besides, there is clear consistency of the rates given to most / least favorite colors regarding their sensual perception as “soft” or “hard”.

However, most favorite colors are generally given lower rates for their sensed temperature, while least favorite colors received higher rates, with blue-green and yellow-green reaching the highest grades.

Semantic feeling (I): The radar chart (Fig. 4a) shows clear preference for red, orange, blue, purple, and green as most favorite colors.

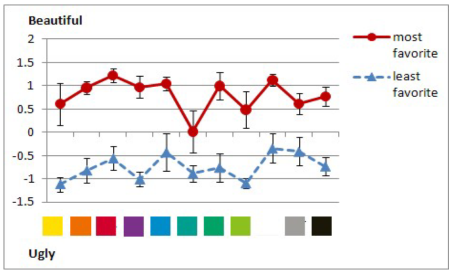

Figure 3a.
“Beautiful-Ugly” –Overall semantic rating.

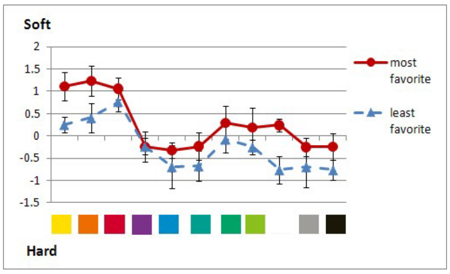

Figure 3b.
“Soft-Hard” –Overall semantic rating.

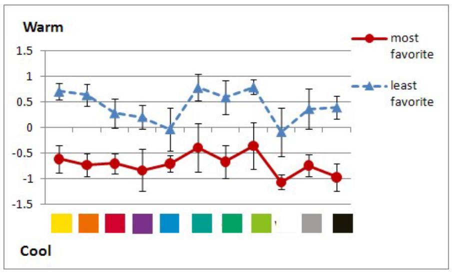

Figure 3c.
“Warm-Cool” –Overall semantic rating.

Yellow, orange and red were clearly perceived softer than other colors (Fig. 4b). Red was perceived warmer than other colors, while orange and purple appeared slightly cooler than yellow-green, green, blue-green and blue (Fig. 4c). (White, gray and black were left out from the color circle radar chart due to their neutral character, see also Figures 5a-c.)

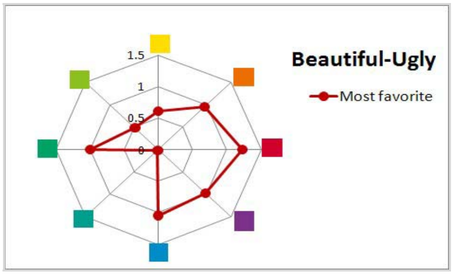

Figure 4a. “Beautiful-Ugly” –by color.

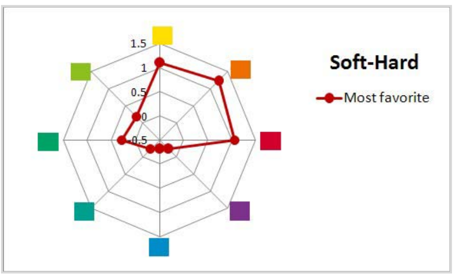

Figure 4b. “Soft-Hard” –Sensual perception.

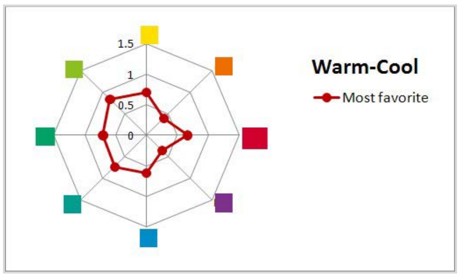

Figure 4c. “Warm-Cool” –Temperature.

Figures 4a-c show the most favorite colors for dining room by color.

Semantic feeling (II): Yellow-green, purple and blue were sensed ugly when chosen as least favorite colors (Figure 5a). The perception of yellow, orange and red as soft colors was confirmed (Figure 5b). Blue-green, green and yellow-green were found relatively warm, while yellow, orange, and purple were sensed slightly cool (Figure 5c).

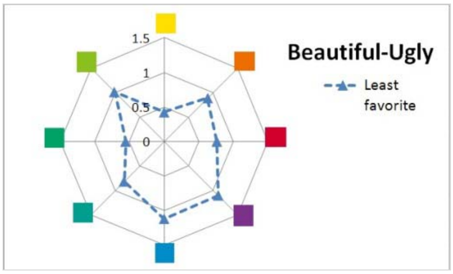

Figure 5a. "Beautiful-Ugly" –by color.

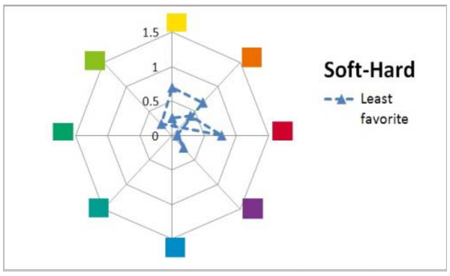

Figure 5b. "Soft-Hard" –Sensual perception.

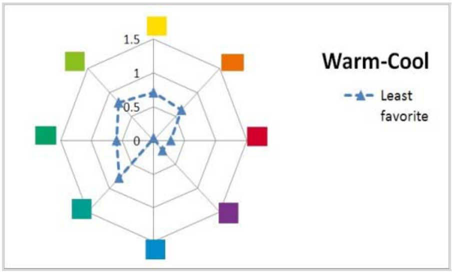

Figure 5c. "Warm-Cool".

Figures 5a-c show the least favorite colors for dining room by color.

Color imagery: White was the most favorite dining space color, followed by blue. White was perceived beautiful and discreet, while partly vulgar. Blue was felt slightly ugly, but elegant by many participants, and sensed relatively hard but with neutral temperature and of almost neutral sound. Yellow-green was relatively disliked, perceived as being quite ugly, slightly vulgar, cool, of neutral consistence and slightly noisy.

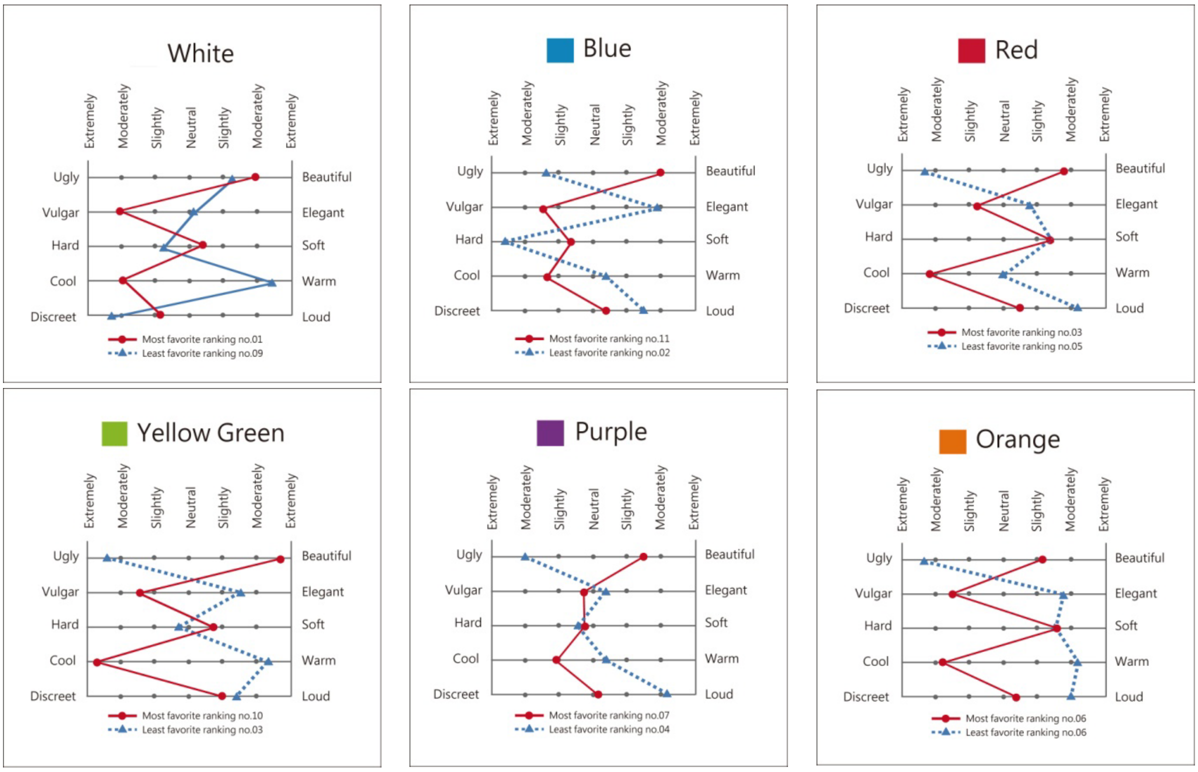

Figure 6. Color imageries of most / least favorite colors for dining space.

Statistical analysis: A set of statistical methods was applied to the collected data, deriving information on hidden interconnections of demographic factors, for building up a color preference prediction model. Male participants relatively preferred yellow for dining room color and females yellow-green. Both genders chose purple as their least favorite color for dining room. Northern residents relatively prefer purple or green colored dining rooms, while Eastern residents prefer blue or gray, and subjects with an international background like yellow-green or white. About one third of the participants who were experienced in color studies chose white for their most favorite dining room color, and so did more than one third of the subjects in the age group of 19.

4. CONCLUSION

Results confirm Saito's (1996) findings on color preference for white in Asian countries. Demographic factors correlate with color preferences on a limited scale. Some methodological limitations should be taken into account for future studies:

(1) Subjects were undergraduate 19-23+ years old students of the Chinese Culture University, a homogenous group of comparatively high educational background. (2) Multi-colored or partially colored rooms, as often found in daily life environment, may evoke different emotional response than single colored space. (3) A computer-generated 3D-model might bring different results than a picture or a real setting, due to perception of spatial surroundings. (4) The size of the projected dining room, the illumination and color accuracy may influence subjects' perception levels of intimacy and thereby color preference. (5) Additional features like table setting, food and decoration may influence color preference.

More research needs to be done to further validate the present results, which can be valuable for designers, architects, or the gastronomic industry. Due to limited space, only selected tables could be shown.

ACKNOWLEDGEMENTS

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Bicentenary: The colour in NOA's (Argentinian north-western) aboriginal cultural pottery

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INTRODUCTION

This work has the purpose of dealing with the process of transformation suffered by ceramic pottery in Argentina. To start the colour study of this scarce primitive pottery we will make a survey from the origin of ceramics in our country.

This first inhabitants were those to discover the wonderful properties of mud as well as the development of ceramics and the application of colour to the first pieces.

In America, ceramic starts in 3500 BC approximately in the Northern Andes regions. It is thought it could have been introduced from Ecuador via Indonesia and New Guinea from South eastern Asia. The place with the most ancient findings was Valdivia, Ecuador, in 3100 BC. It later spread through Peru, Mexico, Colombia, and Bolivia until it reached our country in 650 to 300 BC. It is believed it was introduced through the Humahuaca region and through the north of Chile, spreading along the north-eastern part of Argentina and developing with the different cultures.

Ceramics found in burial sites are true source of information to find out customs and development of the daily life of aboriginal population. It was customary to bury the deceased with their belongings, glasses, plates "pucos" (bowls) and small statues among others.

PASTE ELABORATION FOR THE MANUFACTURING OF PRIMITIVE CONTAINERS

The early inhabitants would collect the clays from river beds in the low water season and mix them with the clay from the hills. Sometimes these clays were kept as savings inside houses or in holes then covered with stones.

The whole family would take part in the elaboration of ceramics; men would devote to the manufacturing of large pieces like urns and women those smaller in size like utensils. The making of ceremonial pieces of the most importance was reserved to the shamanes, spiritual leaders and wise men of aboriginal communities. They had a wide knowledge about minerals and herbs and used those skills to make ceramics. Pot making was a task carried out, many times, in a semi-consciousness state, a totally spiritual task.

The north western clays contain percentages of natural mineral antiplastics like quartz sand, feldspar remains, visible mica, calcium carbonate, volcanic ashes, iron pyrites and so on. They would often add other antiplastics, depending the place of settlement. Grated vegetal coal, excrement, burnt bone (calcium phosphate) which were crushed once the piece reached 600 ºC, these elements lessened contraction while the pieces dried and, once eliminated, gave lighter and more porous pieces giving, as a result, a post-cooked greyer colour which is visualized from the center of the ceramic wall which must not be mistaken for the grey of the reducing atmosphere which will only colour the inner and outer wall exposed to smoke.

The washing of clays and minerals was a very widely used technique used by aboriginal peoples.

In the Andinian region we can find clays with a high degree of impurities being iron oxide of about 3 and 9%, the most commonly found depending on the place of extraction, giving as a result a reddish ceramics.

The most ancient ceramics found are greyish or black because the early bakings were carried out in open fires in a smoky and reducting atmosphere with a scarcely 500 °C to 600 °C exposure giving under cooked pieces as a result.

KNOWLEDGE ABOUT THE PROPERTIES OF MINERALS FOR THE MANUFACTURE AND PREPARATION OF PIGMENTS

Colour is spread together with style peculiar to each culture and is bearer of knowledge throughout its way. The interchange of products among the different Andinian communities contributed to the fusion and diffusion of regional styles before the Spanish conquest.

Metallic earths that are mineral oxides gave red, white, black and cream colours and gave birth to different shades of these colours which were considered basic to aboriginal peoples.

There are dark clays which exposed to 800/900 °C change colours and may turn whitish, pink or reddish because these muds have acquired carbon throughout their geological sedimentation. Greenish/yellowish clays exposed to those high temperatures may also give a reddish colour because of their contents of ferric hydroxide which hydrates during the baking process becoming ferric iron oxide or red depending on its percentage and giving a distinctive shade.

Ceramic red varies in shade forming reddish, brownish or ochre according to the percentage of iron oxide in the clay depending on the quality of the oxide. The strength in colour will be given by those percentages ion the clay which NOA vary between 3 and 9%. Ferric oxide produced clean colours warm red or brick; ferrous oxide produce greyish shades.

They used a store called "hematina" which is a variety of iron oxide, which they crushed in mortars to make "engobes" and coatings for the pieces.

Some clays from that region also contain smaller percentages of manganesum oxide and in this case the reddish becomes darker.

Yellow: this colour was achieved with the impure kaolins found in some parts of NOA. If this mineral is found free from impurities we get white colour ceramics.

Black: using pirolusite, a variety of manganese oxide, the aboriginal peoples were able to get manganese black.

TECHNIQUES OF FIRE COLOUR APPLICATION

The above mentioned mineral pigments were crushed in stone mortars to obtain very thin particles with which they made engobes or coatings and later spread with thin feathers or wool fleece to cover surfaces or design iconography proper to those cultures.

Another technique which was used was that of "the negative" where the ornaments appear on the natural surface of the vase, while the rest is painted in a contrasting colour.

Some pieces would hold bi-chromatic painting: red-black or red-white among other shades, first the pieces were covered by a thin layer of light engobe and then decorated in black or white with a paint brush on the surface, producing a contrast of colour.

The pieces obtained by cutting techniques engraved or decorating with graffit could also de coloured with a layer of engobe before the cuttings were made or add the colour after being baked. A paste made with kaolin was used to introduce in the engravings. Many of these works show different techniques used to make the same piece.



Original art from the 1st century BC to the 10th century AC, collection from Cancillería Argentina, Buenos Aires, Fundación Proa.

PASTE MODELLING AND TOOL HANDLING

The first containers built in pre columbine ceramics were mostly for ceremonial use. As time went by earthen glasses, pots, and bowls came into existence and formed part of the usual table service.

The process started by taking a lump in one hand and pressing the centre with the other fist, the forefinger was used to hollow the interior obtaining a bowl or glass; a knee could also be taken as pattern. Our aboriginal people would always carry out their pottery job sitting on the ground.

To elaborate pots they would start from a falt base and achieve height adding stripes, laying each one on top of the previous layer and using their fingers pressure would erase the joints and give the piece the necessary thickness. They would use woolen tufts as sponges to achieve a nicer finish.

The burnishing or polishing was achieved with smooth stones which provided a deep lustre either on the raw paste surface in leather condition or on the colour coating or on a thin engobe layer. To achieve this process rolling stones or wet leather were used. To do engravings they would use sticks, canes, kernels, bones and sharp tools.

Then feathers and vicuna wool fleece were used as paint brushes. Some times broken vessels were used to start a new piece.

ADJUSTMENT OF BAKING ATMOSPHERES AS COLOUR MODIFIERS

The composition of paste can originate different colours depending on the temperature and atmosphere to which the piece is exposed.

For example: the grey of the dough becomes black at low temperatures, reddish brown at 800 °C; yellowish and greenish raising its temperature.

The first pieces were baked in open fires, some on the ground and at times inside shallow holes. These ovens didn't regulate the flux of air originating black or grey effects on the piece showing lack of oxygen. The fuel used by aborigins could have been wood, llama excrement, dry leaves, etc. The surrounding atmosphere during the baking also affects the colour of the vessel.

Smoke or complete reducing atmosphere: If we take ferric oxide (red colour) it becomes ferric that is to say is reduced and gives the piece greyish or blackish shade.

Oxydizing atmosphere: this is achieved by baking in abundant oxygene and little smoke in clays containing high percentages of iron (8 to 9%) and obtaining a red brick colour or pink in pastes with a lesser amount of mineral contamination.

THE ARRIVAL OF THE SPANISH COLONIZATION

With the coming of the Spanish conquerors, pottery stopped being a spiritual activity and started becoming a very precious activity representing Andinian cultures. Productive pottery was developed by unskilled workers.

CONCLUSIONS

To strengthen a national and Latin American culture it is necessary to learn about the development of the first self-sufficient societies; their way of life and identity taken for their true value, as they play an essential part in the future of the Argentinian ceramic art.

Ancestral art and pottery gave birth to long lasting activities which to these days are being carried out by many communities using the original processes.

Throughout my visit to different communities in NOA I visited factories and artisan workshops and I was told about their ancestors techniques and customs. They learn from observation which they inherited and know about the virtues of the earth. These inhabitants have added new processes developed from daily practice and development of ceramic activity.

The new generations of pottery makers are open-minded enough to adopt new techniques and also show interest in learning about different products with which to enrich their work. They speak about their wish to include new technology to their ceramic output.

An Artisan knows that his spirit as well as those of his ancestors are represented in each piece he may produce, since I reckon that in NOA, ceramics is still considered a spiritual activity.

The need to use natural elements, in going back to our origin, gives us a kind of enjoyment in this speedy World, where time rules.

It is important to turn ceramic activity into a wonderful and pleasure giving activity, an artistic or productive job which requires a certain knowledge and which offers the new generations the possibility of greater development and legacy throughout time.

New designs will certainly come up, ancient techniques and aboriginal design identify us as Latin Americans. Different ways open to the future; the load of knowledge which ancestral pottery making offers, gives us the possibility to generate new and brilliant opportunities to contemporary Argentine ceramics. After concluding the first part of this study I have come to the conclusion that vase ceramics, in spite of being considered of ceremonial use, appears together with the need of holding solids and liquids. I think that ceremonial use doesn't exclude utilitarian pottery, on the contrary it is primitive domestic pottery which confers ceremonial use in aboriginal ceramics.

From this point I consider I must keep on with my study of pottery colour alter the Spanish conquest.

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Female names associated with rose in food and color relationship

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ABSTRACT

In Turkish, the rose which is reflected to female names constitutes a large corpus. Within this framework one of the most interesting point is color and food relationship. The synesthesia of color, fragrance and taste which exists is based on *Rosa damescena Mill*. namely *Pembe gül* (pink rose). A reading respect to the terms of rose flower and color seems to underline the dominance of the color pink and the privileged role of women. Transformation of some terms of sweets and soft drinks to female names, makes this domain more exciting. Rose culture still exists in Turkish female names and even though many variety of rose specialties are lost, the different stages of the process are still found in the culture.

1. ROSE CULTURE AND WOMAN

Scented rose generates an attractive corpus of color, having a comprehensive religious, cultural and economic past in Turkey reflected by an original food and drink mentality as well as female names. Food is based on the redolent petals of old roses with its specific fragrance, the use of rose water, and the attar of rose. This concept mostly finds its colors in *Rosa damescena* Mill. (*pink rose*) and it is centralized on *gül pembesi* (rose pink). As for *Rosa damescena,* it is "supposed to be a form a hybridization between *R. Gallica* L. and *R. Phoenicia* Boiss" (Baydar 2006).

Personal names with the meaning of rose can be examined into the area of onomastics according to "the etymology, the historical development, the different languages and the cultural problems" (Sakaoğlu 2001: 10). In a research for frequency in 2004-2005, the rose was at the top for 30.90% (Günay 2007: 142). Approximately 500 names related to the word "rose" and its different combinations determined during our study, should not be relied only to tradition. The reason for this is the rose is a prototype that covers all the characteristics of its category and represents them perfectly.

In fact it achieves a universal position in flower culture after lotus due to its color, form and fragrance properties. The rose consists of totality of the model of the necessary and sufficient conditions of flower domain. It is practiced as food and flavour for culinary purposes because of its aroma. It functions in healing, personal care and cosmetics. It may play a role to communicate or to end the communication between the divine beings, the dead or humans. It ranges in the aesthetic objectives with its image from the decoration to display (Goody 2010).

Women have great contribution in the practice of rose culture. From women the gatherers and cultivators to Court ladies it was transferred till today. Rose in Ottomans occupies a special place in color and food culture. Thus, it comes out as female names under the theme of Color and Food. At the present time, rose culture survives in Turkish female names though its content is forgotten. This study will try to establish a special synthesis of Turkish female names that maintain the continuity of the cultural interaction from the Middle East to Iran.

2. FEMALE NAMES AND ROSE FOOD

Rose food is a part of the haute cuisine in the Ottomans. The colorfulness and the union of rose with sweet is dominant in this cuisine of prestige with the roots from Abbasids (9th cent.) and Sassanids (13$^{th)}$ cent.). Sweet scented rose petals are still used today in soup, meatball and omelet in the regional kitchen. In this respect with the dichotomies of raw/cooked and fresh/dried, include names such as *Gül* (rose), *Gülçiçek* (rose blossom), *Gülberg* (petal of rose) in food and Gonca (rosebud) for the beverage (tea) category.

2.1 Color domain and signification of woman with rose food

The corpus of names associated with rose includes seven fields of color. Their reflection to luxurious and prestigious delicacies is only by white, pink and red sweet scented roses. In imperial cuisine, colors were as important as fragrance and flavor. Their practice in soft drinks is explained in the recipes as pink (Baytop 2001: 31) or red (Altıntaş 2007: 87) roses coloring the water. Rich and brilliant nuances reflected in the namings denote the attractiveness of the face, the complexion and the cheeks of the beauty.

Pink is the determinant color because *pink rose* became predominant among the cultivation of the oil-bearing roses in the industrialization process. For instance, the oldest rose desserts such as *gülengübin, gülbeşeker* and *gülşeker* that are based on the preservation of the color and the aroma with honey or sugar, are also pink. Consequently, this explains the reason of the preference of honey color as white for *gülengübin* which is a honey rose jam. Also one of the methods of rose sherbet, is based on dilution of those sweets that were earliest rose jams. Colors, within the Eastern and Ottoman cuisine exclusively in soft drinks, were used as an alternative to alcoholic drinks. The usage for medical purposes of these food and beverages being formerly a Court production popularized in time, was pink as well.

Gülgülî and *Gülâbî* among them, which are the technical terms of color and food, denote female names. Accordingly as in pink rose-*Gülpembe* and pink-*Pembe*, the cheeks and hue of the skin of the beauty are pink and herself is as precious as the names of the distinguished food such as *Gülengübin* –which was proposed for feast tables– on 11 th cent. (Hacib 2006: 795) and valuable such as *Gülbeşeker*, Seraglio's precious rose jam manufactured with high-priced sugar of high quality (Işın 2008: 142). The prestigious status of honey that begins from antiquity leaves its place to sugar which was more expensive in the Middle Ages. My Honey Jam or *Gülümbalı*, is the Turkified form represented in the language of this incomparable sweet, which is extinct today. *Güngül*, cooked under the sun, referring to a method before fire unifies the energy of the sun to the other significances. *Gülâbî* also the name of a pudding with sherbet, has the meaning of sweet too and it is cooling and healing as *Gülgülî* which is a theriac sherbet. Besides *Gülengübin,* united with the meaning of *Gülşifa*, rose healing, is warming, while *Gülbeşeker* is refreshing in old medicine remedies (Altıntaş 2009: 38).

The group of rose colored- *Gülgûn,* connected with the rose color, consists of *Gülpembe* (rose pink), *Gülfâm, Rengigül,* which are all designated synonyms of pink. Among them only *Gülziba* and *Nesrin* refer to rose flower's names and *Gülâbî* to rose water. The dominance of pink is also emphasized by the numerous terms of pink. All these names describe the young woman who gains her beauty from pink rose.

Red rose field has the priority of color, not food. Red color, nearby the function of decoration of food with petals, is also concerned with the tradition of sherbets and syrups. Red color is preferred for some of specialties made with rose petals –red rose water, rose vinegar and pudding with rose syrup– in addition to the ones such as Turkish delight and akide (sugar candy). Therefore red species of *Rosa damescena* and *Rosa centifolia* (*Sadberg)* are used (Baytop 2001: 32). When red is not possible to achieve naturally, they have recourse to other natural or synthetic colorants.

Gülsuyu (rose water), the most important fragrant water between the choice spices, is the only Ottoman fragrance that remains from the past, is still eaten and drunk. As a Near Eastern tradition beginning from Ancient Sumer, it appears within the rituals of the religion and hospitality. A fundamental flavouring of the haute cuisine, other than sweets, was applied to almost every kind of food category from fish to poultry. Gülsuyu is used as a seasoning in 46% of foods. Hence, it serves the function of wine in Western cuisine (Boudan 2006: 50). Other than red rose water, *Gülâbî* like today's *Güllü muhallebi* –a pudding with rose sherbet– and *Gülgülî* which is also a rose rotation, are both pink. *Gülsuyu* or *Gülsu* are eaten with sweets, drunk when chilled with snow or ice and sprinkled as fragrance. This includes the meanings such as pleasing scent, sweet in taste, relieving, cure-all and beauty. *Gülnûş* meaning, rose savouring while drinking*, Seringül* and *Gülferah* a beautiful lady cooling and refreshing are joined to all other meanings. When it is based on color, it means beauty with pinkish body, such as the healing, fragrant sherbet or rose dessert. In fact being a colorless rose product denotes the clearness and the brilliance of her complexion.

2. 2 Narratives about food actions

The preparation of *Gülbeşeker* which was the most luxurious imperial offering for guests, made of luxurious white sugar also becomes a beauty name. Crushing rose -*Gülez* denotes the act of "crushing" freshly bloomed rose petals with the best quality of hard sugar. The concept of high status has its source in the action of the beauty preparing a rose sweet with sugar. It is originated from her acts which is considered as beautiful as her, as the beauty is found in her. Because the action committed will serve to preserve the color and the fragrance of rose, in order to attain the essence of rose, it is also related to *Gülöz* and *Gülbu.* Hence crushed petals of rose with sugar can also be scattered on sweets, the other actions related to *Gülez* are "scattering" and "sprinkling". Beauties named with synonyms such as *Gülefşan*, *Gülriz* and *Gülbiz* can scatter or sprinkle sugar with petals (*Gülşeker)*, rose petals or rose water *(Gülberg* and *Gülsuyu)* over food or sweets*.* Rose water which gives its own aroma, has also the property to fix other scents. In *Ahugül* it retains musk and serves to fix amber in *Gülamber* to enrich rose fragrance with musk and amber.

As it is seen the names are not derived from names and adjectives related to rose, they also may be combined with rose verbs which are appreciated as beautiful. The phases of "cultivation", "gathering" roses, "harvest", preparation of food, are all reflected to female names. It is possible to distinguish the actions of rose before and after food. Before food actions, coming from the fragrant rose production to the rose harvest are articulated as a syntagm, therefore the names that are associated with them, seem to imply every phase in a linearity. *Gülçin* and *Gülderen* gathering wild roses –*Nesrin* and *Nesteren*– refer to the woman the gatherer. In the sense of the wild and domesticated opposition, they realize the very first rose action which falls the wild side of the opposition. In the contrary, if gathering roses comes after their culture, *Gülçin* and *Gülderen* should be followed by rose cultivating, *Gülhiz.* Roses such as pink rose and Centifolia that were gathered after the cultivated rose's harvest, are "brought" by *Gülaver*. *Gülveren* and *Gülsun,* made the acts of "giving" and "offering". Those names, in each section of concepts of field, can form a whole of the real narrative. *Seringül, Tazegül, Seçgül* and *Tezgül* which are all about rose harvest, almost can be articulated linearly. They all mean that the rose harvest is done by handpicking only full-bloomed flowers one by one, in the very early hours of the morning. *Gülseren* and *Seringül*, are about the roses gathered and brought for being "spread" on the ground in coolness before the attar of rose and rose water production.

Gülseren-spreading flowers, and the set of *Gülriz* names-scattering and sprinkling petals or rose water, could not be reduced solely to readings about production. The rose food is based on votive offerings of flower and fragrance related to food in paganic times. These old forms of worship are transformed into status symbols also by a semantic change. Therefore those names include the "decoration" of the feast tables by strewing them with rose petals and sprinkling of rose water in Court and the rituals of high status hospitality.

CONCLUSION

In Turkish language, female names associated with rose related with color and food, suggest an interesting perspective. Everything is on the basis of pink rose and its own color, pink which is focused on the role of women constituting an economic, historical and cultural existence of rose. This position which could be claimed a detailed syntagm, gives life to the names of a forgotten culture.

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Edible colour names

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ABSTRACT

The results of a Web-based colour naming experiment were analysed for the incidence of colour names relating to food, or at least to edible substances. Approximately 21% of 5500 responses in English were derived from or related to food, of which 65% were single-word and 35% multi-word. 443 terms were used twice or more, of which 85 (19%) were directly related to food (e.g. 'cherry red') and a further 53 (12%) were indirectly related to food (e.g. 'sunflower yellow'). Females tended to use colour names related to food more often than males, and subjects with colour experience more often than naïve subjects.

1. COLOUR NAMES AND FOOD

Wittgenstein (1958: 25 ff.) proposed that a notion of comparison is basic to all colour terms. He likened the naming of colours to measures of length: both work by reference to external prototype samples, or standards. In some languages the general word for 'colour' is related to the word for 'like', and in others a suffix 'looks like' accompanies many colour expressions (Berlin and Kay 1969: 38). These suggest the emergence of colour vocabularies from the names of objects that exhibit the relevant hue. Casson (1994) observed that English simplex secondary colour terms such as rose and raspberry were innovated by means of the ontological metonymy "Entity stands for entity's colour". For example, the word 'raspberry' stands for the raspberry's red colour. This metonym is an embodied cognitive structure based on people's experience with physical entities and their associated colours. Secondary colour names for entities with characteristic colour associations have been metonymically converted to colour terms, drawn from five object domains: plants, animals, minerals, foods, and artifacts.

Brown and Lenneberg (1954) believed that culturally important colours should often be employed in direct speech, although each individual culture might differ with respect to the areas of colour space to which they paid the most attention because of different cultural ecology. McNeill (1972) analysed the usage of colour names in many cultures, and concluded that 'In the development of colour words, as in any other linguistic creation, necessity and functional importance are the determining factors, and seem to depend on the chief interest of a people.' Levinson (2001) conducted a study in linguistic anthropology on Rossel Island, Papua New Guinea, where the inhabitants speak an isolated language, known as *Yeli Dnye,* literally 'Rossel language'. Yeli (like most unwritten languages) has no superordinate word for 'colour'. He noted the contrasting structure of their expressions, *yi kuu yaa* and *yi chii yad* ('tree unripe leaf' versus 'tree desiccating leaf'), which serve to pick out green and yellow hues respectively. The adjective *kuu* indicates unripe (of fruit), raw or uncooked (of food), innocent (of people), and, in the collocation with the word for leaves, clearly denotes fresh, new leaves. The adjective *chii* indicates drying, desiccating, withering but not yet dead, and is especially used of vegetation. The underlying dimension of wet/succulent/ green versus dry/brittle/yellow is very reminiscent of the ancient Greek *χλωρός* (*khloros*) which could mean 'fresh, unripe, moist' as well as 'green'. The cross-cultural repetition of this pattern indicates that a simile or metaphor rarely picks up just one property of the metaphorical referent, and is likely to retain multiple levels of meaning.

Rosch (1975) proposed three levels of cognitive categorisation: (1) Superordinate: The whole concept of 'colour' is on the same level as other concepts, such as number, vegetable, animal, furniture, vehicle, etc.; (2) Basic: The most general level at which people spontaneously name objects. The focal colours red, yellow, green, and blue are on the basic level within the 'colour' superordinate category; (3) Subordinate: A finer subdivision of the basic level. Salmon pink, rose pink, and lilac pink are on the subordinate level within the 'pink' basic category. Lin et al. (2001), in an extensive study of colour naming by British and Chinese subjects, used a four-level categorisation of colour names in a perceptual colour space. To describe a colour, one basic name could be used alone, or with a modifier, or with two basic names compounded, or with a secondary term. For the basic colour 'green', for example, the three additional categories would be: (1) any colour name with a modifier, such as 'bright green'; (2) any colour name ending with a compound term, such as 'yellow-green'; (3) any colour name using a secondary term, such as 'olive green'. Lin et al. found that 30 out of the 72 principal secondary names used (i.e. 42%) were related to food. Chinese secondary names were frequently related to commonplace foods, such as milk, butter, coffee, tea, rice.

Macario (1991) investigated the colour associations of preschool children and found that 3-year-olds were more likely to use colour than shape to classify novel items when they thought these were something to eat. In contrast, they were more likely to use shape when they thought the novel items were something to play with. This suggests that young children have already formed a general hypothesis about the predictive validity of colour for kinds of food. Indeed there is evidence that early experiences can be critical in the development of synaesthetic sensory pairs. Ward and Simner (2003) analysed the relationship between speech sounds and induced synaesthetic tastes in a lexical-gustatory synaesthete and found that his synaesthetic tastes derived predominantly from foods he ate as a child. Many were related phonologically or semantically to the name of the taste, so that, for example, the word 'Virginia' induced a taste of vinegar, and the word 'bar' tasted of milk chocolate.

2. EXPERIMENT

A colour naming experiment was conducted via the Web,[1] enabling a large number of observers from culturally and demographically diverse populations world-wide to contribute in a short period of time (Mylonas and MacDonald 2010). The subject had to provide a name for each of 20 single colour patches, presented in sequence at the centre of the display screen on a grey background. The colour naming was unconstrained, so that any combination of words could be used. The stimuli were selected at random from 600 test samples in the Munsell Renotation Dataset and specified in the sRGB colour space. The Munsell system was selected because it corresponds directly to human perceptual judgements of difference and similarity and its five-basic-hue model fits better with empirical data of the basic psychological hues compared to a four-basic-hue model. Data was gathered on each subject's age, gender, educational level, colour experience, display type and viewing conditions, as well as the response time for each sample. A simple graphical test was included in the procedure to determine whether the subject had normal or deficient colour vision. So far, over 1600 people have done the experiment in five languages, of whom approximately 45% used English.[2]

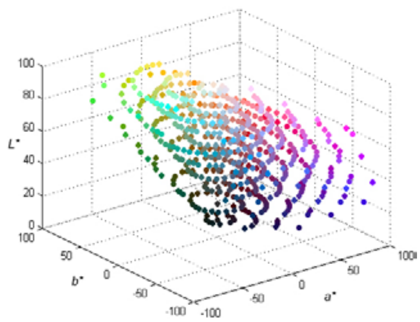

*Figure 1. 600 stimuli of colour naming experiment, constrained within sRGB gamut, plotted in L*a*b*.*

[1] www.colournaming.com
[2] The site also provides versions in Greek, Spanish, German and Catalan.

3. ANALYSIS

The experimental data for non-deficient observers over the age of 16 were analysed. The centroids of the basic colour terms were validated against the psychophysically rigorous results of Boynton and Olson (1987) and Sturges and Whitfield (1995). The refined dataset in the English language resulted in 5428 observations of 1226 unique colour words. 52% of the responses were monolexical (i.e. consisted of a single-word), 42% of two words and 6% of three or more words. The eleven basic colour terms proposed by Berlin and Kay (1969) occurred in 29% while non-basic terms were involved in 23% of responses. The 27 most frequent chromatic colour words showed excellent correlation with the results of the web-based experiment of Moroney (2003) in terms of the location of their centroids. A colour-naming model was developed, based on the ideas of Motomura (2001) and Chuang et al. (2008), with maximum-likelihood parameter estimation.

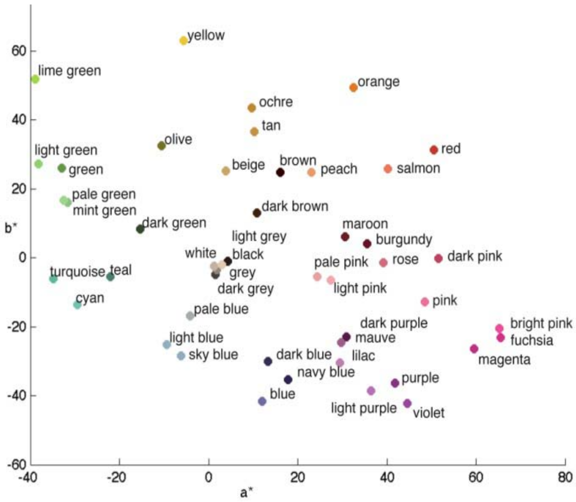

Figure 2. Centroids in a-b* plane of the 47 colours named more than 20 times by subjects.*

The results were analysed for the incidence of colour names relating to food, or at least to edible substances. We distinguish colour names *derived from food*, for which individual mental images can possibly be formed (e.g. fruits, chocolate), from colour names *related to food*, including ingredients or colorants of food, for which individual mental images cannot easily be formed (e.g. oil extracted from flowers or nuts) (Finke 1986). Approximately 21% of 5500 responses in English were derived from or related to food, of which 65% were single-word and 35% were multi-word. 443 terms were used twice or more, of which 85 (19%) were derived from food (e.g. 'cherry red') and a further 53 (12%) were related to food (e.g. 'sunflower yellow'). Females tended to use colour names related to food more often than males, and subjects with colour experience more often than naïve subjects.

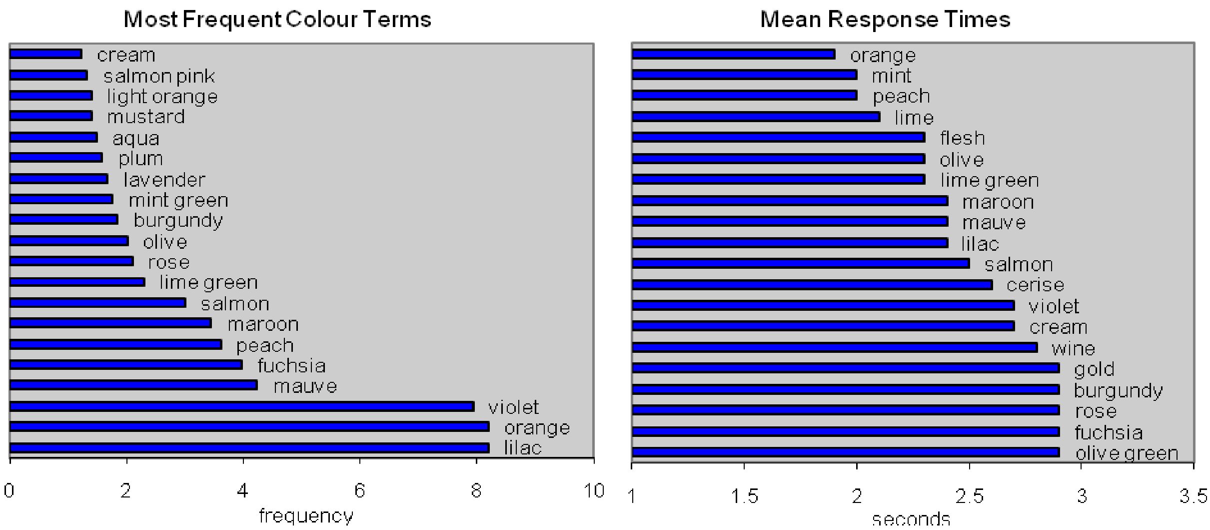

Figure 3. Most frequently used colour terms (left) and most rapidly named colours (right).

The most frequently used colour terms were 'lilac', 'orange' and 'violet' (Fig. 3 left). The analysis of response times showed that 'orange' and 'peach' were named most quickly, followed by various greens (Fig. 3 right). Extra-spectral colours in the hue range between blue and red ('fuchsia', 'mauve', 'lilac') took longer to name. In general, object colours were identified faster than non-object colours. Considering all colour names, those derived directly from food had the fastest response times, indicating that the presence of a mental image (food-object in this case) significantly influenced how quickly participants were able to identify a colour-object (Hutchings 1999: 104).

Classification of the 320-colour Munsell Array, using the MLE probabilistic model with training set of colour names related to food, yielded the arrangement in Figure 4. The results indicate the importance of familiar food-stuffs in the recognition and articulation of colours. This is consistent with recent findings on the influence of language in categorical perception.

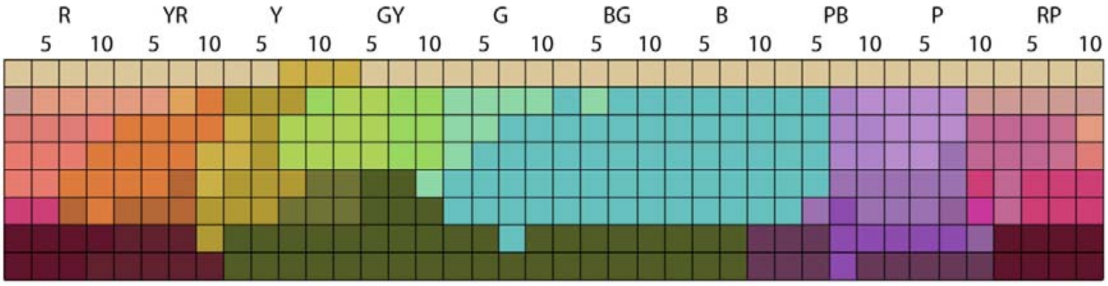

Figure 4. Classification of the Munsell 320-colour array by 28 food-related colour names: 'aqua', 'burgundy', 'cerise', 'cream', 'dark orange', 'flesh', 'fuchsia', 'lavender', 'light orange', 'light violet', 'lilac', 'lime', 'lime green', 'maroon', 'mauve', 'mint green', 'mustard', 'mustard yellow', 'olive', 'olive green', 'orange', 'peach', 'plum', 'rose', 'rose pink', 'salmon', 'salmon pink', 'violet'.

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From red bordeaux to absinthe green, from hot chocolate to cappuccino: Beverages, their referential colour terms and reflections on cultural differences

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ABSTRACT

This paper is not intended as a contribution to the exhilarating debates concerning the definition of basic colour terms launched by Berlin and Kay in 1969; nor does it explore a cross-language comparison of basic colour vocabulary with varying boundaries or models categorising and structuring the colour continuum; and finally, it is not an investigation of the relationship between colour perception and colour identification. Rather this paper gives insights into how beverage-related colour terms express and articulate a society's cultural 'taste' of drinking habits, values and trends. Synthesizing three perspectives –Annie Mollard-Desfour's (1993 to 2009) dictionaries on an exclusively French colour lexicon, Svetlana Krylosova's (2005) comparative approach of French-Russian colour vocabulary and Verena M. Schindler's multi-lingual knowledge focused here on colour terms in English, Spanish and German– the trans-disciplinary and cross-cultural result highlights the complexity of the whole as well as specific ways in which the vocabulary of colour truly serves as a 'mirror' of its respective culture and society.

1. INTRODUCTION

How does colour vocabulary emerge, spread and eventually express the culinary 'taste' of a culture and society in food-related contexts? Indeed naming colours can be broadly related to conventional human experience, sense perception and practical aspects of raising, cooking and eating food. In short, colours are perceived then analyzed, compared and named and designating the infinite array of colours and their shades with words and expressions is not only part of basic human activities and even survival, but also imbedded in more poetic or spiritual practices which are fuelled by fantasy and oneiric imagery.

1.1 System of direct and referential colour terms

According to Annie Mollard-Desfour's linguistic approach, colour terms can be divided semantically into two groups: hyper(o)nyms and hyponyms (Mollard-Desfour 1998: 21). Hyperonyms are fundamental, basic or generic colour terms that define a chromatic field and serve to describe a category in relationship to subcategories. Such hyperonyms include eleven so-called 'direct' colour terms given here in English and French and listed alphabetically according to the French term [in brackets]: blue [bleu]; white [blanc]; brown [brun (marron)]; grey [gris]; yellow [jaune]; black [noir]; orange [orange]; pink [rose]; red [rouge]; green

[vert]; and violet [violet]. This generic colour lexicon coincides with Berlin and Kay's typical stage VII of their evolutionary model with its eleven-term system that includes American English, Mexican Spanish and Russian, but neither French nor German terms (Berlin and Kay 1969: 90). Linguistically these direct colour terms constitute a kind of closed list together with their respective word classes (adjectives, nouns, verbs, etc.), e.g., white [blanc]; whitish [blanchâtre]; whiteness [blancheur]; to whiten [blanchir]. On the other hand, the hyponym is related to the hyperonym in a subordinate matter, as in *bordeaux* [bordeaux] or *vin* [wine], which are hyponyms of the hyperonym *rouge* [red]. As an indirect or referential colour term the result is a more open set of words created by derivation, compounding and borrowing as well as by semantic connotative relationships, e.g., comparative, metaphorical, analogous, etc.

1.2 Compilation of the colour lexicon

Mollard-Desfour's hyperonym-hyponym system of direct and referential colour terms serves in the analysis of the connotative meaning of specifically beverage-related colour terms in French, Russian, English, Spanish and German. The primary sources of terms used in the present study include dictionaries, specific colour monographs (among them, Kelly and Judd 1976, Sanz and Gallego 2001, Ronchi and Sandford 2010), some literary texts and spoken and written vocabulary also taken from websites and chats. The resulting compiled lexicon is not limited to a specific time period. In fact, the lexicon of colour terms is infinite, a characteristic which is particularly due to recent developments whereby colour terms are being created to serve in advertising and promoting commercial goods especially in such sectors as cosmetics, fashion and automobiles. However, it is interesting to note that not all beverages lead to specific colour terms in practice, e.g., *bordeaux* is a shade of purplish red associated with wine from the Bordeaux region in France common to all five languages, while other wines such as *Côte-du-Rhône* do not provide any colour reference in any of the five languages. Some terms are integrated into the vocabulary of daily life and are quite common, e.g. 'milky white', whereas others are sophisticated and are used in specialized contexts only, e.g., a shade of brown called 'enough chocolate syrup mom' is a fanciful invention of a paint company. The connotative meaning of colour terms may also vary from one language and culture to another, as we will see later. The result is a striking panorama of subtle cultural differences, social valorisation or de-valorisation as well as a range of semantic, symbolic, and metaphoric similarities and disparities.

2. CROSS-LANGUAGE COMPARISON

This study inquires into such questions as: Which are the most important beverage-related colour terms of these five specific languages? Are there colour terms shared across all five languages? How is it that some of them have a positive connotation while others do not? In what ways do they reflect the 'taste' of a culture or society? How do their meanings change within a given framework of values and trends?

In general beverages fall into the following categories: 1) alcoholic drinks, e.g., wine, champagne, spirits, liqueurs and cocktails; 2) low-alcoholic drinks, e.g., beer and apple cider; 3) soft drinks, e.g., colas; 4) other cold beverages, e.g., iced tea, lemonade, fruit punch and syrup; 5) hot beverages, e.g., milk, chocolate, coffee, tea and herbal or fruit teas; and 6) other liquids, e.g., milkshakes, buttermilk and yoghurt-based drinks. Recognizing that the possible range of kinds of beverages to be considered is very extensive, this paper does not focus on the field as a whole, but rather on some of the most striking beverage-related colour terms.

2.1 Salient referential colour terms

Some colour terms conform to cross-language generalizations appearing as 'common' concepts, for example:

Milk. French *lait;* Russian *молочный / molotchnyï;* English *milk-white (white as milk);* Spanish *leche, blanco leche;* German *milchweiss, milchfarben, milchfarbig*. In Renaissance bucolic poetry Spanish *leche* refers to whiteness and also to freshness [frescura], smoothness [suavidad] and delicacy [dulzura]. Considered as the embodiment of natural beauty found in a rural environment the mythological figure 'Galatea' is personified by such feminine virtues as precious as milk. French *lait* expresses immaculate, pure whiteness with the additional connotation of light [lumière] and splendour [éclat]. It is used as an extremely valorising and poetic expression referring to the light of the sky, stars, moonlight, dawn and the skin of ideal feminine beauty! *Milky Way* (Chaucer, 1384) alludes to a pathway brilliant in appearance or leading to heaven. Whereas in Spanish the colour referred to is a yellowish white, English *milk* and Russian *молочный / molotchnyï* refer to an opaque or bluish white with the connotation of being pleasant and nourishing and of purest and finest quality.

The pre-eminent and popular role of milk in Russia-inspired specific colour terms, e.g., Russian *цвет парного молока / tsvet parnogo moloka* [still steaming milk], which is used to refer to freshly-milked milk; Russian *цвет материнского молока / tsvet materinskogo moloka* [breastmilk, in French *lait maternel*] are associated with infant memories; Russian *цвет топлёного молоко / tsvet toplënogo moloka* [baked milk] indicates a highly-valued warm, vivid and beautiful 'crème' shade used in describing the colour of feminine skin, animal fur, interiors, furniture and fashion. Russian composite terms may refer to fashion, whereas in French this is never the case. However, the English colour term *milky*, resembling milk, especially in colour or cloudiness, also means spiritless or spineless.

Wine. A common colour term used since antiquity is *wine*, which is always a red colour in all five languages: French *vin*, *couleur de vin;* Russian *винно-красный / vinno-krasnyï;* English *wine, vinaceous;* Spanish *vino*, *vinoso;* German *Wein, couleur vineuse* (1773). Originally English *Claret* –like French *vin clairet*– was attributed to distinguish yellowish or light red coloured wines from red and white wines until around 1600. Thereafter it was used for red wine and is now applied to red wines imported from Bordeaux as in *claret wine.* Today in English language contexts the colour *claret* is commonly understood as reddish-violet.

In general in all five languages wine colour terms are divided into red [French *vin rouge*], white [French *vin blanc*] and rosé [French *vin rosé*]. However, the actual colour range between each category is different depending on the language. For example in Spanish the palette of colour terms goes from white [*blanco*], purple-rose [*clarete*], golden [*dorado*], brown-red [*pardo*], red [*rojo*], rose [*rosado*], dark red [*tinto*] to green [*verde*]. In French, in addition to the three wine terms mentioned above the colours also include yellow [*vin jaune*] and grey [*vin gris*]. French *vin noir* and *vin bleu*, colour terms both related to red wine, have a pejorative connotation: the first –black wine– is a strong, rustic wine, the second –blue wine– a bad quality wine that leaves bluish stains.

Coffee. French *café;* Russian *кофейный / kofeïnyï;* English *coffee;* Spanish *café;* German *Kaffee:* all refer to a medium-dark brown and in general have valued qualities, e.g., often being associated with the colour of skin, eyes or clothing. In particular, the colour vocabularies of fashion and advertisement are rich in sophisticated and trendy colour terms alluding to coffee, e.g., in French *café clair, café très dilué, café frappé, brun café brûlé, Carte Noire* and *moka*, a fine quality coffee with its multiple variants: *moka crème, moka* *délicat, moka intense, mat moka chaud, mat moka doux, mat moka intense;* and also in English, e.g., *mocha, mocha coffee, mocha café, light mocha, mochachino, mocha crème, mocha brown, Swiss mocha, mocha accent, mocha madness*. French *expresso,* Russian *экспрессо* / *èkspresso,* German and English *espresso* and *caffè espresso* (the Italian composite, which literarily means 'pressed-out coffee') are all used to refer to a dark brown, almost black colour. In Spanish there is no such term, but *café solo* (black coffee without milk and the only one served in a little cup) or *negro café* (from French *café noir*) are somewhat comparable.

The addition of milk modifies the chromatic array including such classics as Italian *cappuccino;* French *café crème*, *café au lait;* and the transliterated version Russian *кафе-о-лэ* / *kofe o-le;* as well as translated versions, such as Spanish *café con leche;* and German *Milchkaffee*.

In recent years French fashion trends and a typical Anglo-Saxon colour lexicon have inspired a rich and exciting colour vocabulary in Russian language usage after a silent time period of seventy to eighty years: *кофе со сливками / kofe so slivkami* [skimmed café au lait]; *кофе-гляссе / kofe glïasse* [café glacé (iced café)], *мокаччино / mokatchtchino* [mochachino], *чёрная карта / tchernaïa karta* ['Carte Noire', the leading premium coffee brand in France]; *цвет жидкого кофе / tsvet jidkogo kofe* [a weak coffee], one of few expressions with a pejorative connotation. Many newly acquired Russian colour terms refer to mixtures of coffee and alcohol: *кофе с каплей ликёра / kofe s kapleï likëra* [coffe with a dash of liquor]; *кофейный грог / kofeïnyï grog* [coffee grog]; *кофе мокко с коньяком* / *kofe mokko с kon'ïakom* [mocha coffee with cognac]. Culturally interesting is the different use of the basic colour term 'brown': Latin American Spanish *café* versus Spanish of Spain *marrón*.

Chocolate. French *chocolat*, Russian *цвет какао / tsvet kakao*, English *chocolate, cocoa,* Spanish *chocolate*, German *Kakao, kakaofarben*: all these colour terms reveal a confusing adoption of the original names. Nahuatl *cacaua-atl* is a drink of chocolate dissolved in boiling water or milk (modern chocolate milk) as distinguished from *xocolatl*, meaning 'bitter water', a beverage made from the seeds of the cacao tree. Special colour terms are Russian *цвет како / tsvet kakao* [hot chocolate]; Russian *цвет какао с молоком* / *tsvet kakao s molokom* [chocolate milk]; and Russian *цвет горячего шоколада* / *tsvet gorïatchego chocolada* [hot chocolate], a literal borrowing from the French *chocolat chaud*, which is a colour term in cosmetics in French. Referential colour terms related to coffee and cold or hot chocolate trigger pleasant associations and in general the vast variety of colour names designate beautiful shades.

Tea. French *thé*, Russian *чайный цвет / chaïnyï tsvet*, English *tea,* Spanish *té,* German *Tee*. After water, tea is the most frequently consumed beverage in the world and has inspired a large number of simple and compound colour terms associated with a large palette of shades and meanings.

2.2 Colour terms derived from French alcoholic beverages

A series of French wine growing regions known as appellations has had an impact on colour terms across languages and cultures. The most popular term used in all five languages is French *bordeaux*, Russian *бордовый / bordovyï* [bordeaux], English *bordeaux*, Spanish *burdeos,* German *Bordeaux*. Another colour term is French *bourgogne,* Spanish *borgoña* that includes diverse white and red shades: Spanish *blanco chardonnay*, *blanco de Chablis*, *tinto borgoña*, *tinto Beaujolais*, *tinto de Coulages*, *tinto de Irancy*, and *violeta bogoña;* Russian *божоле / bojole* [beaujolais]; and Russian *божоле нуво / bojole nuvo* [beaujolais nouveau], a literal borrowing from the French *beaujolais nouveau*, a popular *vin de primeur*. French *bourgogne*, however, is better known as English *burgundy,* as in German *Burgund*, Russian *бургунди / burgundi* [burgundy], a term used for talking about colour only and not about wine, as in the colour of the Russian passport. A parallel development since the 19th century is Russian *цвет бургундского вина / tsvet burgundskogo vina* [bourgogne], e.g., as applied by Leo Tolstoy to describe facial emotions.

The most frequent and valorising French colour term across languages, however, is French *champagne*, Russian *цвет шампанского / tsvet champanskogo* [champagne / Russian champagne], as well as its literal adoption Russian *шампань / champan* [champagne / French champagne], English *champagne*, Spanish *champaña*, German *Champagner.* An exceptional colour term is Russian *брызги шампанского / bryzgi champanskogo* [Champagne droplets]. Culturally interesting is the fact that a marketing campaign that was launched in the 19th century using champagne was addressed to women. The result was that champagne shades became associated with delicate, elegant and feminine items in contrast to bordeaux red, which was mainly used as a colour for men. While champagne is often used as a generic term for white sparkling wines, since the 1990s the term itself is a legally protected label exclusively to be applied to sparkling wines from the Champagne region in France. No other product is allowed to use this name. A side result of this protective policy might be the eventual extinction of the elegant colour term ‘champagne’.

Other internationally used and typically French colour terms also include, e.g., *cognac* and *chartreuse*.

3. CONCLUSION

The most striking result of this study is that beverage-related colour terms cannot be analyzed by colour hyperonyms or individual chromatic fields. Some colour terms are imprecise in that they relate not only to a single shade, but also to many colours varying in lightness, saturation and even hue. The second observation is that culturally integrated beverages like milk, wine, coffee, chocolate and tea coexist with a large and rich colour vocabulary. Other widely consumed beverages like beer, however, provide a reduced number of colour terms. This is also true for herbal teas, soft drinks and other cold beverages mentioned above. Surprisingly colour terms relating to Paraguay tea *maté*, Spanish *mate,* are practically non-existent. Other colour terms like Russian *кисель / kisél’* [kissel] is known only in Russian language. *Absinthe* relates to both a green and yellow colour.

A cross-language study enables the bringing to light of essential differences of connotative meanings and the emphasizing of linguistic and semantic subtleties of chromatic terms derived from one and the same referent. A cross-cultural analysis also helps in understanding how beverage-related colour terms reveal some essentially cultural aspects influenced by regional traditional practices or commercial activities and globalization. Based on geographic specificity and culinary taste, these specific colour terms reflect much more than a simple functional vocabulary; they mirror a culture’s sensibility as an important source of a community’s identity. They provide a distinct ‘view of the world.’ Therefore translating colour terms from one language to another is an extremely delicate enterprise. The linguistic approach to colour has its own mechanisms. It implies not just a language problem, but also embraces the whole cultural background through space and time.

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Enjoying food under a new light

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ABSTRACT

After more then 120 years of living under the warm and colour reliable light of the incandescent bulb, we are now forced to replace it for an “energy friendly” source of light. The most faithful electrical light source for colour rendition is soon to disappear. This paper aims to discuss the importance of the incandescent lamp in our daily lives, as well as the colour reliability of new energy-saving light sources that are now to replace the traditional light bulb. There is a vast lack of information regarding the advantages and disadvantages of these new types of light sources now available on the market, and it is perhaps now necessary to define guidelines that can help consumers and manufacturers to achieve the best possible lighting conditions in those areas where high color rendering is required. Although this subject is vast, this paper is mainly focused on the importance of high quality lighting in spaces such as the kitchen and at the dining table.

1. INTRODUCTION

In many countries the process of phasing out all incandescent lamps is already underway and user concern over the suitability of energy efficient lamps is starting to grow. How will we cope in our everyday lives in the absence of the incandescent lamp? Will colours of fruits and vegetables look as vibrant and intense as they do now, under CFL or LED light sources? Would our appetite and enjoyment of food be affected by this change in lighting condition? Are Energy Commissions aware of all the consequences that the ban of the incandescent light bulb could create?

There is a considerable lack of information regarding the advantages and disadvantages of new light sources available on the market, and it is perhaps now necessary to define guidelines in order to assist consumers and manufacturers to achieve the best lighting condition possible in areas where high colour rendering is required.

2. FROM DAYLIGHT TO LEDS

Light can be considered as one of the revealing elements of life. In the beginning, man was accustomed to following the rhythm of daylight, going to bed after sunset and waking up again early in the morning once the sun was up. Natural light was indeed for many years the only source of light. Many years passed before mankind was able to take a piece of wood from the fire and carry it into his cave. It was not until this moment that they were able to sense the feeling of wellbeing for the first time. The warm light of the burning flame had taken away the cold and the darkness, transforming the primitive cave into a *home*. It is in fact this primitive connection between light and the feeling of home, that has been forgotten, but it is precisely this that should always be considered when designing light for home environments.

All the way through history mankind continued to discover and develop new sources of light that could improve quality of living. As the knowledge increased, natural materials like wood and twisted fibers were drenched in animal fat to provide more light when ignited. In the next millions of years, evolution brought with it other ways of producing 'artificial light', and candles, oil lamps, and incandescent bulbs came to life to increase the amount of light that an artificial light source can give, to prolong the autonomy and life of the light source and to fulfill the needs of modern life. In 1876 the first bulb was produced emitting the same amount of light created by 16 hurning candles.

Finally the same primitive man that was accustomed to working from sunrise to sunset was now able to work day and night, 365 days of the year. Ever since, a technological battle began to try to produce more efficient light sources that can give more lumens per watt and that can last for more hours, lately with the great objective of not harming our environment. The significant change from candlelight and gas lamps, to the incandescent light source, is now being significantly changed once again, to discharge lamps, in and around the current period, and now to light emitting diodes.

Given the low efficiency of the incandescent lamp and the political ambition of countries to be 'green', on the 1st September 2009 a new law was established to begin the process of phasing out all incandescent lamps within the EU in the next couple of years, forcing with this all users to replace all traditional bulbs for compact fluorescent or LED technologies.

Are the lighting qualities of the incandescent bulb replaceable by LEDs or CFLs? No they are not. Will the atmosphere around the table be affected by this change in light quality? Yes it certainly will. One main reason for this is that even if incandescent bulbs are considered an artificial light source, the light they emit still comes from a 'natural process'; a burning process. However, the light that CFL and LED sources emit can be considered as a 'chemical light'. The results in quality of light are different, and so far the light of an incandescent lamp cannot be imitated by any other light source.

3. ENERGY FRIENDLY LIGHT SOURCES versus COLOUR RENDITION

Light is responsible for colour. Light is colour and colour is light. It is a fact that the perception of colour varies under different light sources and therefore colour pigments and light cannot be treated separately. It is exactly this intimate bond between colour pigments and light that is often underestimated and sometimes even ignored by people when selecting the right lighting qualities for spaces such as the kitchen or at the dining table.

We are accustomed to preparing and enjoying food under the full-spectrum light of the incandescent bulb and we feel comfortable with this type of light because it relates to our experience of daylight; to our inheritance as outdoor animals. Only by the colour do we know when the broccoli is cooked or when the meat has gone bad. Characteristic colours communicate the status of food and we have learned that through the life experience we have had under the full-spectrum light of the traditional bulb, that has been always faithful to colours and which properties do not change from bulb to bulb. With the new qualities of light that CFLs and LEDs bring into the home environment we will have to re-educate ourselves to achieve the same confidence in colour differentiation and therefore the status of the food, because the major drawback of CFLs and LEDs is that neither are a full-spectrum light source, and the light they emit can vary in appearance form lamp to lamp.

It has been observed that the difference between an incandescent light source and that of a CFL or LED light source has not only to do with the colour rendering index but also with the perceived brilliance and reflectance that the same hue can give under these different lighting conditions.

There is a considerable lack of information regarding the advantages and disadvantages of new light sources available on the market, and it is perhaps now necessary to define guidelines in order to assist consumers and manufacturers in achieving the best condition possible in areas where high colour rendering is required. This information should reach not only every discipline working with colour but also every individual that considers energy efficient lamps to replace traditional light bulbs within the home.

4. CONCLUSIONS

Knowing that the light qualities of the new 'energy friendly' light sources are poorer than that of the incandescent, knowing that the colour rendering is still not high enough, that the spectrum is not continuous at all, and that colours lose their brilliance under these 'energy friendly' light sources, are we confident we will still be able to enjoy food under this new light? The answer remains unclear. People are only just beginning to claim that they can indeed perceive the differences in lighting qualities and that they do not feel comfortable at all under the light of the CFL and LED. In my opinion it is a matter of lack of education, in the case of the energy authorities and the user. We could still 'save the planet' by replacing traditional bulbs with low energy consumption light sources only in areas where a high colour rendering is not needed, such as hallways, storage rooms, outdoor areas etc. … but keeping incandescent lamps in areas where a high colour rendering is necessary, such as cloak rooms, kitchens, dining areas etc. … and by controlling the duration the lamps are in use.

For the time being and until our voice is heard, as an architectural lighting designer my recommendation to all users and professionals working with colour, is to look back to our primitive origins and try to use daylight as 'the source' for good quality lighting and candles to bring back the feeling of home into our modern cave. Daylight is a natural full-spectrum light source that consumes no energy and that is after all cost free in times when our traditional and "energy inefficient" bulb is still incomparable to any other artificial light source.

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Effect of illuminance and correlated colour temperature on visibility of food colour in making meals

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ABSTRACT

Making meals includes many visual tasks. In food preparation, visibility is important in checking the freshness of the food, and in detecting perished, spoiled, or damaged portions. Visibility is also very significant in cooking meat in order to know the degree to which it has been cooked. In this study, we carried out a subjective experiment of the visibility of food ingredients and cooked meat, using light of different sources, illuminance and colours. Subjects observed two colour charts for the food ingredients and cooked meat, and evaluated the visibility according to the four steps of categorical scales. They also evaluated with the method of Magnitude Estimation as the basis for the lighting condition, 1200 lx in illuminance with D_{65} lamps. According to the results, it was found that the visibility was higher as the level of illuminance on the worktop increased. It was also found that the visibility slightly increased as the correlated colour temperature was higher. We showed the chart which could indicate the visibility level under the lighting condition with a combination of the illuminance and correlated colour temperature.

1. INTRODUCTION

The colour appearance along with visual texture and flavour is one of the major factors affecting food eating quality. The degree of pigmentation and the extent of light scatter are very important in distinguishing the degree of freshness (MacDougall and Sansom 2007). In the case of food preparation, colour appearance, glaze, asperity are important in checking the freshness of the food, and in detecting perished, spoiled, or damaged portions. In cooking, meat colour keeps changing with heat, so the colour appearance of meat is significant in understanding the degree to which it has been cooked.

In previous studies (McGuiness, Boyce and Harker 1983), subjective evaluation under the condition of an incandescent lamp was carried out for four tasks involved in food preparation, finding details of a recipe, weighing packages, slicing cucumbers and inspecting utensils. In another study on the lighting conditions of a kitchen (Fukumoto et al. 2009a, 2009b), the task performance in cutting, peeling and cooking was studied under different light sources, illuminances, light colours and light directions. In the General rules of recommended lighting levels issued within the JIS (Japanese Industrial Standard 2010), the value of the horizontal illuminance for task lighting on the worktop in the kitchen is 300 lx, $R_a = 80$.

This study aims to determine the lighting conditions in food preparation and cooking. In this study, we conducted subjective evaluation on the visibility of 2 colour charts for the food ingredients and cooked meat, under different conditions of light source, illuminance and correlated colour temperature.

2. METHODS

We carried out a subjective experiment of the visibility of food ingredients and cooked meat, using light of different sources, illuminance and colours. Figure 1 illustrates the plan and the section of the experimental space. We created 36 different lighting conditions with a combination of illuminance and light colour, using 10 fluorescent lamps (D_{65} lamps and 2700 K lamps) on a ceiling in the experimental space, and 12 lighting conditions with six steps of the illuminance, using two types of LED (2900 K and 5400 K). And we could manage the range of illuminance from 50 lx to 1200 lx, and that of correlated colour temperature from 3000 K to 5500 K. Figure 2 shows the chromaticity under each lighting condition.

Subjects observed two colour charts for the food ingredients and cooked meat according to the measuring results of the luminance and chromaticity (Fukumoto, Okuda and Okajima 2010). And they evaluated the visibility for the food ingredients and the visibility for cooked meat, according to the four steps of categorical scales “clearly visible”, “visible”, “barely visible” and “invisible”. They also evaluated with the method of Magnitude Estimation as the basis for the lighting condition, 1200 lx in illuminance with D_{65} lamps. The subjects were 22 female university students, in their twenties. And they were accustomed to cooking, because they belonged to the department of food science and nutrition.

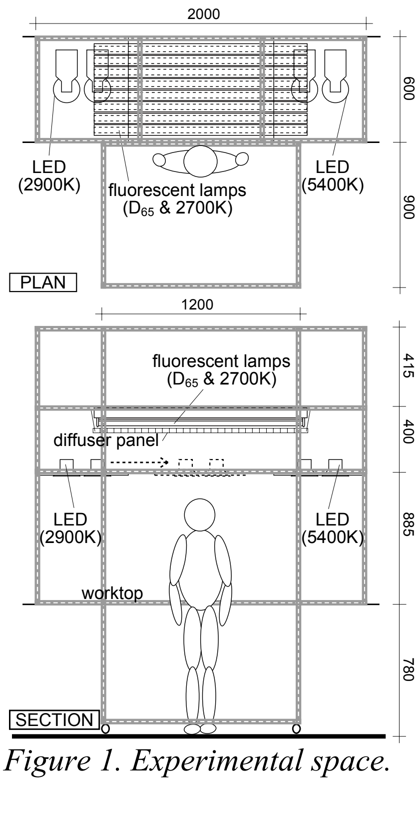

Figure 1. Experimental space.

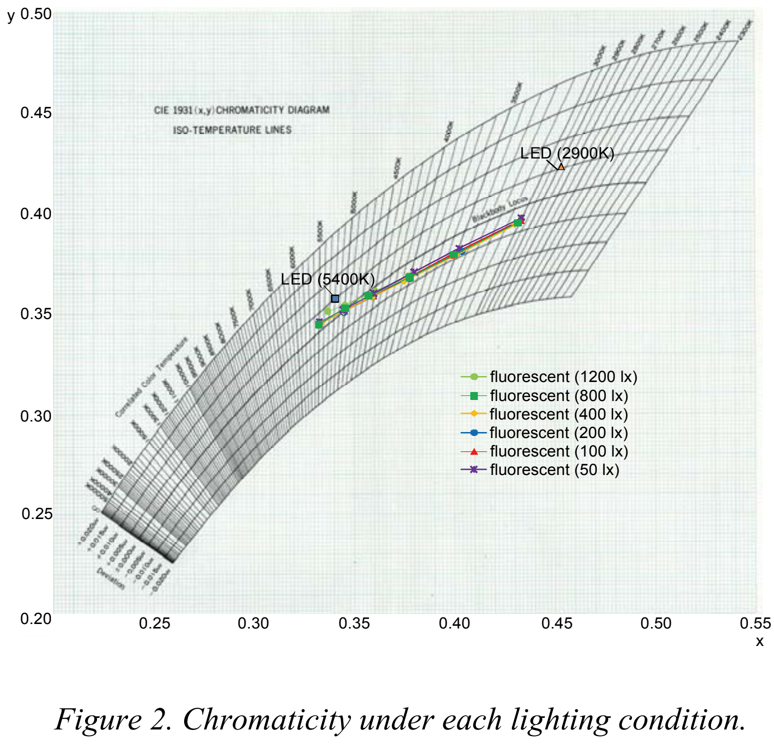

Figure 2. Chromaticity under each lighting condition.

3. RESULTS AND DISCUSSION

3.1 Evaluation results for the visibility of colour charts for food ingredients and cooked meat

Figure 3 shows the evaluation results for the visibility of two kinds of colour charts for food ingredients and cooked meat. It was found that the visibility was higher as the level of illuminance on the worktop increased. It was also found that the visibility slightly increased as the correlated colour temperature was higher.

80% of the subjects evaluated "visible" or "clearly visible" for the food ingredients, under the lighting conditions of fluorescent lamps, in 800 lx / 3000 K and in 400 lx / 5000 K. But they didn't mark "clearly visible" under every lighting condition of LED lamps.

80% of the subjects evaluated "visible" or "clearly visible" for cooked meat, under the lighting condition of fluorescent lamps, in 400 lx / 5000 K, but in the case of 3000 K, they answered "barely visible" under all illuminance conditions. Additionally, 50% of the subjects marked "barely visible" or "invisible" under LED lamps, in 800 lx / 2900 K.

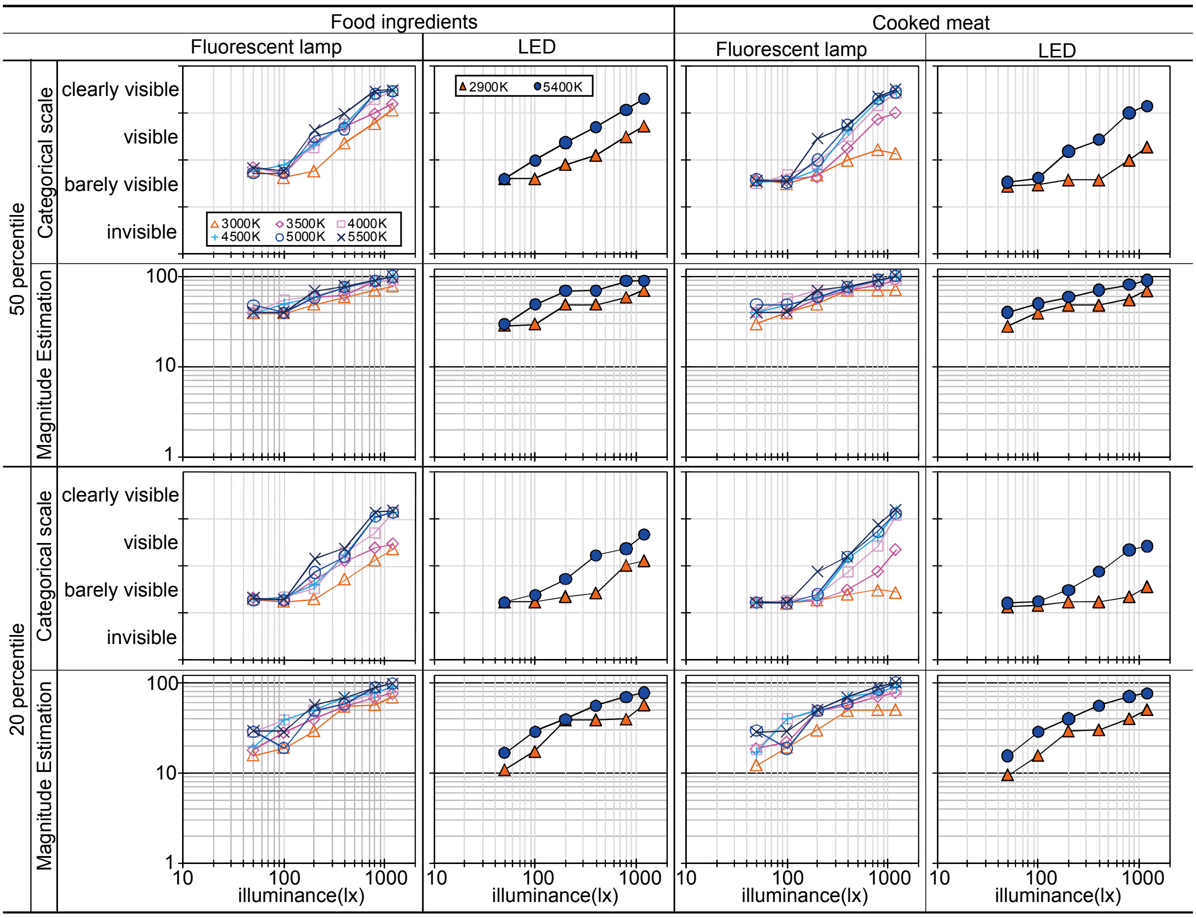

Figure 3. Evaluation results for the visibility of colour charts for food ingredients and cooked meat.

3.2 The charts indicating the visibility level under the lighting condition with a combination of the illuminance and correlated colour temperature

Figure 4 shows the charts which could indicate the visibility level under the lighting conditions with a combination of the illuminance and correlated colour temperature under lighting conditions of fluorescent lamps. According to these charts, 80% of subjects would evaluate "clearly visible" for food ingredients in 1200 lx / 4000-5500K, and in 800-1200 lx / 4500-5500 K. And they would evaluate "clearly visible" for cooked meat in 1200 lx / 4000-5500 K.

These charts show the range of the illuminance and the correlated colour temperature for the required visibility level. We can use these charts to evaluate the visibility level under some lighting conditions, illuminance and correlated colour temperature.

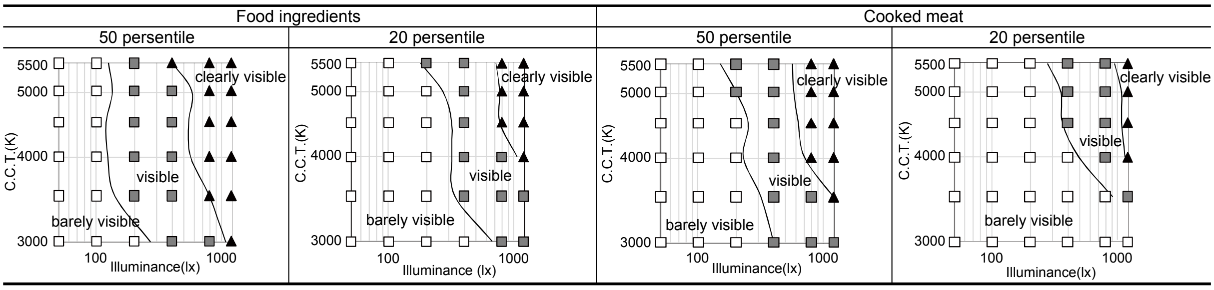

Figure 4. Charts indicating the visibility level under the lighting condition with a combination of the illuminance and correlated colour temperature.

4. CONCLUSION

In this paper, subjective experiment was carried out in studying the visibility of food ingredients and cooked meat, under different conditions of illuminance and correlated colour temperature. It was shown that the higher illuminance was required for the visibility of the food ingredients and cooked meat, as the higher correlated colour temperature. And we made the charts which could indicate the visibility level under the lighting condition with a combination of the illuminance and correlated colour temperature under lighting conditions of fluorescent lamps.

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Color calibration via natural food colors

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ABSTRACT

Color image calibration is usually done with the aid of a color chart such as the Macbeth ColorChecker containing a set of carefully produced color patches. However, in many consumer applications such as Internet shopping, for which the correct reproduction of color can be very important, most users will not have a color chart readily available, and probably are not interested in purchasing one in any case. We propose using the colors of the fleshy interior parts of oranges, lemons and limes, along with cooked egg white as a means of creating a simple color 'chart'. A sample of oranges, lemons and limes from North America and Australia has shown their color to be quite consistent, and therefore potentially suitable as a set of reference colors for color image calibration. Figure 1 shows one of the images used in measuring the colors of the fruits and vegetables. In the case of Internet sales, a seller photographing color-sensitive merchandise, such as clothing, could simply include one or two of these foods in each picture. This would provide an immediate point of reference for the purchaser as to whether or not the image colors are correct. Clearly, if the food colors do not look right, neither will the merchandise when it is delivered.

1. INTRODUCTION

We investigate whether fruit colors are stable enough to be used as a form of color chart for ensuring that the colors in an image are correct. Consider the situation of web-based clothes shopping. It is important that the colors the shopper views from the vendor's web page accurately represent the colors of the item to be purchased. However, the problem is not all the vendor's responsibility. The vendor may present images in sRGB space expecting the shopper to be using an sRGB calibrated monitor under standard viewing conditions, however, the user may have adjusted the brightness and contrast controls of his/her monitor which can significantly affect the colors it displays. As well, the monitor may be being viewed in lighting conditions that are far from those specified in the sRGB standard.

The typical web shopper is likely to be unaware that displays require calibration, that adjusting the contrast and brightness controls will affect the colors, and that the viewing conditions matter. Even if the shopper does realize these problems, it is difficult to deal with them directly. The shopper could purchase a calibration kit (e.g., X-Rite i1Display LT) but it seems unlikely that many people will do this. Even having a simple color chart such as the Macbeth ColorChecker handy would seem to be too much to expect. If all users did have a standard color chart available, then the vendors could include it in all of their images as well. By comparing the real color chart to the vendor's image of it, the shopper could be reassured, assuming the colors match, that the colors of the merchandise will match too.

Since it is unlikely that the typical web shopper will have a color chart available, we consider whether or not the colors of some standard objects could be used for comparison instead. The question is, though, what objects are both readily available and more or less guaranteed to be of a color? Although colors such as Coca-Cola red, or those of some currencies (e.g., the light blue of the 20 Euro note), may be relatively stable, they are not guaranteed to be so and are certainly subject to change. Metals such as gold and silver are another possibility, but the color of gold varies with its purity, and shiny silver is less a color than the reflection of its surrounding colors. In terms of natural objects, many, such as the green of leaves, would appear to be too variable. However, our hypothesis is that the fleshy interior of many fruits, and perhaps some vegetables, may be sufficiently stable to use as reference colors. If so, then a collection of a few fruits or vegetables might suffice as a simple color chart. This 'chart' could then be used by the shopper to validate the vendor's colors.

2. EXPERIMENTAL SETUP

The colors of fleshy parts of navel oranges, limes, lemons, beets, carrots, parsley, and egg whites were measured. Various kinds of paper were added for reference. The fruit, vegetables and eggs were purchased from 5 different stores in the Vancouver area. Both ripe and greener foods were selected. Fruits and vegetables originated from the USA, Mexico, Canada and Australia. The 'white' papers included a paper towel, tissues, printer papers and a selection of business cards of varying quality.

The fruits, paper samples, and a small Macbeth Color Checker were arranged together as shown in Figure 1 and photographed under two incandescent and two fluorescent lights. A Nikon D700 digital camera using 14-bit raw mode was used to obtain the images, and then dcraw (Coffin 2010) was used to convert the Nikon NEF linear images into 16-bit sRGB gamma-corrected TIFFs. Variations of the TIFF images were generated using Nikon ViewNX™ version 1.5.2, an image-editing program. All variations started from the images taken under the cool white fluorescent. Each image was brightened using a setting of 35, and then color boosted with settings 33 and 66, contrast enhanced with settings -25, -50, +25, +50, or shadow protected using settings of 25 and 50. Altogether 8 variations of each brightened image were produced. Figure 1 shows a brightened image with no other variation and the corresponding brightened image with color boost set to 66 displayed on an LCD monitor and then re-photographed with the camera. The LCD was not specifically calibrated, but is believed to be fairly close to the sRGB standard. The pictures of the monitor were taken in a fairly dark room illuminated by early morning cloudy sky.

Using an image annotation program, rectangular image areas were selected from the fleshy part of each food and paper sample, as well as the lower left, lower right, and upper left ColorChecker patches. The positions of the remaining ColorChecker patches were inferred. Linearized sRGB values from each of the rectangle areas were collected and the median R, median G and median B values were taken to represent the color of the sample. This was done to reduce noise, and to remove outliers created by the specular reflection. The median linearized sRGB values were converted to CIE XYZ via the standard 3 × 3 matrix.

The brightness of samples of the same food may vary between images and also within an image due to varying distance from the light source, changing angle of incidence, and to some degree, due to variations between the samples. In order to focus on the distribution of chromaticities of the samples independent of their brightness, we normalized each food sample, paper sample and Macbeth ColorChecker patch to a Y value computed as the average Y under the cool white fluorescent of the samples of the same type. The normalized XYZ values were then converted to CIELAB space. The white patch of the ColorChecker was used as the reference $X_nY_nZ_n$ white. Note that the L^*, a^*, and b^* values depend only on the ratios X/X_n, Y/Y_n, and Z/Z_n. Here, X, Y, Z are the values of the measured rectangular area and X_n, Y_n, and Z_n are the values of the white of the color checker. Hence, converting the colors to

CIELAB space effectively color corrects all images via a von-Kries-type (i.e., diagonal matrix) transformation in the CIE XYZ space.

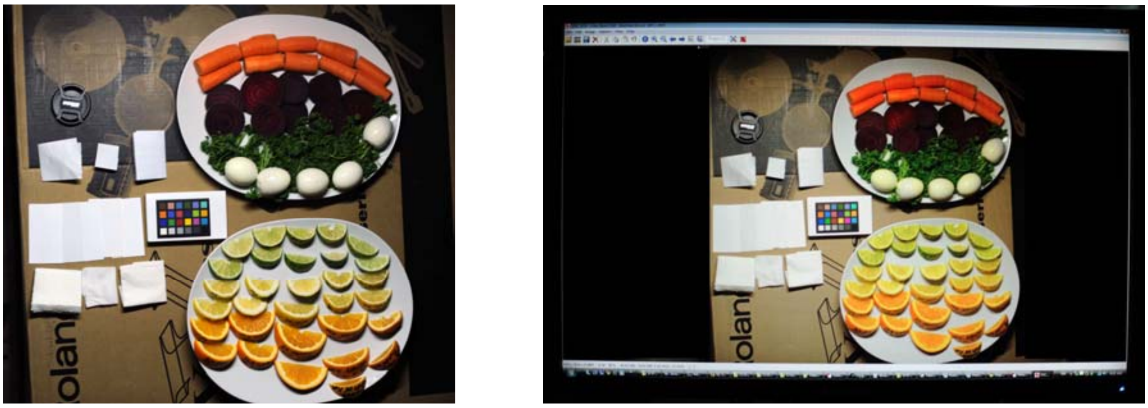

Figure 1. Left: TIFF image of food and paper samples showing the layout. Right: photo of the LCD displaying the image from the left after color boost has been applied. It is easy to see that the fruits on right appear too intense and more saturated, while the eggs are a bit green. The colors differ despite both images being white balanced so R=G=B for the white patch.

3. RESULTS AND CONCLUSIONS

Figure 2 shows the distribution of a^* and b^* values (normalized Y, hence L* too) of the different fruits in a single image. The a^*b^* values of each type are fairly well clustered, comparable to the clustering of the white papers. Hence, it would appear that they could be useful for color calibration.

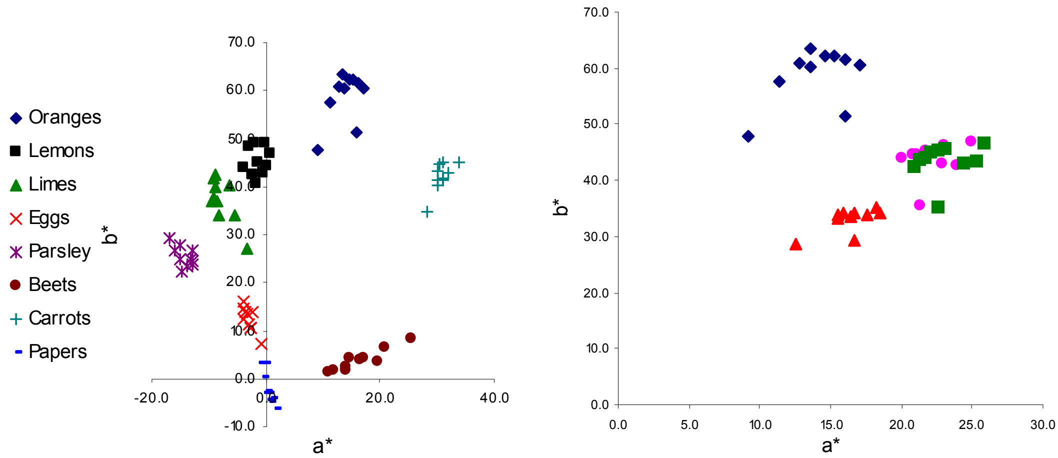

Figure 2. Left: plot of a^*b^* chromaticities of food and paper samples from a single image illuminated by cool white fluorescent. Right: plot of a^*b^* chromaticities of the oranges from four images of the same scene under four different illuminants. Each symbol type represents multiple samplings within a single image.

The next issue is whether white balancing (Lee 2005, Finlayson et al. 2005) affects the fruit colors and the ColorChecker colors comparably. Since white balancing makes whites white in the image, one might assume that all the other colors would follow and be correct as well; however, this is not necessarily the case. The von Kries scaling is far from perfect, and in addition many of the image-enhancement operations found in programs like Adobe Photoshop that are often used to make an image look more appealing often change the chromaticity of non-white colors. For example, and operation that increases the vividness of an image may well be changing the saturation of the colors without having any effect on white. In order for the fruits to be useful as a color chart, it is important that their colors migrate in the same way as the ColorChecker's colors do. That they do is illustrated in Figure 3 where on the left is shown that the colors move together very closely under illuminant change, and on the right that the colors also move together under image enhancement, although less linearly.

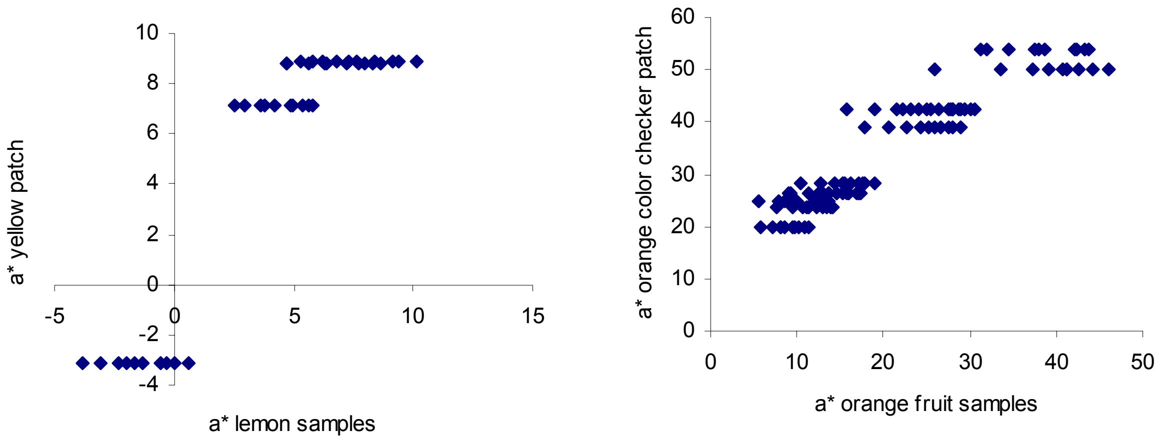

Figure 3. Demonstration of the correlation between the fruit colors and the ColorChecker colors across both illuminant change (left) and image enhancement operations (right). Left: plot of lemon sample a^* values vs. ColorChecker yellow patch a^* values under four different illuminants after white balancing (left). Right: plot of a^* values of the orange fruit samples versus the orange ColorChecker patch a^* values (after white balancing) for the eight image enhancements, the images of the LCD, and the original image taken under cool white light.

The results shown in Figures 2 and 3 demonstrate that it is possible to use a fruit-based color chart to determine when image colors are incorrect, as in the example of Figure 1 (right).

ACKNOWLEDGMENTS

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Using image partition and process synchronization technologies to shine food via web-based color gamut mapping in cross media

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ABSTRACT

This paper proposes a web-based color management system (CMS) to speed up the color rendition of foods in complex images in different imaging devices. Algorithms of color-gamut and tone mappings among imaging media are the focus of the proposed research. The Java Web Start technology was also utilized here and provided a GUI (graphical user interface) service for image cropping, partition and re-combination in parallel and synchronization process. It provided a tool of concurrent color communication for food clients and users, to interact with the web-based food information system. As result, the collection of dataset on color-appearance of food in complex color images could built up. The web-based CMS, developed based on the proposed algorithms and the multi-thread technology, could satisfactorily provide a practical simulation tool for the real world applications on food related industry.

1. INTRODUCTION

Colors of foods give the first intuition whether it is worth to buy or try. Foods, with appropriate hue, lightness and chroma, would look sensationally attractive in the virtual store or E-table restaurant (Inamo Restaurant 2010). A food menu in the virtual store can be produced using either display or printing device. Foods will be easily sold to consumers via virtual stores, if their color appearances produced are really similar to those in the real world. Therefore, it is needed to have a trustable reference of database on color appearance of real foods. It would make the electronic commerce on food more realistic.

The color appearance of foods in the real world can be very diverse. Additionally, reflection prints, projected images, and self-luminous displays all have different ranges of tones that they can be reproduced. Moreover, various technologies are used in each of these classes of imaging media. For example, reflection prints can be made by one of silver-halide photography, ink-jet, electro photography, lithography, and gravure printing; and the quality of the paper or other substrate used can have a large effect on the attainable gamut. Projected images can use film, liquid-crystal, and digital-mirror-device, projectors. Self-luminous images can be derived from cathode-ray tubes, liquid-crystal displays, plasma displays, and light-emitting diodes (Morovic 2008). Therefore, color-gamut or tone mapping across imaging media is an important issue recently (Lee et al. 2001, Lo et al. 2003, 2004, Peng et al. 2007).

In the application of CMS, processes of device characterization, gamut mapping, and color appearance modeling are required to transform colors across various imaging media. Each algorithm, based on pixel-by-pixel processing, performs color transformation and consumes huge computation power. Therefore, this paper proposes a flying-up approach to render colors of food in complex images in different imaging devices, via a web-based CMS. Foods, displayed in different imaging media, can look shining and delicious without suffering computational overhead.

2. APPROACH DESCRIPTION

The color gamut mapping was the focus of this research in the color transformation across imaging media. However, this paper proposed not only algorithms of color transformation but also information technologies of Java web start. Installation of web-based programs in clients could decrease loading of server and network. Further, the proposed approach partitions images and apply multithreads processing to speed up color transformation. Still, foods look shining and fresh without losing their rendition quality on color appearance, especially after color-gamut mapping across imaging media.

To carry out this web-based CMS, the following informations beborehand are required:

- Characterization profile of each image device considered
- Scene-referred images which contain foods of interest for analyzing

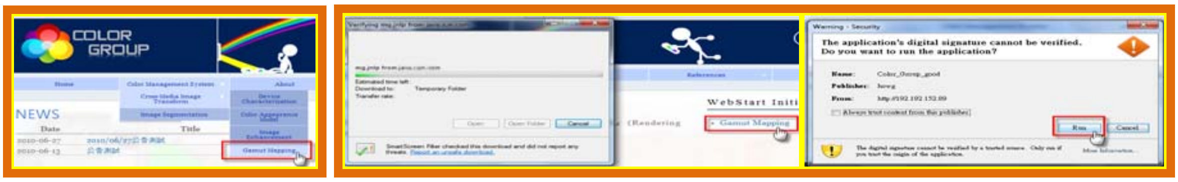
The proposed CMS implemented modules as follows:

- Characterization of imaging devices in question
- Across imaging media color gamut mapping (CGM)
- Fast Fourier transformation (FFT) for retriving hue of images
- Web site to provide installation of Java web start program
- Graphic user interface (GUI) for users to adjust the color appearance of images
- Database management system on characterization of I/O devices and realistic food images

3. IMPLEMENTATION

Color-gamut mapping (CGM) in this study applied multiple focal points and incorporated with both of an S-type of tone function and an Unsharp Mask filter (Lo et al. 2003; Peng et al. 2007). It was modularized into two processes, including mappings of original medium to reproduction medium (medium-to-medium mapping, MMM) and original image to reproduction medium (image-to-medium mapping, IMM). The MMM needed only to be carried out once in the beginning. The generated corresponding information was, then, saved into a database and could be reused without performing mapping again. The IMM was carried out in the distributed users or clients' end of computer system after Web Start service had been activated. With image segmentation and re-combination approach, each mapping module performed by a multithreaded programming to achieve parallel and synchronization processing.

A Java Web Start (JWS) technology utilized, as shown in Figure 1, provided easy installations of the proposed systems. A JWS service would be started when an image was imported into the system. First the RGB (red, green, blue) information of image would be retrieved. Then, corresponding color-appearance data, including J, C, H, M, Q, and S, were calculated via the forward process of CIECAM02 color appearance models (Fairchild et al. 2002). Further adjustment of details in images could be performed by food users or clients, via an image sharpening algorithm, combined with CGM derived in parallel processing. The image sharpening algorithm used a fast Fourier transformation via highpass or lowpass filtering (USM) (Lo et al. 2010). Finally the reverse transform of CIECAM02 model was applied to obtain RGB for the corresponding destination imaging device of interest. Figure 2 presents the action module of the proposed CGM.



(a) Choose program module *(b) Web download* *(c) Installation*

Figure 1. An example of Java web start installation – Color Gamut Mapping (CGM).

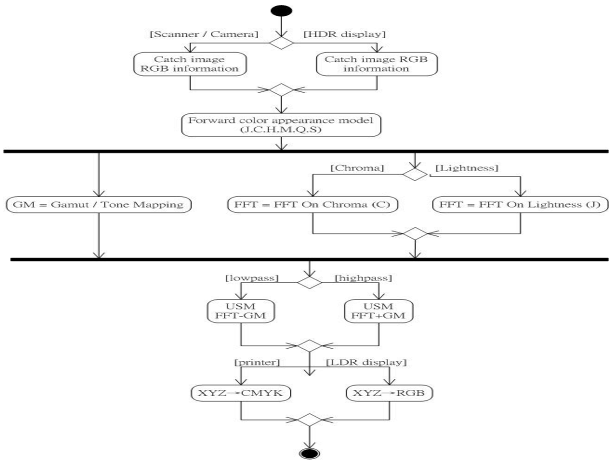


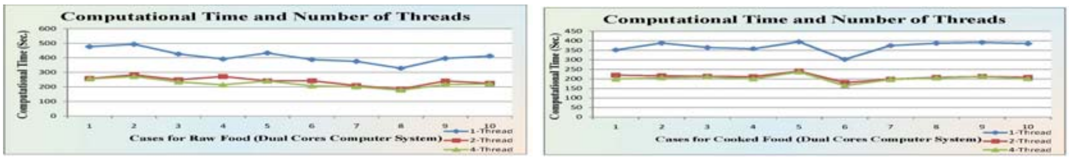
Figure 2. Working flow of color management system – proposed CGM across imaging media.

In this web-based GUI service, a reference target was configured using an X-Rite ColorChecker Passport alongside with 3 ramps of red, green, and blue. The reference target was used as a visual aid to help with color correction/adjustment and dataset collection of various food color-appearances. The ramps of RGB in visual reference target had perceptually pure appearance of red, green, and blue respectively, when seen on AdobeRGB type of display devices (set to white point of D_{65}). The database system, therefore, was the major platform for information exchange during the mapping and processing procedures.

4. SIMULATION AND DISCUSSION

Performance of the proposed approach derived was evaluated using food-rendition indexes, in terms of both the computational time of mapping and the rendition quality of food considered in complex images among different devices. Testing cases of different kinds of food are analyzed and compared between modules with and without the parallel processing of mapping. All of these simulations are done by a notebook – Sony Vaio Z VGN-Z46TD/B with Intel Core 2 Duo P9700 / 2.8GHz and 6GB DDR3 / 1066MHz.

To prove the performance of the proposed approach, 10 cases for raw and cooked food were simulated, respectively. Figure 3 presents the computational time by using different number of threads for raw and cooked food. It is obvious that the CGM with parallel processing had great benefit on the computational time. The speed of processing was nearly twice fast when the number of threads was double in the dual-core computer system. Since the simulated computer system was dual-core only, 2-thread had almost half computational time of 1-thread, but 4-thread only saved a little bit computational time than 2-thread. In other words, if there are enough cores in the computer system, the more partitioned images there are, the more computational time could be saved. The relation of computational time and threads are linearly decreasing if the number of cores is greater than or equal to the number of threads been used.



(a) Raw food *(b) Cooked food*

Figure 3. Relation for computational time and number of threads

Figure 4 shows the reproduced results of FFT plus CGM for maintaining the color appearance across imaging media. The renditions of food images, produced using this web-based CMS system derived in this study, still keep sensationally pleasing color-appearance and important texture details.

(a) Exp.1: Adobe RGB *(b) Exp.1: s-RGB* *(c) Exp.2: Adobe RGB* *(d) Exp.2: s-RGB*

Figure 4. Two examples for FFT plus CGM across imaging media

5. CONCLUSION

The web-based color management system plugged with GUI service, which utilizes the Web Start technology and combines with multithreaded programming, had proved its applicability of shining food when they were surfed on the web. The proposed approach not only provided an platform for color gamut mapping across imaging media, but also a referenced database for color appearance of physical food. The simulationr results showed that the propsoed system was effecient and practicable for real world applications.

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Matrix influence on color perception: A study of cornflake processing stages

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ABSTRACT

The aim of this study was to analyze color perception in relation to physical changes occurring during laminated corn products processing. Cornflakes production stages from raw grits involve grits cooking, lamination and toasting. Color was measured at the different stages by a calibrated computer vision system and Maillard reaction markers (surface fluorescence, carboxymethyl-lysine (CML), furfurals and browning index) were also measured. During cooking opacity decreased and the samples became dark (L* and b* values decreased and a* values increased). After lamination, opacity further decreased, and the samples appeared lighter, while the pigment concentration did not change. Toasting generated bubbles in the matrix and L* apparently increased due to the increase in opacity, although brown pigment concentration increased. Pigment concentration did not correlate with surface color due to the destruction or generation of interfaces.

1. INTRODUCTION

The appearance of a food is one of the most important factors defining consumer acceptance. The result of complex interactions of incident light with the food matrix affect transparency, translucency, gloss, lightness (Caivano 1991), and chromatic perceptions (Briones et al. 2006). The refractive index difference among the different phases of a non-homogeneous food causes light dispersion and therefore appearance changes (Saarela et al. 2008). During cornflakes production several steps change both the color and physical structure of the matrix. After milling of corn kernels, grits are obtained that are then steam cooked in the presence of water and sugar, salt or malt extract. Cooked grits are laminated by compression to obtain flakes. The final toasting step is carried out under hot air current. During these steps physical transformations at microstuctural and macroscopic levels occur. At the same time brown polymers are generated by caramelization and Maillard reactions. The objective of the present work was to study the effect of physical and microstructural changes on the color perception at different process stages of laminated corn products.

2. MATERIALS AND METHODS

2.1 Samples

Samples at four industrial process stages (raw grits (G); cooked grits (CG); laminated grits (LG) and corn flakes (CF)) were provided by a local breakfast cereal manufacturer.

2.2 Color measurement

Chromatic properties and luminosity of samples were determined by a computer vision system (CVS) composed by a digital camera (Power Shot A70, Canon, USA) operated trough software. The samples were displayed in a standardized cabinet illuminated evenly using a D65 standard light source. The angle between the camera lens axis and the lighting source axis was 45º. CIELAB color coordinates were calculated from the images using Adobe Photo Shop software (Yam and Papadakis 2004). Samples opacity was calculated as the ratio of L* values over black (L^*_b) and white (L^*_w) backgrounds. The sample color without background effect was analyzed in a 2 cm thick layer of sample, at which it behaves as opaque. Hue angle (h'_{ab}) was calculated according to CIEDE2000 formula (Gaurav et al. 2005). CVS was calibrated using a spectrocolorimeter Minolta CM-508d, D65 light source and 2º angle observer, by measuring fifty dull color cards with both methods.

2.3 Microstructure and Maillard reaction markers

Sample microstructure was observed through a Philips XL 30 electron microscope by environmental mode (ESEM) without previous treatment. Surface fluorescence spectrum was measured by using an Ocean Optics spectrofluorimeter (Ocean Optics, Dunedin, USA) with an excitation wavelength of 340 nm and 45º geometry on samples compressed into tablets. To avoid fluorescence quenching effect, the intensity ratio of the main fluorescence peaks, detected at 448 nm and 520 nm, was calculated (520/448). Color of protease hydrolyzed extracts was calculated from transmittance spectrum in a Shimatzu 1620 UV-VIS spectrophotometer by calculating the CIE tristimulus values X, Y and Z (D65 light source and 2º observer angle) and a browning index (BrI) was calculated as previously described (Buera and Resnik 1990). Reaction markers 5-hidroxymethylfurfural (HMF) and carboxymethyl-lysine (CML) were quantified by RP-HPLC (Ameur et al. 2006) and by competitive enzyme-linked immunosorbent assay (MicroCoat Biotechnologie, Germany), respectively.

3. RESULTS AND DISCUSSION

3.1 Maillard reaction chemical markers and surface fluorescence

Maillard reaction indicators HMF and CLM correlated between them and with the browning index of the aqueous extracted samples, while fluorescence profiles changed in the cooking step and then remained constant (Table 1).

Table 1. CML, HMF content, browning index and surface fluorescence ratio for cornflakes production stages samples, raw grits (G); cooked grits (CG); laminated grits (LG) and corn flakes (CF) (standard deviation).

Sample	CML (μg kg^{-1})	HMF (mg kg^{-1})	BrI	520/448
G	1275 (490)	0.6 (0.6)	4.6 (0.6)	0.93 (0.1)
CG	3627 (363)	20.3 (1.5)	9.2 (1.8)	1.1 (0.05)
LG	6187 (1021)	17.3 (1.9)	9.2 (1.1)	1.1 (0.04)
CF	6120 (530)	48.5 (8.8)	12.7 (2.5)	1.1 (0.03)

3.2 Appearance and microstructure

As shown in Figure 1a raw grits behave as opaque materials, with opacity values close to 1. Opacity decreased after cooking since water uptake followed by starch gelatinization and lost of starch granule structure led to a more homogeneous matrix.

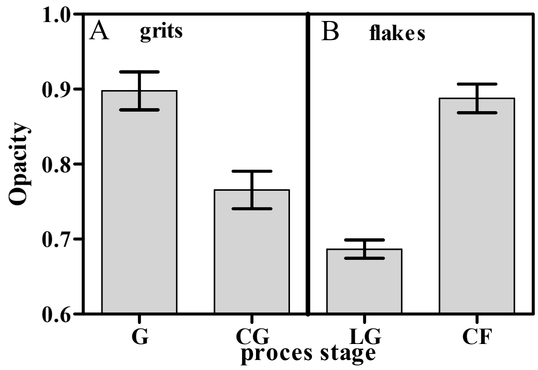

Figure 1. Compared opacity values of a): raw (G) and cooked grit (CG), and b) laminated grit (LG) and cornflake (CF). Error bars represent standard deviation.

Due to the change in sample geometry promoted by the lamination process, opacity values of LG decreased further. Toasting process produced sudden water evaporation and created a porous structure as shown in Figure 2. The pores are filled with air, and the refractive index mismatch between the air and the matrix is significant. Thus, many scattering events happened within the corn flake, the paths of separate photons rapidly became chaotic and the opacity of the final material (cornflakes) increased as compared to the laminated samples (Figure 1b).

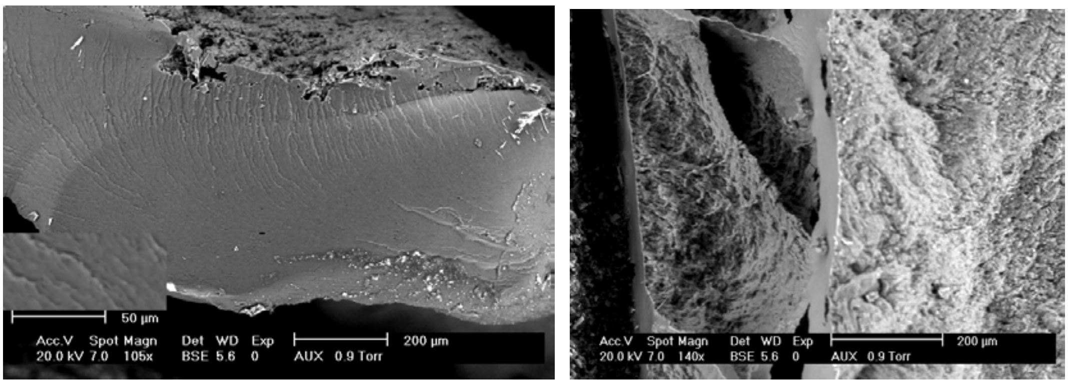

Figure 2. ESEM images of a transversal cut of laminated grit (left) and cornflake (right). Magnification is indicated in the bottom of the images.

3.3 Surface color

Figure 3 shows the changes of L*, a*, b* and h'_{ab} during the different stages. The decrease of L* and b* and the increase of a* during the cooking process can be attributed to the brown pigments formation. However, the increase of L*, b* and h'_{ab} after lamination and toasting is due to the microstructural changes affecting appearance, since the concentration of brown pigments increased, rather than decrease during these steps.

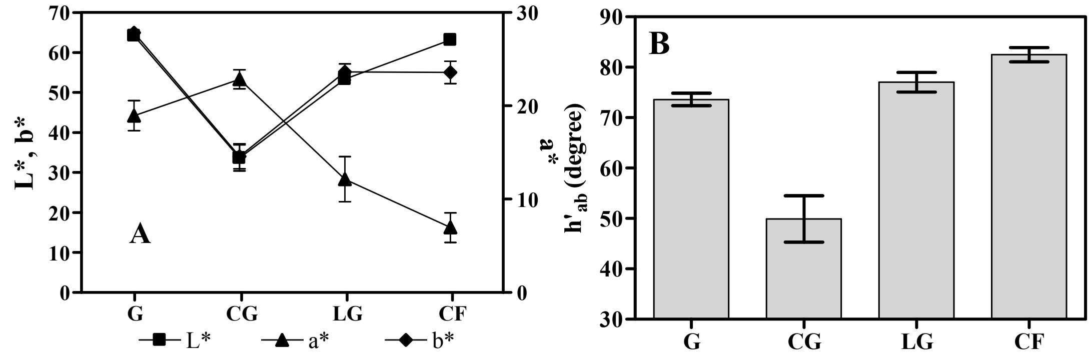

Figure 3. a) Chromatic coordinates in the CIELAB color system, and b) hue angle for the different process stages, raw (G) and cooked grit (CG), laminated grit (LG) and cornflake (CF). Error bars represent standard deviation.

4. CONCLUSIONS

Major pigment increase due to Maillard reaction was observed after cooking and toasting stages. Fluorescence changes occurred mainly during cooking. Surface color and brown pigment development were not correlated in the different stages of the industrial process of corn flakes. Surface color is affected not only by pigment development but also by microstructural changes. These changes involve the destruction or generation of interfaces and affect the way in which light interact with the sample matrix. In this way, an integral approach that takes into account color, pigment concentration as well as microstructural and physical changes is important in order to understand visual color perception of foods.

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Colour and visual appearance in foods

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ABSTRACT

Since almost a decade I have involved myself in the study and understanding of the visual phenomena called *visual appearance*, which was added to the experience of almost 40 years in subjects related to colour, and, among other subjects, colour of foods: salted anchovy, beans, corned-beef, noodles, apple juice, orange juice, milk sweet (dulce de leche), corn, apples, margarine, honey, fish, sausages, tomatoes, wheat, wine, "yerba mate", etc., has been some of the subjects which were studied while I worked at INTI. The present work deals with the intention to describe something more than colour. In fact, intents to establish a reasonable ground to understand a very complex phenomena, such as the whole visual appearance phenomena, which includes colour, but does not restrict to it. It is well known that only three primaries are necessary to see colour. We shall forget in this abstract to define which primaries are we dealing with. Presently we shall accept that they are three: one red, one green and one blue. Too, we shall not specify which were these colours. Now, when we see a texture, such as the skin of an orange or a lemon, the shell of a walnut, a peach or a strawberry, not only colour identifies the product, but the morphological characteristics of its surface and its *visual appearance.* Simply to imagine problem complexity it is sufficient to tell that up to six different orientation angles can be set up relative to the horizontal defined as 0º (90º, 60º, 30º, 0º, -30º and -60º). To this one must add what it is called *spatial frequencies*, which are the lines of different width which we recognize as "bar code" used to identify commercial products un the supermarkets paying boxes. It is supposed that only eight of these spatial frequencies are needed to identify its appearance effect. Three colours, six orientation angles and eight spatial frequencies make 144 variables, 144 possibilities. Then, the question irises the skin. If we have three different detectors in the human retina, one for each of the three colours we see... Do we have 144 different detectors systems in the retina to see form, colour and texture? Which are they? How they work?

INTRODUCTION

The problem to evaluate colour in foods is present since the human been appeared on the surface of earth, thousands of years back in history. Based on visual experience primates choose the food to eat. Colour and visual appearance in combination with other senses, help to fed themselves. Since then, the political and economical changes in the society introduced the mass production of foods. Even nowadays, people choose the products in the food shops guided by their experience. Their *total appearance* as described by Hutchings (1999) which joined all the senses in a whole perception mode including different aspects of the social life.

He describes the total appearance as formed by three parts: *receptor mechanisms*, *inherited and learned responds to specific events* and *immediate environment*. The *receptor mechanisms* are the inherited and acquired sensory characteristics such as *colour vision* (including adaptation, after-images, constancy, discrimination and metamerism), *aging effects* (cataract, glare, light intensity need and yellowing) and other senses (hearing, smell, taste and touch). The *inherited and learned responses* are: *culture, memory, preference, fashion*, and *physiological* and *psychological effects.* The *immediate environment* elements are:

geographical factors (climate, landscape and seasonal changes), *social factors* (crowding, personal space and degree of awareness), and *medical factors* (survival and need, state of well-being and protection).

The present work limits its scope to the proposal of a new mode of classification of visual appearance limited only to what the people sees, without any other consideration respect to environmental, cultural or historical background or surrounding.

A NEW CLASSIFICATION OF VISUAL APPEARANCE

As the reader can see, this approach is much more than the "simple" perception of visual appearance (including colour). For the "total" appearance" history and environment of the person who observe and evaluate the scene are pertinent. The present work will only try to describe new information about a much more restricted view. How people can see, recognize and describe colours, forms and objects, including surface termination and texture without any relation with other external factors like in the case of the total appearance.

In 1978 was published my book on colour measurement (Lozano 1978). After 30 years I tried to rewrite it, but when I got into the appearance measurements, such as gloss, I found much more information about different aspects of visual appearance never mentioned before. Particularly those related to the finishing of automotive paints. Simultaneously, the development of new characteristics of computers (such as memory and velocity) and the approach of new programming techniques such as the "graphic software", the "inverse graphic rendering", the employ of fractals and wavelets and the techniques used to create and describe movie pictures, particularly those animated films created for children by the firms Dreamworks and Pixar, and the extent use of Fourier maths, together with the advance and research on contrast sensitivity in human vision, have change completely the approach to visual appearance.

In a meeting of the CIE TC 1-65 Visual Appearance held in Paris, France (see CIE 2006), I presented a work with the modified proposition of a previous paper (Lozano 2006a,b) The original proposition was modified and presented is the described in Figure 1.

It is important to mark that the circle is divided in three parts as is the whole visual appearance phenomena. They are: *colour, cesia* and *spatiality*. Colour is the most known and is composed by *luminosity* and *chromaticity*, this later is also divided in two known components: *hue* and *saturation* or *chroma*.

Luminosity or clarity allows going further to luminous reflectance and transmittance and, from there, to whiteness. This is a part of the circle shared with cesia, which is described as visual appearance without colour (Caivano 1991, 1993, 1994, 1996, 1997, 1999, 2001, Caivano and Doria 1997). A new component is introduced and is named *spatiality*, which is determined by the space appreciation or evaluation through the visual system.

There are visual appearance phenomena which joints the spatiality with colour, such as *metallic*, *pearlescent* or *iridescent* appearances in which as the angle of illumination or observation changes, colour also does. Therefore are dependent on the spatial distribution of the incident and observed light. We call this group *spatial colour*. Cesia has also three components. One is shared with colour: luminosity, *luminous reflectance* and *transmittance*, *clarity* and *whiteness*. The connection of whiteness with colour is the effect called *yellowness*, when whiteness is modified adding a colour contamination, such as yellow, product, in most cases, of aging or deterioration.

The other two components of cesia are *permeability* and *diffusivity*. The first is related to the capacity of the material or object to absorb light. Normally, the result of permeability is *opacity*. The second classification is related to diffusion of light by means of scattering. *Gloss* (or the contrary, *mat* or *dullness*), *translucency* and *transparency* are visual appearances related to this property.

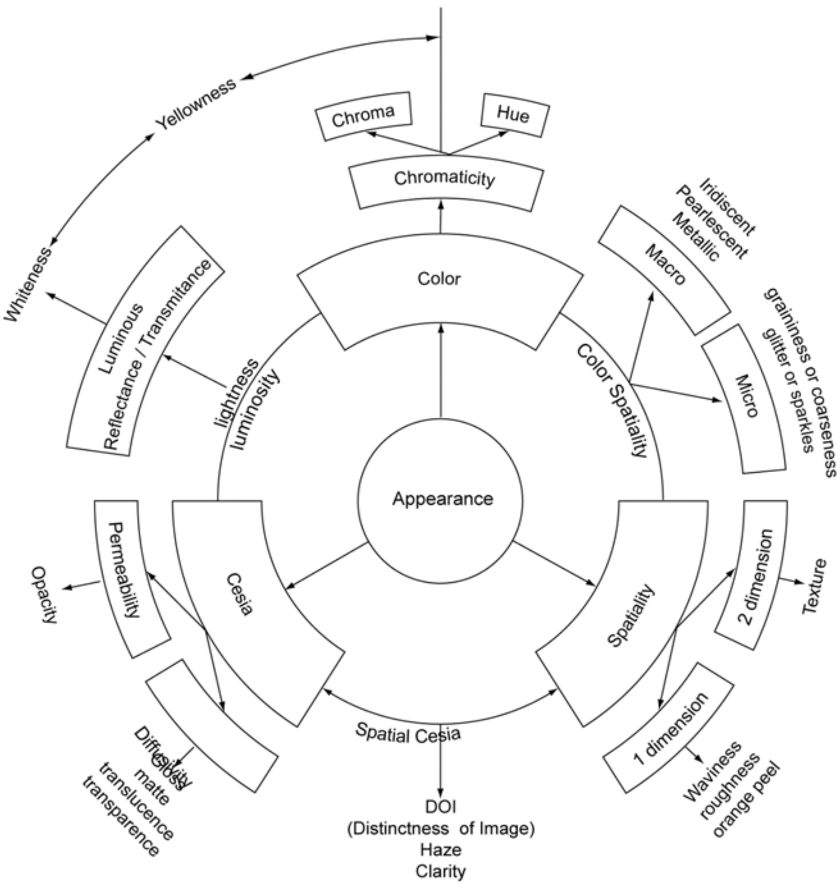

Figure 1. Circular scheme of visual appearance divided in three components: colour, cesia and spatiality. The intermediate are spatial colour, spatial cesia and lightness or clarity in between colour and cesia.

Following down the circle it is found what is qualified as *spatial cesia* which are properties of cesia dependent of the spatial perception of the appearance without colour evaluation, such as *definition of image (DOI)*, *haze* and *clarity* (this is related to the perception of light diffusion in a transparent liquid). These appearances are related to cesia because are independent of colour perception and need a spatial evaluation of the visual effect. In the case of DOI needs to observe definition of images reflected in the surface, haze is perceived in the space around the light source reflection and clarity is observed in the whole image of the liquid in the glass or bottle.

Then we found the new proposal as *spatiality* of *one* and *two dimensions*. Why one and two dimensions? Is there no three dimensions? Well, at first sight, it is difficult to explain it. The human been when tries to catch an object with his hands, uses his two eyes to evaluate the distance, but, when is seeing an scene, he is not any longer able to calculate distances directly. He depends on the elements which composed the scene and evaluate the sizes of the objects present in it, comparing with his previous experience. He sees the scene, as in a picture or a photograph, in two dimensions and guess distances and size of these objects with respect to the surrounding ones. He is able then to evaluate the visual appearance in two dimensions.

When an observer looks in a linear mode such as a footpath covered with paving tiles which has transversal lines respect his march, the lines are discriminated if they are near, but with distance the transversal lines disappear becoming a uniform view of the surface. Instead, if the lines are in the same direction of walking, then, the lines converges in the horizon, normally, to a point away from him. In this case, the sight is evaluated in only one dimension. The same occurs when people judge the effect called orange peel.

The typical spatiality of two dimensions is *texture*. To evaluate texture we need two visual dimensions to classify or discriminate it. Within the classification of spatiality of one dimension are *ondularity, rugosity* and *orange peel*.

The last item is what McCamy (1996, 1998) defined as *micro* appearance. He also proposed to call *macro* appearance what we defined as colour spatiality, composed by metallicness, pearlescence and iridescence, already mentioned.

Micro appearance is something rather new. It appeared in the last years as a new form of finishing in automotive paints, with nothing similar in nature or in previous human manufacturing. The visual effects are *glitter* (or *sparkling*), and *coarseness* which are produced by particles immersed in the paint and seen under specific modes of illumination. The first are seen under directed light sources reflected by the paint. The second needs an almost completely uniform diffuse illumination to evaluate its characteristics.

FOOD AND ITS GLOSSY APPEARANCE

Normally, foods do not shows too much gloss in its appearance, except some fruits which can be manually polished, as apples. But what is gloss? Are there several classes of gloss? Hunter and Harold (1987) have classified five types of gloss but really actually only three are accepted as different kinds of gloss as one can see in Figure 2.

Normally evaluated gloss is measured as specular reflectance, varying the incident angle and depending on the type of materials (usually 20º, 30º, 45º, 60º, 75º and/or 85º) but as you will see later the angularity does no take into consideration how the incident flux is spatially reflected, but only how much is reflected referred to an accepted standard. Sheen is classified gloss when materials are observed at grazing angles, such as is done with matt papers. Surprisingly, the standard for measuring papers use 75º instead of 85º.

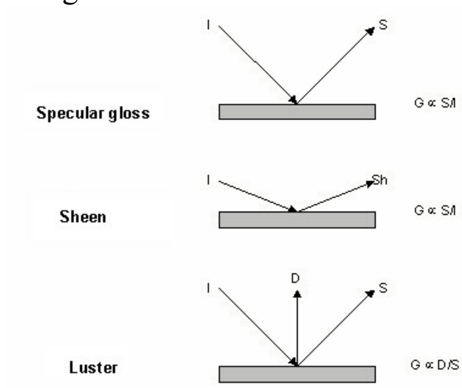

Figure 2. Three different types of gloss as classified by Hunter

In the measurement of luster, the specular reflected flux measurement is compared with the diffused reflected one. It is a way to evaluate this property, but,… On what grounds? There is little evidence of psychological evaluations of this type.

If one revises different standards to evaluate other aspects of appearances referred to gloss and distribution of the light reflected near the specular angle one can see Figure 3.

The right scheme of Figure 3 shows different angles near the specular to measure different type of appearance, at 18 minutes from the specular reflection angle is measured DOI. With respect to this definition, one must question the size of instrumental apertures.

The appearance called bloom is measured 2º apart from the specular direction. Finally at 5º apart is measured haze. But… Why these differences? Which psychological studies support these definitions? Figure 4 shows the shape of the specular reflectance curve for different glossy materials.

It is possible to see that curves of specular reflection can change the shape of the reflection peak. This represents surfaces more or less polished and how the reflected light is spatially distributed. It is possible a better understanding looking the differences of goniophotometric reflectance curves shown in Figure 5.

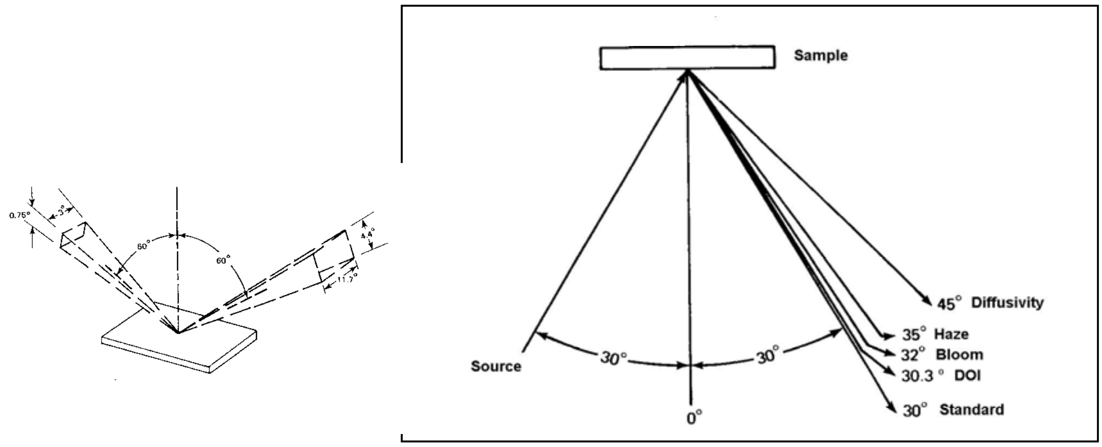

Figure 3. Left: Different illumination and measuring apertures. Right: With an incident angle of 30º, at 0º standard gloss is measured, at 30.3º, definition of image (DOI), at 32º, bloom and at 35ª, haze.

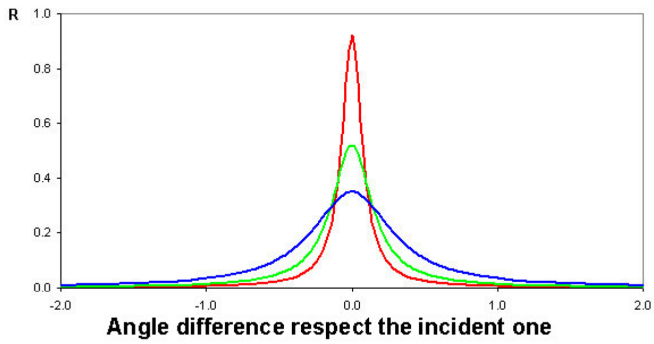

Figure 4.

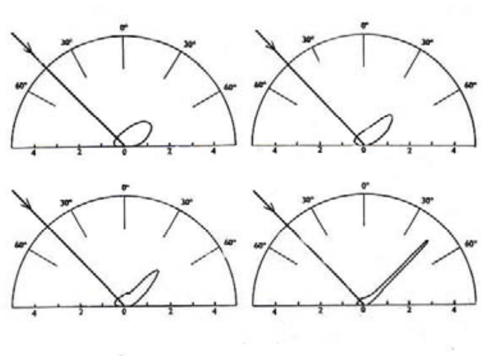

Figure 5. Goniophotometric curves of reflectance for different papers.

One can see that shape corresponding to a normal writing paper (up, left) and to the most brilliant glossy coated paper (down, right). The shown shapes change a lot. From an egg shape to a spine one, oriented to the specular reflectance direction. As conclusion, we can say that the spatial distribution of the reflected light is needed to be known to really understand what is the human eye seen and judge.

TEXTURE, SPATIAL FREQUENCIES, FRACTALS, WAVELETS, FOURIER ANALYSIS AND OTHER RELATED MATTERS

Foods have texture. It is easy to define difference between an orange, an apple, a plumb or a peach, because its texture is quite different, but… What about oranges, mandarins and lemons? Their textures are similar, colours and shapes can help to difference them. What is really annoying is to give an answer when somebody ask us to describe a texture. To describe textures differences. To try to understand the problem we face y will introduce a new concept: the *spatial frequencies.*

As one can see on the left drawing, what is defined as *spatial frequencies* are stripes black and white of same width, and the number of lines in a unit of length is called spatial frequency. In the right appears the drawing of an alphabet in where a letter is displaced one place, giving place to formed order as one see the figure distanced from the observer.

Figure 6. Left different spatial frequencies. Right: the effect of distance of a geometric configuration.

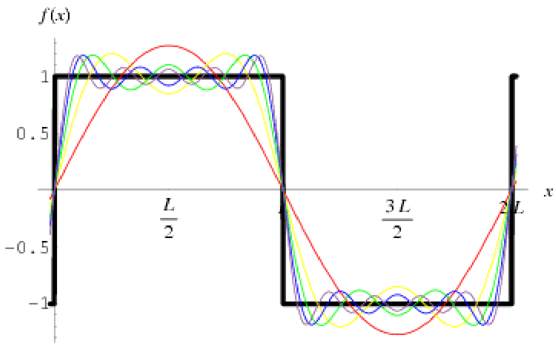

Figure 7. A square wave with 5 elements of the Fourier series approximating the square function.

How we deal with spatial frequencies: With Fourier analysis, which are simple series which adds sinus or cosines to match periodical functions as one can see in Figure 7 with the square function.

This effect is present in the observation of all textures, and is evaluated trough the spatial frequency analysis. But this is not the whole affair related to texture perception of the human been. Some other mathematical elements were introduced recently. One of them are the *fractals*, created by Mandelbrot (1967) created to explain why the scientists cannot measure real images. Taking as an example the one he gave. How to measure the length of Great Britain coast? Where do we stop? In the green part? In the limit of the sand? On the size of a grain of sand? Where?

Mathematical fractals cannot measure real images and surfaces, it existence must be defined in all scales. On the contrary, physical surfaces have a superior limit where the scale is applied. The inferior limit is defined by the size of the constituent particles. In his work on this subject Pentland (1984) states that the surface is fractal if the fractal dimension is stable and can be approximated in *just one scale* of a wide range of them. Pentland suggested that fractals can be used as model to describe textures. In 1975, Julesz (1962, 1975, 1981a,b) presented the theory of *textons* as the basic mathematical compound of texture, element which allows to classify mathematically texture structures. Hundred years back (Haar 1910) created the *wavelets*, which were rediscovered by Gabor (1946), but really reused by Daubechies (1988), a little bit more that 20 years ago, which initiated the use of wavelet to compress information related to images which are needed to transmit.

To transmit images was, and is now, the problem. Twenty years ago we had computers know as the XT, succeeded by the AT, with and operating memory of 640 Kb. A diskette could have a memory from 720 Kb to 1.2 Mb. Today we talk about hundreds of gigabites. With the computers speed we have a similar picture. Therefore we have now enormous possibilities to be able to process images which was impossible then. Consequence of this is the advance of the techniques to develop what is called *graphic software* and *inverse graphic rendering*. Both techniques dedicated to be able to show objects or drawings (such as comics or animated films) under different type of illumination while the animated personage of the film moves into the scene. This can be seen in *Toy story* or *Monsters Inc.* which provide an incredible touch of reality to the scene.

The software programmers tried hard and achieved a great work, but… Let me now try to understand what happened. The have used the new capacities of the computers available today and processed the images and reproduced them in a reasonable way which enjoy people delighted with these films, but… Does explain how the human mind process that information? How does the human been to process such complicated and enormous quantity of data? Which normally is also processed by people who could have no education? Even primitive earth inhabitants?

SOME NUMBERS TO END

To measure the reflectance of a sample in all directions in the semi-sphere surrounding it, as one can see in Figure 8, it is need time and patience.

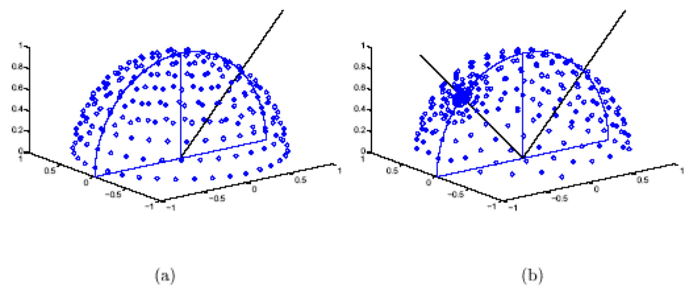

Figure 8. Measurement points with the requirements of the new techniques related to graphic software.

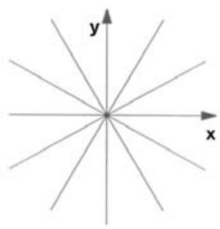

Figure 9. detection angles for spatial frequencies in human vision.

To measure such quantity of data Takagi et al. (2005) needed 16 days to measure 48139 points, which could be reduced to 1485 which can be measured in near 4 hours if a great simplification is made. Nevertheless each sample needs 4 hours to characterize its spatial reflectance. This data usually is employed to evaluate automotive paint appearance. Once again, which is the correlation with the psychophysical evaluation? No answer.

To finalize I wish to mention that the study of textures allowed to think that the human vision is capable to determine 8 different spatial frequencies, and 6 different angular positions respect to the vertical or horizontal, as seen in Figure 9.

If it is accepted that to see colours the human been has three different cones in his retina, and to detect 8 spatial frequencies and 6 angles of these frequencies with respect to the vertical or the horizontal as shown in the figure above, then to evaluate a texture in colour he needs, at least, 144 simultaneous visual mechanisms to process that information. How is this achieved? As far as I know there is no answer yet.

A final recommendation: many colour and appearance instrument manufacturers claim about the marvellous properties of them. Be cautious, first we need to know how people make the evaluations. An instrument can mean nothing if is not really related to what the people see. If there is no psychological and psychophysical support of the scales used in the instrument, probably its validity is questionable.

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Posters

Food and its packaging. Color, transparency and sense

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ABSTRACT

Visual communication is one of the most powerful means to convey facts and ideas. Perceiving an image involves our participation in an organization process which has a structure, an order and a system of relationships that allows us to build up meanings. Between the outside world and man's experiences stands a network of meanings, a maze of signs, that mediates this relationship. The spectrum of the objective world that surrounds modern men is unlimited. In this sense, designers have found in food an interesting field of action. Even though it has neutral zones, this field has aspects that intersect and sometimes overlap with views of other specific disciplines that focus on the design language of form. Considering that designed shapes carry a meaning, and that the designer defines the formal qualities of the products, we are interested in inquiring about the importance of the visual appearance of packaging, containers or displays of foods, particularly its sensitive manifestations, to suggest meanings and provoke feelings and emotions associated with food. Transparency, translucency and brightness can enrich the visual language, enhancing the expressive possibilities of the products. The use of glass food containers, allows us to imagine transparent bowls that *exist without existing*, without imposing virtually its materiality, using the product as a visual image, to convey emotional advantages and benefits of it. Due to this communication the consumer perceives a superior quality product at the moment of purchase. Its impact on the shelf is well known, the consumer sees the product, its color and imagines the smell and taste, awakening all the senses. The designer uses these tools to differentiate their designs and to emphasize quality, safety, elegance and durability. The message arrives almost instantaneously, therefore, it is clear that the transparent material remains the top choice at the moment of designing food packaging. The designer develops seduction techniques to tempt consumers or customers, highlighting the distinctive features of the packaging such as brightness, quality of the presentation, functionality, and image.

FOOD AND ITS PACKAGING. COLOR, TRANSPARENCY AND SENSE

"Vision shares with speech the distinction of being the most important means by which apprehend reality." (Kepes 1969)

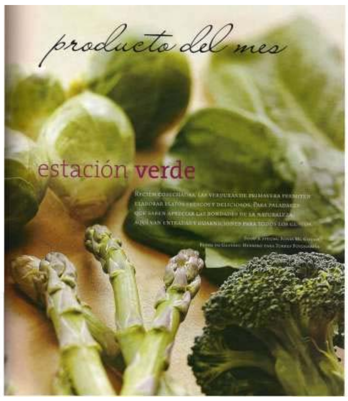
Visual communication is one of the most powerful means to convey facts and ideas. Perceiving an image involves our participation in an organization process which has a structure, an order and a system of relationships that allows us to build up meanings. Between the outside world and man's experiences stands a network of meanings, a maze of signs that mediates this relationship.

The spectrum of the objective world that surrounds modern men is unlimited. In this sense, designers have found in food an interesting field of action. Even though it has neutral zones, this field has aspects that intersect and sometimes overlap with views of other specific disciplines that focus on the design language of form.

Considering that designed shapes carry a meaning, and that the designer defines the formal qualities of the products, we are interested in inquiring about the importance of the visual appearance of packaging, containers or displays of foods, particularly its sensitive manifestations, to suggest meanings and provoke feelings and emotions associated with food. Transparency, translucency and brightness can enrich the visual language, enhancing the expressive possibilities of the products.

The task of designers must be to seduce consumers, and make them choose their products. The design of this particular packaging is a big challenge. Many aspects should be combined to gain customers and capture images, by knowing which the design trends are, decide the material, learn their benefits, and potential technologies. There are many strategies and skills that must be developed to reach the consumer, transmitting the image of the product, and ensure their loyalty. The coordination of all these aspects will generate a product that will be able to compete with a considerable number of others.

The selection of the transparent material allows, due to current technologies, to define the shape, size, colour, texture and various forms of closures. The product will be attractive as its transparency will project an identifiable, recognizable, readable, and reliable image, facilitating the direct perception of the colours of food.



The use of glass food containers, allows us to imagine transparent bowls that *exist without existing*, without imposing virtually its materiality, using the product as a visual image, to convey emotional advantages and benefits of it.

Glass containers have been used for a long time, to contain and preserve food. Today, glass allows us to design lighter, colourful, bright and opaque containers. Technology gives us that possibility through fluxes, stabilizers and other components to combine colours, shapes, textures and decorations.

Using sophisticated techniques, we can obtain even translucent surfaces containers, which also provide protection from ultraviolet rays to preserve food. Also, by using sunscreen, the most common colours (amber and green) can be produced, but by using a more sophisticated process red, gray and blue can also be obtained. The wine industry is one of its biggest consumers.

The screen printing process with enamels enables the identification of the designer's brand. Social recognition will give the distinctive character forming a process of assimilation.

Due to this communication the consumer perceives a superior quality product at the moment of purchase. Its impact on the shelf is well known; the consumer sees the product, its color and imagines the smell and taste, awakening all the senses.

The designer will use these tools to differentiate his designs and to emphasize quality, safety, elegance and durability. The message will arrive almost instantly, therefore, that´s the reason the transparent material remains the top choice.

Glass has survived many attempts of replacement, but no other material has managed to match its colour and brightness. This characteristic is the most difficult to achieve and match.

Besides being a clean material that respects the odour, colour and original taste of food, it conserves food properly, preserving its nutritional value, and is an insulator and can be reused to store other products. By choosing this material, designers also take an environmental commitment as it is a naturally occurring material and provides sustainability to the project, because it is 100% recyclable and does not pollute.

The most striking feature of these packages is that they communicate the natural colours of food and makes them more attractive, allowing us to see the product and generate the need to buy, choose and take. This packaging produces emotions on a client that will only stand for fractions of a second in front of a gondola. However, the food already exists in the memory of the consumers, and the transparent container reaffirms the pre-existing mental models. The colour and flavour of these foods are already fixed in the mind of the consumer. The designer will only reaffirm the food in their memories. The designer mediates this association, product / buyer, creating the need to purchase.

Transparency links the meanings of foods, colours and flavours existing in the consumer´s memory and use the product as a sign.

The designer of these types of packages shall deliver a simple message and not be overloaded because the food already has a chromatic message. The design will only enhance its aesthetics and make it more attractive. It will evoke memories without creating any distraction. It will surpass the psychological level to enter the physiological field.

The colour of the food will impress the perceiver, as the product is seen and draws attention. The food will have a value of symbols capable of communicating the idea of the farm. Its emotional and sensual qualities will make it more appealing. This visual identity will go far beyond the supermarket shelf. The package will accompany the consumer to the kitchen, the dining table, desk, or anywhere else where the product may be used.

The container will be the medium that will transfer the product's personality. The transparent container is primitive and quiet. The food and the colour will be the marketing device.

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Packaging design for food: Teaching color and cesia in designers' education

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ABSTRACT

The present work is included within the research project "Design, development and production of didactic material for teaching color and cesia". It has the aim of revising the main issues in the comprehension of both color and cesia phenomena –perception of spectral and spatial distribution of light, respectively– in order to design and develop new material for theoretical and experimental support in courses related to design education. In this occasion we will present preliminary findings related to package design for food products, involving revision of curricular programs, observation of theoretical and experimental lectures and the design of practical applications from students.

1. INTRODUCTION AND FRAMEWORK

The characteristic of global production and distribution model, in which several food products are produced nationally but often targeted to global markets, requires a higher preparation of designers, as they have to work for a much more informed and prepared audience. In this context, package design –considering it as the creation of visual codes with strong semantic value– has become a complex field in which concur diverse abilities and knowledge.

Within this field, color and cesia – perception of spectral and spatial distribution of light, respectively– play a fundamental role, as highly pregnant variables for visual communication. Though, design professionals must be adequately formed to be able to develop and articulate specific knowledge in order to deliver an appropriate answer for a competitive package.

This work is presented within the frame of the project "Design, development and production of didactic material for teaching color and cesia", in which the authors aim to revise the main aspects involved in the comprehension of these visual phenomena in order to elaborate materials for both theoretical and experimental support in courses related to design education, specially within the Faculty of Architecture, Design and Urbanism, at the University of Buenos Aires.

The project starts from the hypothesis that a greater systematization of specific knowledge, associated with proper didactic tools introduced in workshop dynamics and curricular activities could improve the learning opportunities, the incorporation and adoption of more sophisticated methods and concepts in the management of color and cesia variables, elements of high importance for designed object's performance.

In this opportunity, we will present preliminary results of the project, focusing particularly in those aspects related with packaging design for food, and including among other contents: a) compilation and analysis of curricular contents in subjects as morphology, technology, design, etc.; b) interviews with head professors and teachers directly involved in color and cesia lessons; c) observation of theoretical classes and practical applications developed within these courses.

As it was defined on the main project, we will take as work field both Graphic and Industrial Design careers in the Faculty of Architecture, Design and Urbanism at the University of Buenos Aires. Nevertheless, it is expected that the final results could be useful broader, including not only the rest of careers of the Faculty but also other institutions.

2. PRELIMINARY FINDINGS

As the project is on its first stage of development, we will present just the preliminary survey of the field. In such order, we have organized this stage in three lines of work: collection and revision of curriculum, interviews with professors and observation of lectures and exercises, and –particularly for this paper– detection of relation to package design for food, or other food related application of exercises.

2.1 Revision of curriculum

Our first step in this research project was to collect and revise the syllabus of color related subjects in both Graphic and Industrial Design careers (see Table 1). In this corpus, *color* appears with different levels of relevance and treatment. These differences are even more evident in the comparison of both careers.

Table 1. Color related subjects in GD and ID careers. Between brackets it is pointed out how many approaches are offered for each subject.

Level	Graphic Design	Industrial Design
1	Morphology I (7) Technology I (2)	Morphology (2) Physics I (1)
2	Morphology II (7) Technology II (2)	Special Morphology I (2) Physics II (1)
3		Special Morphology II (2)
	Graphics for Product –elective– (1) Graphic design for products an package –elective– (1)	

In Graphic Design *color* is considered a central instrument, being treated more intensively within the first levels –appearing as topic of theoretical lectures, and issue for exercises, and seen in the higher ones tangentially– embedded as requirement in formal exercises and included among other items in theoretical expositions.

We noticed that in both Morphology and Technology, hue, value and saturation variables, from the Munsell color solid, are the most recurrent terms in curriculum. In the latter subject, color is an important aspect and it is always seen in relation to printing systems. In its syllabus are remarked the importance of the knowledge of both color models CMYK and RGB; its related color spaces CIELAB, Munsell, etc.; color catalogues and atlas as Pantone; and color measurement, and the particularities of each printing system as offset, rotogravure, silk-screen, flexoprinting, etc.

Within Industrial Design career, *color* is not treated as central, but it is present explicitly in two subjects: Physics and Morphology. In the case of Physics, *color* appears as a secondary issue, as it is included as part of larger groups of knowledge –such as optics (in case of Level II). In Morphology *color* appears as a theoretical topic in curriculum on all three levels, but not always has associated exercises, and even in those cases they are limited both in time and depth.

As far as elective subjects (for both GD and ID) such as Graphic Design for Products and Packages and Graphics for Products, we have seen that color is highlighted as a key element within the issues on curriculum. In the first case, two of central topics in the subject are all related with color, with the aim of developing the capability of selecting adequate colors for each product. It is also included as discussion and exercises concerning color and shape, meanings of color, optical illusions, color and identification, color in marketing strategies, creative guides of color, the synesthesia phenomenon, color and taste, legibility, etc. In the latter subject, color is mentioned across the curriculum, in aspects such as "how to apply color to a product or manage correctly brightness, transparency and opacity".

Among the cited bibliography we have found the theories of Johannes Itten, Jean Paul Favre and André November about color and communication; the *Harmony color* by Ideaki Chijiwa and *Interaction of color* by Joseph Albers. In several subjects bibliography about color was recommended. The most named authors were Itten, Ostwald, Munsell, Arnheim.

It has to be said that in none of these cases it is specifically included *color* in relation to *food package design*. Nevertheless, we have seen that some of the exercises are applied to such end (see 2.2).

2.2 Observation of lectures and workshops

In our visit to classrooms for observation of didactic approach of *color and cesia* issues, we have seen that in most cases professors choose to start with a theoretical introduction and later apply those concepts to a practical exercise, to train students in the work with color. Also, each course try to relate theory with its core problem: i.e. in Morphology (GD) it is of interest to teach how color modifies structures, or in Technology (GD) exercise how to produce and reproduce color in different systems. In general, we have observed that a common concern is focused on how color determines perception.

2.3 Linkage with food package design

As long as we observed, there are just a few explicit linkages with package design. One of the topics mentioned as extremely relevant to package design is the work on color codes related to specific product segments, as they represent a key factor in the relation with consumers.

This issue is approached in some of the courses intuitively and linked to certain tacit conventions, but with no real theoretic fundaments. Another strategy is to study the existing package within the segment, and build conclusions from them in order to propose new combinations. A third type, work on the linear metonymic linkages such as 'red' for 'tomato', or metaphors such 'green' for 'natural'. In other case, students work based on their own 'feelings' for colors, from a set of sympathetic pictures such as sunsets and natural or artificial landscapes.

On either of these cases the approach are highly informal and spontaneous, and work more on the preconceptions –even prejudices– of color signification than on a systemic analysis of socio-cultural codes related to color and food products.

Nevertheless, we noticed a high interest in deepening on color knowledge –both theoretical and practical–, but we also detected that it is necessary to develop new material in order to facilitate the teaching process.

Table 2. Didactic strategies in first sample observation (Graphic Design career).

	Theoretical introduction		Exercise		
	Main topics	Didactic material	Aim	Concepts	Didactic approach
Morphology / A	There was no theoretical introduction.		To control color variables (hue / value / saturation)	Color perception Color variables Munsell color system Chromatic palettes	A game using color t-shirts as vehicle for experimentation and training. Encouraging students to make their own chromatic palettes.
Morphology /B	Color perception Color variables Munsell color system Monochromatic, analogous, alternate, complementary colors Simultaneous contrast Color temperatures	Oral presentation. Sheets of paper with chromatic circle and Munsell charts	To sensibilize color perception To understand how color modifies structures	Color perception Color and structure Color dominance / subordination	An observation exercise with a black box and a fruit or vegetable inside to analyze how light affects it. Structuring with color by painting same pattern with different color combinations.
Morphology / C	Color palettes, harmonies, contrasts Interaction of color Chromatic circle Color as an element	Power point Oral presentation	To understand how color modifies structures	Color and structure Figure and ground	An exercise of painting polyhedrons and producing different visual readings.
Graphics for Product (for both GD/ID)	Introduction to color thinking Light vs. pigment Ostwald system Pantone Matching System	Power point Oral presentation	To see how culture affects color decisions To control color variables	Color and taste Color and perception Chromatic variables (hue / value / saturation)	Students try to produce specific colors from acrylics, based on some qualitative attributes. Then, they make two more samples with different hues while keeping up the same value and saturation
Technology/A	Color spectrum Color temperature RGB and CMYK models Colorimetry Color spaces How to reproduce color	Experience with three lights (red, green and blue each one) and colored filters. Teachers bring print samples to visualize how each system reproduces color.	To understand how the subtractive and additive synthesis work.	Color synthesis. Color spectrum Color spaces	Based on 4 color markers (CMYK) students work on a full color image, by synthesizing color mixes with different intensities of markers. One of the aims is to visualize printing techniques for color synthesis.

*ID color related subjects have programmed their color lectures and exercises on the 2nd semester.

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Colour interaction between food and non-food products

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ABSTRACT

Concern for the consumer is the main reference point for designers of packaging. For that reason they seek information on ideas and forms of life at the time, and this is what determines trends in consumption. Groups of products usually interact with each other. One such case is that of personal hygiene or beauty products, which tend to interact with the group of food products. In this context, this paper aims to analyse some of the factors that come into play when product lines come under different groupings. Such would be the case of food products interacting with non-food products, such as those bodily hygiene products. Care for the exterior and the interior means that colour can be related with different association weightings, and the existing code systems are, in many cases, inappropriate. A review of the variables presented by this new complexity is seen as being necessary, and from there, a decision can be made as to the criteria for defining the values of luminance, chroma and saturation to be taken into account.

INTRODUCTION

When defining the visual variables for a product, packaging professionals consider its future consumer. First of all they need to decide what type of message the product in question should provide. Based on this message the colour key to be used is proposed. So knowledge of the colour codes of the raw materials that intervene in the manufacturing of the product, but also knowledge of the ways of life and ideas of the different types of possible users are crucial.

Although in its origins packaging was born out of a basically utilitarian need, its function has changed throughout its history, to become in recent decades an object of personal identification.

New guidelines on conduct determine new codes. Those referring to the conservation of the body and an optimum physical state, in particular, ensure and prolong quality of life, giving rise to phenomena of interaction between food and non-food products.

The aim of this paper is to look in greater detail at the phenomenon of product presentation, which is in turn a determining factor of its colour characteristics.

NEW CONTEXTS, NEW CODES

Within the visual variables that intervene in product packaging and labelling, the application of colour responds to a variety of factors. Commercialisation and the subsequent search for competitiveness have led to the carrying out of numerous studies with a view to recognising and evaluating user behaviour (Gao and Xin 2006). In that regard, over the years, coding systems have been produced in relation to the different lines or groups of products, whether they be food (wines, biscuits, dairy products, cold meats, other meats, condiments, etc.) or non-food (cleaning products, kitchen articles, personal hygiene, etc.).

These systems are ruled, in the majority of cases, by the colours of the raw materials, or by elements associated with them. The theory of elements (Kim 2006) proposes that the four elements of nature possess the characteristic badge of carrying within them both constancy and change. These apparently opposing values are generally ranked very positively by the consumer. Besides they provide an important approach to perceiving an image of all that is natural, the primitive, as an association with the creation of the universe. Earth, water, air and fire go to make up the representation of something as complex and immense as the world at its creation, that is besides the artifice. Consequently, colourless liquid products that would appear to present chromatic ambiguity appeal to the elements-nature relationship in order to elaborate their message associated with the genuine or the original, and therefore, all that is healthy. Food products carry within them the presence of at least three of these elements (water, earth and air).

However, in relation to colour, transformations are observed over time when establishing conducts or parameters of evaluation. From the existence of established colour codes for the different product groupings to be commercialised, there was a movement to new alternatives as a result of the large-scale development of products and containers.

An example is the colour green: years ago green was associated with unpleasant images, such as vomit (Kaszubowski 2005). Nowadays that reading has changed radically, not only because green is associated with all that is natural, but because the consumer identifies it with health, low calories, proteins and weight loss.

Another example is the use of black. While in the past it was associated with death and depression, today it has a sense of elegance, wealth and sophistication.

Similarly, the number of products has multiplied geometrically, thus expanding supply and competitiveness when choosing. This has also led to the need to offer differences to attract the attention of the consumer, generating a greater opening in the ranges by material or product, beyond those that refer back to raw materials, or flavour.

Looking more deeply at the problem of the multiplicity of products plus the speed of turnover, what some call "brand design" appears (Chaves 1988). So colour became one of the factors in identifying a brand, more than a product, or flavours or raw materials. The captive consumer's attention would be directed to the brand rather than the product.

In this context, to the problem of the interaction between groups of products is added the plus of brand, or at least series, identification. Figure 1 shows examples of packaging of disposable hankies with direct allusion in form and colour to food products– fruits in this case, whose attributes are observed below- and it becomes a question of identification of series and brand, rather than product itself.

However, we cannot fail to mention the presence of new packaging technologies and technical innovations in printing systems. These innovations allow the qualified reproduction of drawings and illustrations as tools, with a great variety of colours, textures, glosses, reliefs, with greater ease, time and even cost savings. These facilities have similarly given rise to a greater possibility of transgressions and ruptures, in keeping with the times, and which the market has been able to support

CULTURAL CODES

The factors mentioned above, plus other commercial transformations, as for example the creation of Mercosur, exceeded cultural limits. Due to the need to enter other markets, ruptures of internal codes have occurred, in an attempt to develop new keys that will satisfy or complement groups of consumers from different countries.

It is not easy to reverse these guidelines which have been permanently present in society, since concepts are interlinked nodes in a mental network of associations. This may be so, but repeated prototypical expressions tend to be incorporated very rapidly into the memory of the individual and the group. Meanwhile, if a concept invokes multiple associations the most eagerly awaited ones will be activated according to the context (Schmitt and Simonson 1997).

INTERACTIONS

Interactions may occur within the same general group of food products, for example, in biscuits or crisps flavoured with vegetable products, aromatics or sausages. These cases are very common in the market and usually consider raw materials to be colour references.

It is of interest to analyse how the associations between the possible chromatic alternatives occur and the factors that come into play in the cases in which the product lines belong to different groups. Such would be the case of the group of food products interacting with groups of non-food products, as for instance, bodily hygiene products, or cosmetics.

Faced with these problems we need to look at the difference between the market which is active in demand - the user has genuine need- or the receiver market – the need is generated by the commercial and production system.

The example that concerns us, and that is central to this paper, takes a certain characteristic of behaviour that is clearly identifiable among a broad sector of society: care for both the exterior and the interior revealed in the presence of the body and health care. Among the associated factors we can mention those referring to food as a vital and essential element, which can be associated to health maintenance, in relation to its protein attributes. In turn, these are related with aesthetic factors of the body, weight control, skin quality, etc. Both are determining factors in the prolongation and optimisation of the quality of life, and in turn interact with cultural or regional identity, or with the contemporary. These factors allow colour to be related to various association weightings.

The examples given attest to the interplay (subliminal) proposed. Reference has already been made to the characteristic of series/brand. We now emphasise the allusions to the fresh, natural, tasty, vitamin qualities, which are "applied" to a product of hygiene support: paper handkerchiefs. In this case the chromatic proposal rescues the colours, which we could term hyperrealistic, of the natural products to which it alludes. The similarity of this treatment to the production of food packaging is remarkable and worthy of note since it displays the product very realistically.

If we seek the attributes of the products themselves, we can list associations such as lightness, softness, volatility. Please note that the chromatic link is indirect, via reference to the natural product (water melon, orange, etc.). So the line of association would be fresh fruit – natural – healthy – adaptable, light, soft, volatile… passing from the natural object – to the body – to the artificial product.

Figure 1 attempts to transfer to the skin or hair to which it will be applied the proteins, oiliness, density, even heaviness and compactness of almonds or honey. Colour, texture, mass, intensity are attributes transferred to the user through colour, texture and treatment. Also the hyperreality of goodness as a food is present in a personal hygiene product. In this case the lines are inverted: natural object – to the artificial product – to the body (skin or hair quality).

Figure 1. Soaps "citrus & cream" and "miel & almendras" (honey & almonds).

The interaction of modalities would appear not to stop there. The code systems would seem to be limited and inappropriate, in many cases, due to this diversity of associations. A review of such systems together with openness to the variables that this new complexity puts forward can be glimpsed. As we see the criteria for a decision on values of luminance, chroma and saturation that should be taken into account will be those determined by the raw materials in play, which, for the time being, appear to be linked to the treatment of food products.

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Importance of label and labeling in food commercialization

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ABSTRACT

The International Trade Center, which depends on the UNCTAD/WTO, produced a study in 1998 on the importance of food product packaging, labels and labeling for developing countries. While Argentina has a GDP per capita of $ 14,413, the poverty level is 51.4 percent, of which 7,777,000 are indigent. This provides for an interesting case study because even among the poor and marginalized sector of the population product commercialization is important due to its strong presence, often in manufactured products and in other low-cost products. As seen in the case of Argentina, the low-income sector is influential due to its size; to such a degree that banks, NGOs, religious organizations and even the State offer support to small business in this sector via programs of microcredit.

The problem, however, arises when low-income small business owners are not familiar with basic market rules, within which color is crucial because it helps to identify products and promote sales. The present study is based on firsthand experience working with street vendors in the neighborhood Villa Hidalgo, San Martin Province in Buenos Aires, Argentina.

1. INTRODUCTION

The general guidelines for labels and labeling of food products were established by the *Food Products Code* in 1991. This commission was created in 1963 by FAO/WHO to develop food standards, guidelines and related publications, such as practice guidelines under the Joint FAO/WHO Food Standards Program. The main purposes of this Program are protecting consumer's health and ensuring fair trade practices in the food trade, as well as promoting coordination in establishing food standards in all food products, which is carried out by international governmental and non-governmental organizations.

The Codex defines "label" as any sticker, brand, image, or other descriptive material or graphic that has been written, printed, or stamped and placed upon the packaging of a food product. "Packaging" is understood as any written, printed or graphic material that accompanies the label, covers the product, or is sold with the product or in relation to it to promote product sale.

Within the packaging and labeling framework of this study, all packaging is required to clearly indicate the characteristics of the product´s content in order to fulfill current public health and security norms. Of course this required information must be integrated into the design and presentation of the packaging, which can often present layout challenges. Furthermore, it is difficult to fulfill the aforementioned requirements and simultaneously to obtain an attractive package and higher cost package, given that the majority of the population falls in the low income category and therefore is extremely sensitive to price changes. As a result, label and packaging quality and design are often sacrificed to sell at a competitive price point, often overlooking their commercial importance. The question of cost, however, is not definitive; rather psychological and visual factors determine the purchase of one product rather than another, as well the quality of the product itself and the color and design of the package, no matter how simply they may be presented.

2. DEVELOPMENT

Food products can be produced on farms, harvested in rivers, fields and seas, or produced in factories, but it is the label that individualizes the product and makes it identifiable to the consumer. If we consider the market, we realize that all brands grow and develop via the relationship and interaction established with the consumer. The challenge, then, is to design brands that in some way become lasting and serve to identify the product in the consumer´s mind. This is achieved when the product is known for the brand instead of the product itself. It does not indicate that a brand can never be redesigned, but the redesign should be sure to preserve elements of the original design. A paradigmatic case is the Coca Cola bottle, shown in Figure 1.

Figure 1. The evolution of Coca Cola bottles over time. There have been other recent changes that were later rejected. It is interesting to keep in mind that the two rival colas are differentiated for their color. Red represents Coca Cola and blue is emblematic of Pepsi. In China, Pepsi has broken tradition and launched a red can as part of its new marketing campaign. Could one speak of a "cola color war"?

2010 2006 1998

Figure 2. Special editions of Budweiser beer designed for three different World Cup tournaments.

An interesting case is the "special editions" designed for a specific moment or special event. We are all familiar with the label change each year on the bottles that appears during the Christmas season. During the 2006 World Cup in Germany, Budweiser made a notable change to the label. They did the same in 1998 and have done so currently for the 2010 World Cup. Following in Budweiser's footsteps, Quilmes, another beer brand, also makes special labels for the World Cup. These label presentations provide a meeting point in which the consumer can identify with the product and the experience of the moment. Often times label design is the only way to identify a product and its distributor, due to the fact that it may be the only element within the budget of a small-scale producer. In many cases color defines the product or the product color is transferred to the label to leave part of the product visible. In all cases, it is the color that stands out on the label and strengthens its product or brand image. The producer's brand name and type of product often is stated on the label, as in the case of Bols liquor, Argentine dulce de leche liquor (shown in Figure 3). The original color of the dulce de leche is represented in the packaging color. In the same product group, the brand Chimbote is an interesting example, due to the fact that the popularity for the brand has been such that consumers ask specifically for the Chimbote brand and not generally the dulce de leche product.

Figure 3. Various brands of Argentine food products. To the left, the famous Chimbote dulce de leche. The label is relatively simple, but it is known for its high-quality product. In the center photo, various jams from the same producer. Note the label is the same, while the lids are different colors to distinguish different flavors. To the left, a dulce de leche liquor from the maker Bols.

In particular we are interested in low-cost labels. As an example, we select different brands of handmade alfajores. These are characterized by their white wrapper and sticker which identify origin and quality. Examples are shown in Figure 4. Other labels have a more refined presentation, but the quality is always high. This example shows that the label can evolve over time according to commercialization location and cost. The Havanna alfajor, which comes in gold or silver wrapping, is sold in the US using the name Wuavana; it uses a lower-quality wrapper and sells at a lower price point, while maintaining the high quality of the product. The alfajors Romeria, Amalfi and Chocolat (see Figure 4) use a more detailed design which indicates that any brand has the potential to evolve according to the market and the investment possibilities of the label manufacturer. The same can be said for the labels of any type of handmade baked goods. The goal, then, is to find the most appropriate image, which best represents the product and is the most efficient in cost and investment. White or color labels are always an option, handmade labels, printed on home computers or duplicated in photocopy are another low-cost option. In such cases, the value-added can be the lettering and font, which should be closely chosen and elaborated. An identifying logo and a splash of color can be added to the label to distinguish from other products.

In regards to the packaging, which can be produced with the label or can be separate, the regulating norms are strict and are determined by the type of food which the label identifies. Expiration dates are important, as well as those of elaboration, packaging, sell-by date and consumption date. If the product in question is a foodstuff, its ingredients, additives and preservatives must be specified. Additionally, the quantity of added water must be indicated, except when water naturally comprises part of the ingredients. Lastly, the net content and net weight, producer name and address, country of origin, nutritional information and calorie content must all be clearly indicated. Most importantly, understanding color as the protagonist of the product's visual message is crucial for product recognition.

Figura 4. Simple and low-cost brands. An exemplary packaging in the Argentine industry has been the Jorgito alfajor, whose original label was simply white. Jorgito began as a family business in 1950 and became a registered company ten years later. Today Jorgito exports to the United States and Europe. The wrapper color identifies the various flavors of alfajor.

From the design perspective, all colors are not identified with equal significance; this has to do with the distance from which the packaging is observed and the relationship with neighboring and accompanying products at the point of sale. Note that the color also helps identify the organization and change in display required over time of any product vendor. Understanding color is only achieved by interacting with it, in the construction and destruction experienced during moments of success and failure. Elaborate theory is not necessary, only sensibility and much patience during trial and error.

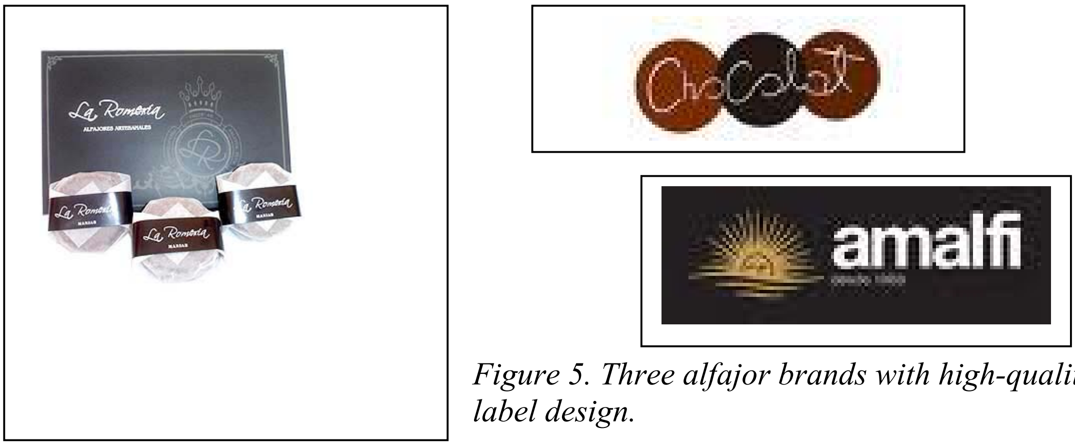

Figure 5. Three alfajor brands with high-quality label design.

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Legal value of color and form in the "small print"

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ABSTRACT

In packaging and food documents there are almost always parts written with the so-called "small print", especially parts where the ingredients, which include the dyes used, are declared. Not only are small, but they are designed in such a way that cannot be read: its thickness, spaces, its forms, its colours, its contrasts with the background make biologically impossible to understand at a glance. It is common to invest a great effort in propaganda which is intended to advertise the product and can be read easily and clearly. It is also usual to perform similar effort so that the list of ingredients of the product cannot be read. Today are increasingly better knowledge about human perceptual limitations and it is possible to quantify key variables that allow or not, to read a text. This allows to legally define the set of constraints on the right to be able to read a text preventive, under normal conditions of reading, as is traditionally referred to as "small print", and that is obviously not only small size. This study identifies several features of the letters that go against its own objective to be read. Achieved with either of them would lose all value in favor of who wrote it, but it can continue be taken in favour of the recipient reader. Is possible to define a few fonts, their minimum size types and minimum contrast with the background, beyond which should be required a larger size to be read. This would simplify the basis for a possible international rule. Legal norms should respect human standard capabilities to ensure compliance. It should be considered as not written anything that is written in a humanly illegible way, humanly unreadable letter and impediments to the reading of preventive texts should be punishable. Especially is inadmissible letters in a color on the same color or similar brightness as the background, when the proper contrast between letters and background is not reached.

1. MINIMUM HEIGHT OF LETTERS

1.1 Basic Notions of human eye biology: "Segregation of visual information begins at the retina" said Kandel (2000: 423). The retina has a tag called fovea and in its Center is the foveola. In this, the cone cells (almost all with maximum sensitivity for red and green), are thin and in higher density, and the immediate processing layers of the retina devote them great proportion of neural cells. They also retire for the cones to get light more directly (Adler 1994: 596) (Fig. 1). That refined organization determines that the foveola is part of our retina increasing our ability to discern luminic information. For standard observer, foveola, which size is slightly more than quarter millimeter (mm), by its distance to pupil, determines a high-resolution geometric solid cone of almost 1º (54'). What is seen in this field of maximum acuity (FMxA) will be at its maximum perceptible detail (Adler 1994: 595) (Fig. 2).

With that field we see with our highest resolution, even to read letters and signs. At the most common reading distance, perhaps around 33 cm, that cone geometry has a circular base of about 6 mm diameter on the text read. This is a ratio of approximately 1/55 (Adler 1994: 404). Being such a small field, we need to read moving eyes in inspecting lines mode (Adler 1994: 179). The route of the reader watching not only contains written lines, but also the two adjacent leadings for writing up and down not to interfere it or confuse reading. At the most common distance reading, the band traveled by the reader watching is of about 6 mm., and is composed of 3 strips of approximately 2 mm each one: what was written in the separate line by two leadings (Bardier 2001: 24).

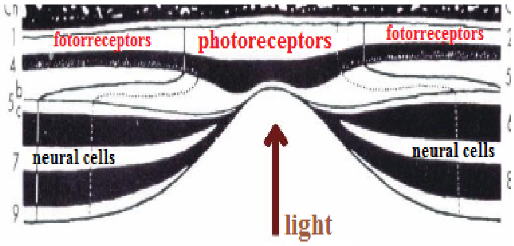

Fig. 1. At the foveola the photoreceptors are thinner and compacted, layers of neurons are retrieved (modified from De Polyak 1941).

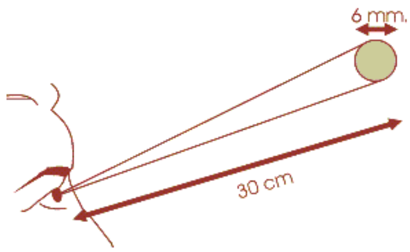

Fig. 2. At normal reading distance, we clearly see a circle of 6 mm diameter.

1.2 Minimum height yet optimal: In the fonts used in press and communications (e.g.: Times New Roman 12), the lowest height (e.g.: a, n, z) is 2 mm. To complete the band read, we add a 2 mm completely free net leading on the written line below.

But such a step we must take it on high points of this line (e.g.: b, d, l), since they commonly protrude 1 mm. And we must also add 2 mm free space to the top written line, carefully taking this measure from the bottom of the lower letters (e.g.: g, p, y), descending almost 1 mm. In that type and font size, net reading band meets the 6 mm required for reading without confusion (Fig. 3).

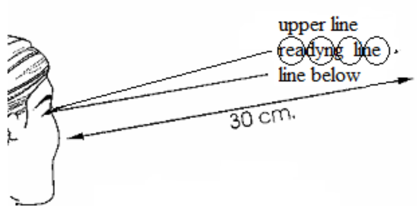

Fig. 3. Reading we cross, with our circle of maximum acuity, a strip of 6 mm wide, centered on the writing line.

In such text, when lines are only common letters without outbound, up or down, each leading measures 2.8 mm. Total gross of the reading band is 7.6 mm, which makes it even more comfortable reading. Capital letters (e.g.: A) of that type and font size measure 2.8 mm. Where upper and lower lines are also capitalized, net line spacing is more comfortable. If you mix with lowercase, is the same as when are all lowercase. Although uppercase are larger, more readable, they less differ from one another and reading becomes less understandable.

1.3 Permissible minimum height: These are the minimum optimal dimensions for a normal reading distance under normal conditions. Its strong biological basis has been endorsed widely by experience and traditions, even though there always were economic reasons to decrease its size. They are very close to the minimum possible, by supporting very little reduction, which could be justified only: 1) Forcing the view through a closer reading, which, even in good light conditions, for the average reader should only be done in a very small percentage (17.5%). Given the serious situation that almost a half of the population has reduced visual capabilities and is already at the limit of its possibilities, this might be a socially discriminatory criterion. 2) Not to compliance some secondary feature required by the visual system (e.g.: reducing leadings). This resignation is only justified for texts that have most letters without outbound up or down. In this case net reading band can assimilate the brute band.

The smallest permissible printing heights can be reduced in the most common letters, as it is the "o", to 1.7 mm. High letters as the "l" and the capitals, 2.3 mm. And the same for those which protrude down, as the letter "g". Crude averaging (the height of a common letter + the height of a high letter / 2) remains of approximately 2 mm. The total read band, now ignoring protruding letters, remains 6 mm. These dimensions are in Times N. R. 10 and the Arial 9 (although its reading band is slightly reduced). The smaller letters, yet for the normal humans, are illegible. And for those with reduced visual capabilities they would discriminatory.

2. POLICY ABOUT THE HEIGHT OF THE LETTERS

To highlight the importance of the topic, regulations of some countries are cited below.

2.1 Argentina: Article 1: "Typographic characters must not be less than ONE POINT EIGHT (1.8) millimeters in height." That article and the following resolution 906/98 of the Ministry of Economy of the Nation, set the minimum height the letter used for consumption, offers, budgets, contracts, etc. must have. "ONE POINT EIGHT (1.8)" what we have written in size 8, because in them what the law says is true (Fig. 4).

2.2 Chile: "With a letter size not less than 2.5 mm." Clauses that do not comply with these requirements will not produce any effect on the consumer. Act 19496, 14 July 2005. That paragraph is written in size 11.

2.3 Uruguay: "Typographical characters used in contracts of accession may not be in any case smaller than 10 points of size. Circular 2016 BCU. ARTICLE 195 (CONDITIONS OF CONTRACTS….). That paragraph is written in size 10.

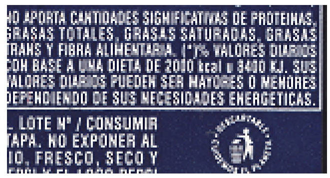

Fig.4. This printed meets Argentinian law because the uppercase has 1.8 mm height. Note that the circle is 6 mm.

3. WIDTH OF LETTERS

3.1 Optimal width: For the same biological reasons cited before, letters should have a layout with an average width of 1.5 mm, being the finest of about 0.8 mm (e.g.: l, t), until the thicker, with 2.8 mm.(m, w). Most (e.g.: a, n, z) are very close to the average width. If we add separations between letters, measure becomes 2 mm. The maximum resolution is a circle of 6 mm, and its centre is 2 mm height 2 mm width. So, each time we take a look with our FmxA, we cover 2 to 4 letters. They coincide with a syllable. We need to place separator points or commas every 3 figures: 1,000,000. The fonts used in press, such as Times New Roman 12 and Arial 12, satisfy either this optimum standard.

3.2 Minimum width visible: Width reduction should be, at best, proportional to reduction of height of the letter. Therefore common letters, such as "o", should be not smaller than 1.3 mm width. The usual letters 9 Arial and Times New Roman 10 meet this minimum. Thinner letters are unreadable to the average reader, because: 1) Diminish the visualisation of each letter, and 2) Introduce into the FMxA more than one syllable and more than one line.

The font Agency FB 10 meets minimum standards of height, but is clearly uncomfortable when reading. The same applies to Bodoni MT Poster Cmpressed 9. It is worse for readers below the average (Fig. 5).

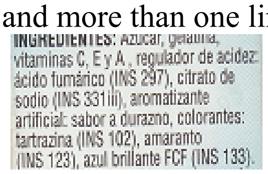

Fig. 5. Letter height acceptable and unacceptable bandwidth. Circle of 6 mm.

4. THICKNESS OF LETTERS AND THEIR SEPARATION COMPONENTS

4.1 Biologic justifications: Inside the diameter of the foveola fit 60 to 75 cone cells. Our maximum resolution power is, therefore, of 1/60 to 1/75 the diameter of the field maximum resolution. This determines the minimum resolution angle (AMR), approximately 1 minute degree (Adler 1994: 537). At common reading distance, this is almost 0.1 mm.

4.2 Optimum thickness: We can write **thick** or thin letters. However, if the thickness of the sticks is less than the visible minimum, reading becomes impossible, because the thickness of the cells limits discernment of letters' parts. This thin thickness (0.1 mm) is valid only if we stop to look at, or remain in the horizontal travel view. However, for mobile reading, it is necessary the thickness of the vertical strokes to be three times greater (on average): 0.3 mm.

4.3 Minimum thickness: Thickness of letter components is not reducible, as it would be seen for most of the population. But: **a)** The Arial 9 font has uniform thickness of approximately 0.3 mm everywhere. In theory, if the reading eye makes arrests of its movements, as the FMxA is circular, for all sides should be of equal thickness. The ability to distinguish between letters gets lost (McLean, 1993: 67). **b)** Times New Roman 10 maintains the thickness of the vertical sticks (0.3 mm) and refines the horizontal (0.1 mm). As in the beginning and end of the stop between sacadic movements there still remains mobile vision, this suites best to rapid reading than the constant thickness (Adler 1994: 543, 557). **c)** Thinner or tighter letters: are almost unreadable with normal view at normal distance, and do not support reductions.

4.4 Bold: In all cases, a letter thicker than the rest of the text is more readable, so for almost all fonts there is a "bold" type. Arial 9 improves **if it gets bold**. The Times New Roman 10 **also improves**.

4.5 Separation between letters:: 0.1 mm. in letters with outgoing horizontal. And more than 0.3 mm in fonts of uniform thickness (e.g.: Arial 9).

5. CONTRAST BETWEEN LYRICS AND BACKGROUND

5.1 Optimal contrast: All the indications above were made for fonts in black ink on white paper or vice versa.

5.2 Minimum acceptable contrast: In the case of coloured letters and/or coloured background, size shall be increased to 17.5% in the case of either contrasting colors (purple, blue or red) in yellow, yellow-green, orange or green.

5.3 Mimetic contrasts: It is not possible to read when the letter and the background colors are isovalent (Orange in green, purple or blue in dark red, or yellow in orange, yellow in white). If you should warn of dyes harmful to health, there is a double damage (Fig. 6).

5.4 Non-existent contrasts: Much less are legible letters on equal color as background color. White against white, and red against red: are invisible, although they can be printed.

5.5 Changing contrasts: The background and letters compounded camouflage (Fig.8). Nor are legible letters that change shape, texture and/or color (e.g.: shape, texture and/or color).

5.6 Contrasts with inconvenient cesia: can be very inconvenient for comfortable reading.

Fig. 6. White letters on clear background prevent read. Circle of 6 mm.

6. PRINTING QUALITY

6.1 Inappropriate Design: Text should be placed where it can be easily readable. Locations perpendicular to the rest of the text, in the background, in the bottom of the product, not integrated to the main text, hidden in foldings, are inconvenient (Fig. 7).

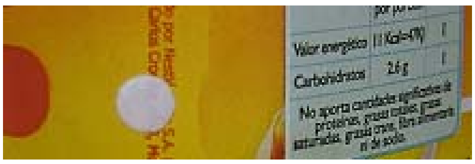

Fig. 7. Vertical texts, on secondary sites, with low contrasts and unreadable letter, are inadequate.

Texts that do not meet standards of good printing, punctuation and understandable lexicon, are difficult or impossible to read. Although the size should be increased, these shortcomings may not be offset. If these standards are not met in this sense, texts should be corrected or given by unwritten. Additionally, small print suffers the printing defects more than normal text. Warnings legally required should not be taken as accomplished when letters are badly printed, stained, grassed, or discolored. The printing quality should be better to the best of the rest.

7. RECOMMENDATIONS

It should not be taken as written what may not be easily readable. A text is comfortably readable at common reading distance when it meets the following minimums:

1) Letter height: 1.7 mm. Height of uppercase letters, numbers, or high letters: 2.3 mm. Average height of the letters [(common+high) / 2]: 2 mm.
2) Net Leading, completely empty: 1 mm. Gross spacing: 2 mm
3) No horizontal elements thickness: 0.3 mm. Horizontal elements thickness: 0.1 mm. Separation between letters with outbound: 0.1. Without outbound: 0.3 mm.
4) Average letter width: 1.5 mm. Separation between words: 1 mm
5) Contrast between lyrics and background: white with black. Only homogeneous and heavily contrasting colours, if all the dimensions of the letters increase over 17.5% should be accepted. Camouflage colors should not be used (changing colours, similar colours in letters and background).
6) Printing quality should be equal to or better than the rest of the form without torn or bound.
7) Text should meet the usual rules of the language and the typography.
8) The text should not be located in disadvantaged or uncomfortable areas, vertical, slant or hidden positions.

Conditions 1 to 4 are fulfilled by 9 Arial and Times New Roman 10 letters. Competent legal bodies should publish lists of types of acceptable sizes and letters.

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ColorAdd. Color identification system for colorblind people

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ABSTRACT

In the most developed countries colorblindness affects 10% of the male population. This handicap incurs limitations as well as uncomfortable personal and social situations for those afflicted that depend on others to choose products in which color is a predominant factor, such as pieces of apparel and decoration.

A sample group of colorblind people questioned in a recent study found relevant the development of a system which would allow them to identify colors. The development of a graphic color identification system was the answer to this need, its concept and structure making it universal, easy to communicate and memorize.

This system can be applied to a variety of products and allow the colorblind to reduce or even eliminate their dependence on others.

1. INTRODUCTION TO THE COLORBLINDNESS PROBLEM

Colorblindness is the common denomination to a congenital alteration related to the incapability to distinguish several colors of the spectrum due to a visual deficiency.

This people have a normal vision relatively to the other characteristics which compose it, even though the deficiency hampers, or even makes it impossible for those afflicted to perform certain everyday social and professional tasks. Colorblindness affects approximately 10% of the world's population and it's a handicap usually of genetic origin associated to a flaw in the X chromosome. Because of this, 98% of colorblind people are male.

The first symptoms of colorblindness are detected at school age due to the difficulty in interpreting drawings, maps and identifying colored pencils. Later in life a colorblind person is prohibited of performing certain jobs, while some professions will bring added difficulties.

2. MATERIALS AND METHODS

Using primary colors, represented through simple symbols, the system was constructed through a process of logical association and direct comprehension, allowing its rapid inclusion in the "visual vocabulary" of the user. This concept makes additive color which lets the color blind relate the symbols amongst each other and with the colors they represent, without having to memorize them individually.

The system proposed is based on the search of the pigment color, using as basis the primary colors –blue (cyan), red (magenta) and yellow its additive secondary colors, because the colorblind person does not possess the correct vision of the colors, nor a tangible knowledge of how their addition works (Figure 1).

The secondary colors are formed using the basic forms as if "mixing" the primary pigments, making their perception and the composition of a color pallet easy (Figure 2).

Figure 1. Graphic symbols: 3 primary colors / white and black.

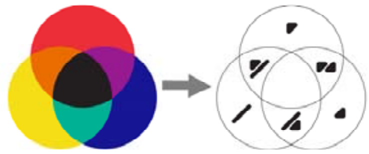


Figure 2. Graphic symbols: three primary colors and their addition.

By associating the icons representing white and black to define darker and lighter tones to the basic forms and their additions, a wide palette is constructed. Conventional color designations were attributed to the additions and other combinations of colors (Figure 3).

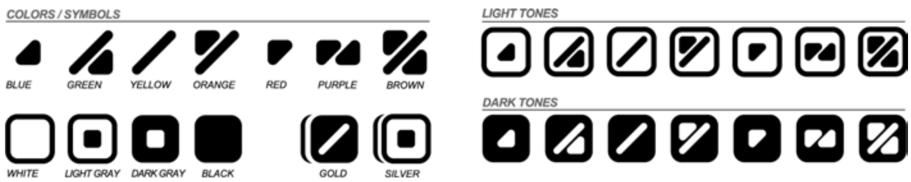


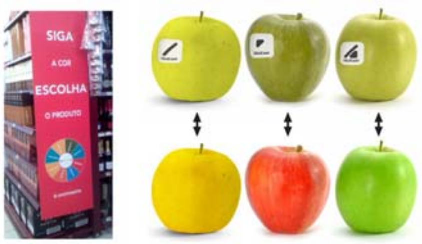
Figure 3. Monochromatic graphic code – complete layout.

Grey, was divided into two tones: light grey and dark grey. The importance of gold and silver implies the creation of a specific icon.

The totality of the code, represented in Figure 3, covers a considerable number of colors and can be easily conveyed through information posted at the sales point, on web sites, or the product itself.

3. APPLICATIONS (SOME EXAMPLES)

The application of the system is transversal to all the areas of the global society, regardless of their geographical localisation, culture, language, religion, as well as to all the socio-economical aspects.



Food. Color is a major issue when identifying food elements, it is also a way to distinguish certain characteristics, in its own package, and a factor of orientation in markets (Figure 4).

Figure 4. Food store / Apples seen by a colorblind / packaging.

School and stationery. The inclusion of the system in the school and stationery leads to inclusion (Figure 5), allowing the color blind kid a perfect integration.

Figure 5. Simulation, pencils seen by a colorblind.

Transports. The metro maps are equally valid on what concerns the use of the color identification code, to individualize the different transit lines (Figure 6).

Figure 6. Metro map Porto, Portugal / Seoul, South Korea.

Clothing and textiles. In apparel, the symbols can be applied to tags or integrated into the clothes themselves, similarly to maintenance and care information (Figure 7).

Figure 7. Application on tags and cards added to the clothing.

4. CONCLUSIONS

Each day society grows more individually centred. Each person becomes totally dependant on itself and asking for another person's help, besides creating some frustration and feelings of dependence, is not even always possible. The "wrong" interpretation of colors can harbor insecurity in social integration of the individual whenever the projected personal "image" is a key factor in rendering judgment. The color identification system, aimed at color blind, can be greatly beneficial to a group which represents such a significant percentage of the population. Its use, given the characteristics of the system, means a practically insignificant cost and its adoption by the industry and society can improve the satisfaction and wellbeing of individuals whose particular vision characteristics deprive them of a fully independent every day experience.

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Breakfast cereal packaging in Australia

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ABSTRACT

How is a product that is essentially in the colour range of beige to brown presented through packaging? How do colours of package graphics enhance the product and differentiate it from its competitors? How do companies that market breakfast cereal present their products and ranges, to successfully compete for consumer choice from the supermarket shelf? In investigating these questions the use of colour in breakfast cereal packaging in Australia was assessed, visually and numerically, to identify colour characteristics, the most often used and the most proportionally used colours. Nineteen mixed cereals were selected; and included four brands *Uncle Toby's, Kellogg's, Sanitarium* and *Vogel's*. Visual analysis of the cereal packaging front face indentified significant characteristics. The predominant colour reflected the content or the context of the cereal, while the brand range identity remained consistent. The numerical analysis assessed both the most often used and most proportionally used colours. The results showed that the two top ranked colours in both categories were white/cream and "cereal" (brown / beige).

1. BACKGROUND

A bowl of cereal is a long-established breakfast choice in Australia. Breakfast cereal is generally ready-to-eat or quick to prepare, children can even serve themselves as no cooking is involved, and it is considered by all ages as a healthy start to the day. Australia 80% of adults eat breakfast regularly and around 50% eat cereal for this meal (Williams 2002). Consequently, the value of breakfast cereals sold in Australia in 2004 was around $ 894.5 million (Burton 2004). The main types of cereal are biscuits and bites, flakes and puffs, cereal for children and mixed cereals (e.g. muesli and flakes with fruit) (Woods 2007). For the purpose of this study I will focus on wholesome cereals, and exclude cereals marketed primarily for children and porridge because it requires cooking. As the cereals being investigated for this study are essentially in the colour range of beige to brown (neutral colours) it is important to note that for lovers of brown, the colour epitomises a wholesome, nourishing reference to all that is essential in food. However, for many people, brown represents a muddy, unappetising colour. Thus brown requires the visual support of additional colours to make it visually appealing, while communicating its content and nutritional value within the supermarket context.

2. METHOD

After reviewing the types and numbers of cereal available it was decided to look at only mixed cereals, as this provided a good-sized group from which to choose the cereals to investigate. The nineteen mixed cereals selected for the study are available on the Coles (a large Australian supermarket chain) online shopping site. The cereals included four brands (*Uncle Toby's, Kellogg's, Sanitarium* and *Vogel's)*, four individual cereals, and four ranges of cereals; all were visually and numerically analysed.

Digital images of the front faces of the cereal packaging were taken and visually analysed to identify the similarities and differences of the images as a group. Next, the four or five most predominant colours, in terms of area covered, were extracted using a colour picker tool. Each colour was then identified, along with its predominance, its initial colour name, and its RGB (red, green and blue) values. Over seventy colours were retrieved.

When a colour was similar to another colour, averaging the RGB values to obtain a representative colour reduced them to a representative colour. The final colour list contained eighteen colours.

3. VISUAL AND NUMERICAL ANALYSIS RESULTS

The visual analysis of the images of the front face of the cereal packaging showed the following characteristics:

- A main colour, covering an area between one to two thirds of the face;
- A white / cream colour is always used within the image; and
- There is always a picture of the product on the face.

Additionally the image colours were assessed to determine how often each colour was used (i.e. rank). Each colour was assessed with respect to the proportion of the total areas of all the images covered by a colour. The results were then compared to identify the most often used colours and the most widely used colours (in terms of proportions). Table 1 shows the results for both analyses.

3.1 Most often used colours

The results of the numerical analysis show that the most used colour tends to be white/cream (used 19 times), with all cereal packaging using a version of the colour. Additionally, the second most used colour tends to be the colour “cereal” (used 14 times). The least used colours were yellow, tan, olive green, grey-ish and fuchsia, with each being used only once in the entire set of packaging.

3.2 Most proportionally used colours

Interestingly, the results from the most proportionally used colour paralleled the results for the number of times a colour was used. Thus, white / cream and cereal were top ranked for the most proportionally used colours. Colours such as reddish, purple and green moved up in ranking, although they were not used often; but when used were the major colour.

3.3 Comparison

The ranking difference between the most often used and most proportionally used colours can reveal some interesting details. The colours white / cream and cereal had the same ranking for both and, as such, the colours were used often and in large portions.

Further, the colour apricot, ranked 9th in the number of times used and 4th in proportion used, was used only a moderate number of times, but over a large area. Similarly, light green (from 7th to 12th) and washy purple (from 12th to 17th) had large differences in their ranks, signifying that the colours were used often, but only in small amounts.

Colour	Name	No. of times used	Rank	Proportional value	Rank
	apricot	4	9	15.36	4
	aqua	5	7	7.30	11
	blue	9	3	20.05	3
	brown	6	5	13.55	5
	cereal	14	2	27.20	2
	fuchsia	1	14	3.84	13
	green	3	11	9.38	8
	greyish	1	14	2.56	15
	light green	5	7	6.26	12
	mid green	6	5	8.96	9
	olive green	1	14	3.84	13
	purple	2	12	7.68	10
	red	8	4	13.55	5
	reddish	4	9	10.14	7
	tan	1	14	1.14	18
	washy purple	2	12	1.52	17
	white/cream	19	1	33.70	1
	yellow	1	14	1.71	16

Table 1. Numerical results.

5. SUMMARY OF ANALYSIS

In summary, the following overall conclusions can be drawn about colour and Australian breakfast cereal packaging. First, the packaging always contains white / cream colours and an image of the cereal. Second, the colour blue tends to be used only as an element of the brand identity, which, however, can take up a significant proportion of the packaging image. Third, cereal packaging tends to use colours that can be found in the natural environment. Fourth, the use of colour can represent both the context of the cereal (e.g. healthy) and/or the content of the cereal (e.g. containing apricots). Finally, while most packaging is dominated by a beige to brown colour, visually appealing and supportive additional colours are also used.

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The color research of food package in global market

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ABSTRACT

The research about several successful cases in the food packages in Chinese market including imported and domestic products finds that all of them choose red as important color communication language. In order to exploring the successful communication process between products and customer, the paper firstly tries to find out the clue from traditional Chinese color culture, analyzes and summaries the history origin, classical character and the package application in ancient time, then elaborates Chinese red and gets conclusion that red experiences three main steps 1) inescapable biological reactions, 2) symbolisms of the conscious and 3) cultural influences and mannerisms, finally figures Chinese special red culture and red preference, and summaries that the color culture and color preference still influents the sale of products. Finally, concludes that modern package design based on color culture can improve value-added of product and identity of brand, promote the communication between product and customer. food package design need consider the different color culture, color preference and color semiotic in order to help the better communication between brand and local market.

1. INTRODUCTION

Economic globalization promoted by the direct investment of trade and capital and convenient transportation already opens a market gate and brings opportunity once in a blue moon for all the companies all over the world, at the same time, the market competition is also becoming more an more fierce. Under this situation, the visual communication and the brand of the corporation become more and more important in the fierce market competition to outstand products in thousands upon thousands of goods. Color as an important visual communication element in the process of design, essential media of culture and ideology, embodies and represents corporation culture, and maintains it in independent status. At the same time, culture diversity in global market asks designer to consider the diversity of color culture, color preference in local market. So in the new century, it becomes a quite important research topic how to choose and design color in the process of product package in order to obtain emotion resonance and recognition of identity.

According to the PHD research of Leslie Harrington about the reds of love and rage: a note on the risk of eliciting negative emotions, Red is a color that has a rich and long history, one that can be linked to human existence. Many brands and products look to leverage red as part of their communication efforts with customers, at the same time, due to the strongest energy of red who has the power to either stimulate or evoke specific physical and emotional resonance, red always is associated with the five common positive emotions: amazement, ecstasy, joy, love and passion even though in different civilization (Harrington 2008: 108). But in their study, also discussed that sometimes in some many cultures, red can be associated with four negative emotions: aggression, anger, rage, and terror. But in east country, China if somebody pays attention to the package design, production communication and culture custom, always can find a strange phenomena, majority of successful products always have all kinds of relationship with red in the process of visual communication, especially in the food package fields.

2. DATA COLLECT AND ANALYSIS

In order to increase understanding of strange phenomena identified to be linked with Red in China. The sample consisted of 10 most famous domestic alcohol brands in China and their 55 products (Figure1).

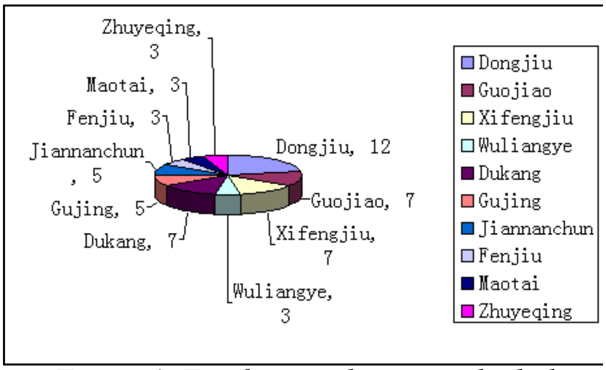

Figure 1. Ten famous domestic alcohol brands in China and their 55 products.

Respectively 12 products of Dongjiu, 7 products of Guojiao, 7 products of Xifengjiu, 3 products of Wuliangye, 7 products of Dukang, 5 products of Gujing, 5 products of Jiannanchun, 3 products of Fenjiu, 3 products Maotai and 3 products of Zhuyeqing, most of them have long histories and hold a big market quotient. Among them, it is obvious shown as Figure2 that Guojiao and Wuliangye use red as a main color in all serious of products packages, in 12 products of Dongjiu, 4 products use red as main color, 6 products use it as associate color and rest two of them use red as a brand letter color. Jiannanchun, Maotai and Xifengjiu most of them use red as main color, in some cases, even though never use red color as a main color, also use it as associate color and point color. Only one case, Zhuyeqing use less red in package design due to its name from bamboo, so green becomes main color in product communication process in order to provide customer fresh image.

And in all the products which use red as associate color and main color, the color codes in Natural Color System main focus on 2070-R, 1080-R, 2080-R, 0590-R and 3060-Y90R (Figure 3).

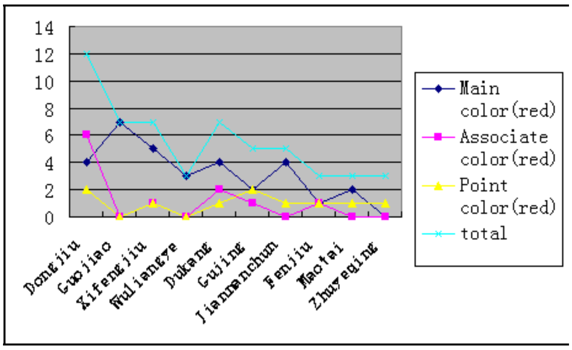

Figure 2. Color codes in NCS.

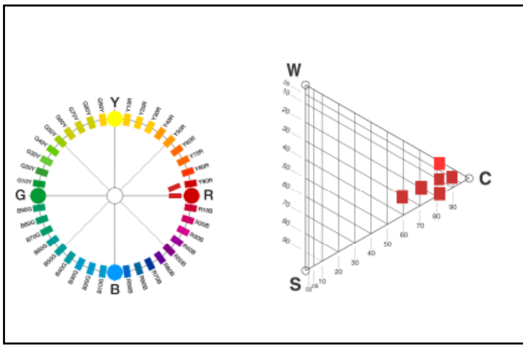

Figure 3. Color codes in NCS.

3. FINDINGS

In order to answer the conclusion made by above data analysis has to trace back to traditional chinese color culture to discuss about the origin and forming of China red preference.

3.1 The origin of 'China red'

'China red' cannot find accurate origin from the 1.15 million results of Google research, but if talking about 'China red', can find a lot of information about vermilion, (Martín-Gil et al. 1995: 759). Also spelled vermillion, when found naturally-occurring is an opaque reddish orange pigment, used since antiquity, originally derived from the powdered mineral cinnabar. Chemically the pigment is mercuric sulfide, HgS. Like all mercury compounds it is toxic. Today vermilion is most commonly artificially produced by reacting mercury with molten sulfur. Most naturally produced vermilion comes from cinnabar mined in China, giving rise to its alternative name of China red (Huang 2001: 28). From the above describing about the earliest origin of red pigment, vermilion, can judge that china is one of countries to earliest use this pigment.

3.2 The form of 'China red' culture

And from the archaeological findings and historical documents can provide a great number of proofs. For example, Shen nong in Chinese legend, who found the use of fire and initiated the knowledge to the people, got the name of 'king yan', and his territory was called 'red county', from that moment, china also called as 'supernal red territory. (Li 2005: 52) From the aristocratic tombs of Shang dynasty also found most part of the articles with red color decoration. All of these tell us that China has a long history of preference red.

As described in the part of the origin of 'China red', can found that it has a long history, but passing earliest ancients' adoration of fire from Eolithic until today, 'China red' passed the revolution of different dynasties, the preference of red which already melt into Chinese traditional culture, experienced the transform from royal privilege, aristocratic to be used in a popular style, become an important part of every most important moments of our life. Here, according to the vicissitude of different dynasties, we make an analysis and summary in order to give a clear skeleton. Just show in Figure4, China red culture is classified three periods, first one is original from prehistory to Zhou dynasty, due to the aspiration to life, also the adoration of fire, sun and blood, the people living in that period, began their preference to red, also can found the proofs from the prehistory remains, such as the ashes surrounding with the reddish iron ore powder specialists presume that the prehistorically people hoped that the dead person can get new life through this way and relive in the future, because they thought that red was symbolization of blood which can give them lives and power. With the process of civilization, entering into Zhou dynasty, that was a period of culture bloomy, philosopher Yan Zhou brought forward five-colors theory, color began to collaborate with society class, became the mean and symbol of dividing different social class and rank, and during this period, red only could be used by the leader of empire, aristocrats. So red signified the power of empire, dignity, worshipful, splendid and glitter. After Tan dynasty, red was not the privilege of aristocrat, began to be popular in the life of common citizen, especially when festivals were coming, people always pasted red couplets at the entrance of gates, hung red lanterns above the yards, even the firecrackers and children's clothes always choose red as a lucky representation of following year, all of these not only is the symbolization of reunion this year, also foretell and aspire the good luck in following year.

Except the above application of red, wedding, new-born, congratulate on elder's birthday, handcrafts, furniture, and architecture, even the honesty person's face in chinese opera is colored by red, just following the more and more preference of red in folk, red turns into the China red, the totem of Chinese culture, and convert of inspirit.

3.3 Chinese red and Chinese alcohol culture

This is a proverb in Chinese traditional culture, alcohol is not enough when you meet bosom friends and alcohol is the symbol of reunion and the necessary element in these celebrations such as the matrimony, festivals and important moments. The meaning of luck and reunion is combined with Chinese special alcohol culture, it is natural that red becomes a most popular visual communication language to transfer the luck and wish especially in different important moments.

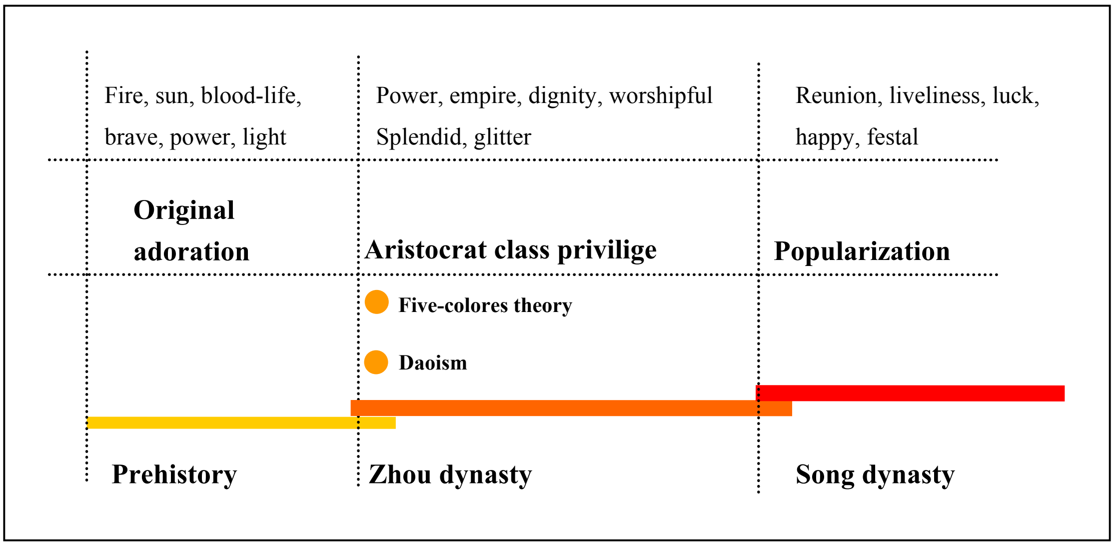

Figure 4. History and China red culture.

4. CONCLUSION AND FUTURE DIRECTION

In Frank H. Mahnke's research about colour, environment and human experience, he assumed "Color Experience Pyramid" which consist of six basic interrelated factors influence this experience, including 1) inescapable biological reactions, 2) the collective unconscious, 3) symbolisms of the conscious, 4) cultural influences and mannerisms, 5) influence of trends, fashions and styles, 6) the "personal relationship" the individual has to color. In the design process of food packages, the color experience pyramid can be look as a important reference to explain the forming process of particular red preference phenomenon by Chinese people in special culture background.

Red from the viewpoint of inescapable biological reactions, due to its high lightness and high saturation, it is nature to become an effective instrument to distinguish company's brand products from other products in full of beautiful things in eyes. But it is undoubted that symbolisms of conscious, cultural influences and mannerism also improved the forming of 'China red' and the fixation of chinese red preference, even the influence of new trends, fashions and styles and rapidly change of "personal taste" still never change the traditional color culture, and this kind of color preference still influents the sale of products. Especial facing the fierce competition, design will become the core of product in the future. Package design as vital tache of design process, design based on color culture can improve value-added of product and identity of brand, promote the communication between products and customers. Food package design need consider the different color culture, color preference and color semiotics in order to help the better communication between brand and local market.

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Influence of package colour for mineral water plastic bottle to consumer's purchase motivation

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ABSTRACT

The aim of this study is to know the influence of package colour for bottled mineral water on consumers' purchase motivation. We conducted a questionnaire survey to find out factors associated with purchase motivation and found that more than half of the participants considered 'shape, design and colour of label/bottle' as an important factor. In this study, visual assessments were carried out to investigate suitable colours for a label, and also to investigate the influence of label colours on consumers' purchase motivation and impressions. The results indicated that consumers tended to think bluish colour was the most suitable colour for a label of bottled water and stimulated purchase motivation. It also gave positive impressions to consumer. In fact, much commercial bottled water uses bluish labels. However, the results also showed that reddish colour was considered to be more fashionable and unique.

1. INTRODUCTION

Colour stimulates consumers' purchase motivation. Therefore, various colours are utilized to design packages of food, drink and so on in order to raise purchase motivation. The concrete roles of package colour are to get eye-catching, discernment, actuality, association, fashion, preference, and aesthetic properties. There are many previous studies about the package colours and the relationship between foods/drinks and colours; for example: Hutchings (1994) and Wei et al. (2009).

In this study, we focused on package colour of bottled mineral water. The mineral water is transparent, but not coloured. Therefore, we guessed that the package colour design which has reminded of the image of mineral water is required more than that of other drinks and foods. The aim of this study is to know the influence of package (label) colour of bottled mineral water on consumers' purchase motivation. In this study, a questionnaire survey was conducted to find out factors associated with purchase motivation. Then, colours of labels of commercial bottled water were surveyed. Visual assessments were carried out to investigate suitable colours for a label, and also to investigate the influence of label colours on consumers' purchase motivation and impressions.

2. PURCHASE MOTIVATION

This study was begun with a questionnaire survey on consumers' purchase motivation for bottled water. Fifty Japanese university students including 25 females and 25 males joined this survey. Their average age was 21.6 years old. In the questionnaire, the participants were asked to select items which stimulated their purchase motivations from 8 items. Note that multiple answers were allowed. As the result, 73% of the participants answered 'reasonable price' as one of the important purchase motivations followed by 'taste' (61%), 'shape, design and colour of label/bottle' (55%), 'brand' (50%), 'still/sparkling water' (32%), 'soft/hard water' (32%), 'country of origin' (12%) and 'mineral content' (7%).

3. LABEL COLOURS OF THE BOTTLED WATER

3.1 Label colours of commercial bottled water

Colours of labels of 101 bottled water (commercial products) were identified in terms of CIELAB L*a*b* values. To do this, digital images of the bottles were first captured via a digital camera *Canon EOS 20D*. The RGB values read out from the image were converted to CIE XYZ values using a camera characterisation model: a polynomial model using the least squares method (Cheung et al. 2004). Then, the L*a*b* values were calculated from the XYZ values. Two colours used for the first and send largest areas on the labels were extracted as representative colours of the bottles. Note that if the second largest area was less than twice as large as the third largest area, only the colour of the largest area was used as a representative. Figure 1 (a) shows the distributions of the extracted colours. It can be seen that around 60% of the colours were bluish colours; namely, colours in the hue area of greenish blue to purplish blue. The differences between the Japanese and foreign products were that yellowish and reddish colours were used more for the foreign products (around 30%) than the Japanese products (around 10%).

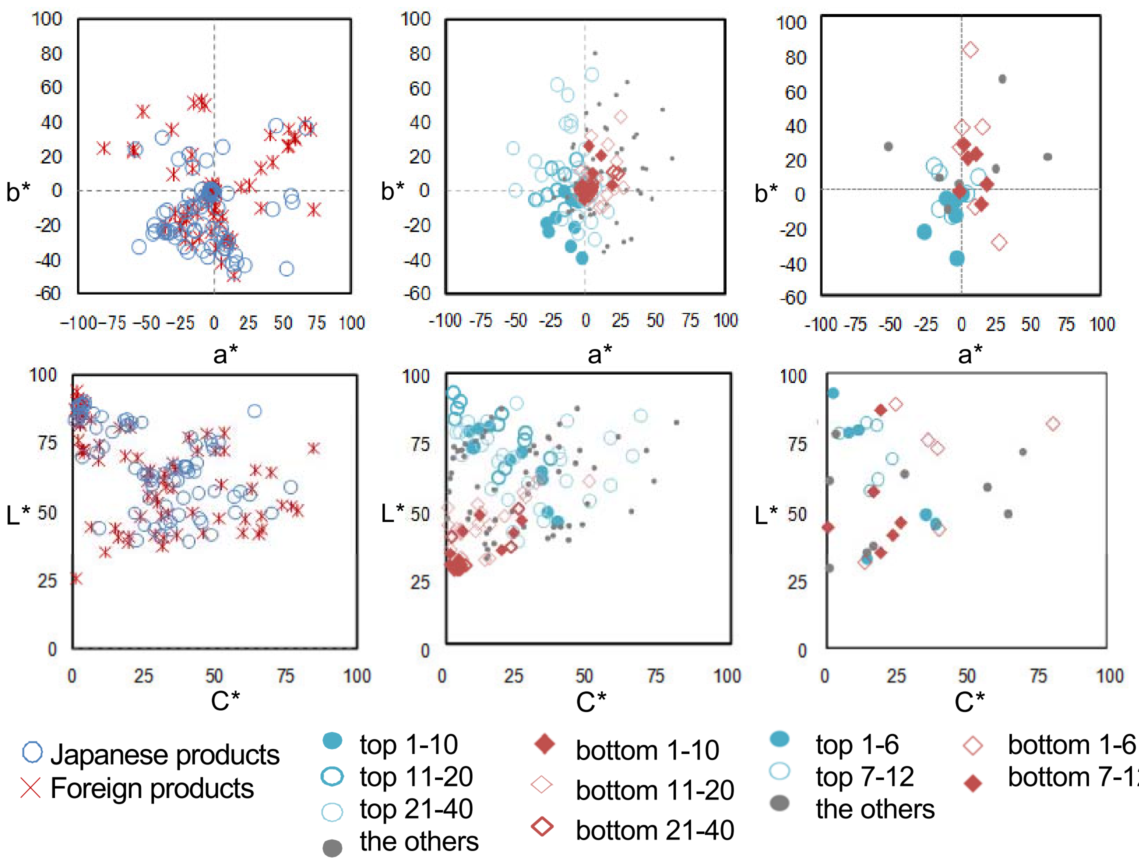

Figure 1. The label colours plotted on a-b* diagrams on the top and L*-C* diagrams on the bottom. (a) Label colours of the bottled water. (b) Suitable /unsuitable colours as a colour of bottled water. (c) Label colours give the impression of "Will not buy - Would like to buy".*

3.2 Visual assessment using a paper samples

Suitability of colours for a label of bottled water was investigated using all the 199 PCCS colour papers as samples. The size of the samples was 175 x 120 mm. The samples were presented in a viewing cabinet *Judge II* with a light source of a CIE D_{65} simulator. A seven-point semantic differential (SD) method was applied to scale the suitableness of the colours of the paper samples. A subject was asked to assign a category for each sample in terms of 'Suitableness-Unsuitableness' as a label colour of bottled water on a -3 to 3 scale; the categories were: -3: 'extremely unsuitable', -2: 'quite unsuitable', -1: 'slightly unsuitable', 0: 'neither suitable nor unsuitable', 1: 'slightly suitable', 2: 'quite suitable' and 3: 'extremely suitable'. A total of 30 Japanese university students with normal colour vision, including 15 females and 15 males, took part in the experiment. Their ages ranged from 18 to 25 years old with an average of 21.6 years. The average of the categories assigned by the subjects was used as a measure of suitableness/unsuitableness for each sample. Figure 1 (b) shows the colours of the samples with the indications of the suitableness/unsuitableness. The samples were divided into 7 groups according to their suitableness/unsuitableness; the top 1-10, the top 11-20 and the top 21-40 suitable colours; the worst 1-10, the worst 11-20 and the worst 21-40 suitable colours; the others. The result indicates that the bluish colours are found to be most suitable and the dark and less saturated colours are not suitable for a label of bottled water.

3.3 Visual assessment using a bottle samples

The impressions of the bottled water with 33 different colours of labels were evaluated. The 33 PCCS papers were used as the labels. The 33 colours were including 28 chromatic colours (7 hues x 4 tones: red, orange, yellow, green, blue green, blue and purple hue, and pale, soft, vivid and dark tones) and 5 achromatic colours (white, light grey, middle grey, dark grey and black). The size of the paper wound around a bottle was 55 x 175 mm. The samples were presented in the viewing cabinet *Judge II*. Similarly to the previous assessment using the paper samples, a seven-point SD method was applied to scale the impressions of the bottle samples. The impressions evaluated in this study (SD word pairs) are given in Table 1. A subject was asked to assign a category for each sample in terms of the impressions individually on a -3 to 3 scale. A total of 40 Japanese university students with normal colour vision, including 20 females and 20 males, took part in the experiment. Their ages ranged from 18 to 25 years old with an average of 22.3 years. The average of the categories assigned by the subjects was used as a measure of the impression for each sample. Figure 1 (c) shows the colours of the samples with the indications of the subjects' answer for the impression of "Will not buy – Would like to buy" that is purchase motivation. The samples were divided into 5 groups according to the subjects' answers; the top 1-7 and the top 17-12 colours which give the impression of "Will not buy – Would like to buy"; the worst 1-7 and the worst 17-12 colours which give the impression of "Will not buy – Would like to buy"; the others. From this assessment, it was found that the bluish colours gave the positive influence on the purchase motivation. On the other hand, the dark and less

Table 1. SD word pairs and their values between purchase motivation and the other impressions.

SD Word Pairs	r
Will not buy – Would like to buy	–
Not ecological – Ecological	0.80
Not refreshing – Refreshing	0.90
Hard to drink – Easy to drink	0.90
General – Unique	-0.76
Unhealthy – Healthy	0.80
Bad taste – Good taste	0.95
Unclean – Clean	0.91
Cheap – Expensive	-0.09
Low mineral – High mineral	0.60
Warm – Cool	0.68
Not fashionable – Fashionable	0.68

saturated colours gave negative influence on the purchase motivation. As shown in Table 1, the relationships between the purchase motivation and the other impressions were investigated in terms of the correlation coefficients, *r*. The high correlations (r > ± 0.8) are found from the impression of 'Ecological', 'Refreshing', 'Easy to drink', 'Healthy', 'Good taste' and 'Clean'. The relationship between "General–Unique" and the purchase motivation was -0.76. This means that the purchase motivation is associated with the impression of 'General' rather than that of 'Unique' and this indicates the subjects prefer general design of the label. 'Fashionable' is usually positive impression for many commercial products such as fashion items for girls and it can be considered to give purchase motivation to consumer. However, in the case of the bottled water, this impression did not show a high correlation with the purchase motivation. The colours which give the impressions 'Fashionable' and 'Unique' were the reddish colours. These results suggested that the subjects unlikely buy fashionable and unique bottled water. They prefer general bottled water.

4. CONCLUSIONS

In this study, purchase motivation for bottled water and the influence of label colours on consumers' purchase motivation and impressions were investigated. In the questionnaire survey carried out in this study, more than half of the participants answered that 'shape, design and colour of label/bottle' influenced their purchase motivation for bottled water. It suggests the importance of the package of bottled water. However, unlikely fashion items for girls, the purchase motivation of the subjects who attended the visual assessments did not related with the fashionable colours or the unique colours of the labels. They seemed to prefer to buy the general colours' bottles which were bluish colours. The bluish colours were found to be suitable for a label of bottle water and it also gave the impressions of positive feelings such as 'Ecological', 'Refreshing', 'Easy to drink', 'Healthy', 'Good taste' and 'Clean'. In fact, many commercial products have already used bluish colours. Therefore, it can be concluded that bluish colours of labels tend to sitimulate purchase motivation. Thus, they are safe to use for labels. However, if you want to design eye-catching bottled water, it would be better not to use bluish colour labels, but to use saturated redish labels which give the impressions of 'Fashionable' and 'Unique'.

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Exciting architecture for exciting food

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ABSTRACT

The consumer of the so called "evolved society" has loosened every reference with the food origin and with all the processes staying between production and goods. The nature and environment where the food come up are very far from the (super)market shelves. On them are exhibited exciting (hyper)colored objects coming from a reality re-creation planning, filling this new reality by an aesthetic (sur)plus, finalized to make fascinating and easy to buy products. The food shown here is simply a lifeless object and its watch must give pleasure. In this context the colour is strategic. But the built container, where the food goods are sold has also a big importance than products. This new heathen temple celebrating the food market, but also casket, victual warehouse, food vital spring, is strategic for our contemporary interpretation of the reality. The paper will report about this attractiveness of colour due to some contemporary architectural typologies/technologies. In this contemporariness containers, of people and goods, it take place the rite allowing everybody to get low effort food, where the great number of people exalt the sharing of fashion, of messages, of communications and of all the signal apparatus needing a specific architectonic contemporary typology. The study case area is the Verona province as "extraordinary" example distributed all over the north of the Italian peninsula, but detectable also in many European countries.

1. FIELD DELIMITATION

Inside the "Colour and Light in Architecture" research Unit of the University Iuav (Istituto Universitario di Architettura di Venezia, the original birth name) of Venice there is a group involved on the topic of the environmental and architectural effects of colour into the contemporariness. This group has made some analysis concerning the non residential buildings as innovation/change engine. In particular the study area has been delimited, only for this argument, choosing the Verona province, because of his contiguity with the most productive Italian pole, the Milan area, where usually the novelty appears first.

Secondly, the Veneto district, where Venice and Verona are located, together with others five provinces, is a continuous multi polarized built territory, without remarkable reciprocal differences, except for Belluno that is located on mountains and the small historical part of Venice that is an island. This fact allows us to consider the entire Veneto region as a unique environment, with quite similar people dialect, behaviour and built environment. Reading this territory by zenith aerial perspective it is not a surprise to see that the urban and suburban sprawl is continuous, dense and polarized where some medium or small cities appears. Some number can help our demonstration: the city of Venice has about 270.000 inhabitants, Verona 250.000, Padua 213.000, Vicenza 115.000, Treviso 82.000, Rovigo 52.000, Belluno 37.000; inside the entire Veneto district we may count approximately 4.900.000 inhabitants, on a territorial surface of 18.391 square kilometres, where 581 municipalities take place.

In this case study area the people has historically, making the built environment, followed the logic of similitude, analogy, copy as well. So, when somebody decided to introduce a novelty, specially if the changer/innovator is member of the religious apparatus, of the aristocratic or well-off class, the common people have been, and today is too, attracted to copy them. This kind of top-down innovation is obviously reinterpreted introducing a kind of low cost novelty and praxis. From here, the next phase is the creation of a lifestyle. So the houses seem little churches or small villa (so called also on the current property market). In this way all the territory, and the people involved on the everyday life reach a kind of general homogeneity. The houses are similar one to the other, the wear too and without big differences the food is quite identical, if you live in a sea or mountain country, or in a plain valley. The capillary road/railway network and the common use of private or public means of transport reduce the distances, eliminating at the same time the differences. Once a change is introduced not too many time occur to homologate all this territory. The only exceptions concerns the historical city centres, where the preserving laws are allowing a kind of make-up of the building facades, often over the limits of the good sense. In these parts of the cities we encounter often a “colour plan for the historical centre”, able to modify the face of the historical development of many city blocks, deleting the history.

This territorial homogeneity is interrupted by some interventions functional to our market driven society. A relative new architectural typology is born from when the globalisation occurred and the easy displacement comes up, creating a kind of world shrink (Marc Augé 1992). This typology is that similar to the shopping mall, or covered retail centre, but not as intended on the others side of the world. At our latitudes, where the commerce rite has a very long tradition and where the moment of the purchase is connected with an historical important function of gathering and socialization, the building displacement and appearance is strategic.

In the Veneto district this kind of buildings is capillary present. We counted an average of one every 15 kilometres, and very frequent near the seven cities mentioned (one every 5 kilometres in cities low populated, and more on the other ones).

2. EXCITING FOOD

For the Verona inhabitants, and obviously not only for them, the food comes up from some farmville, located on a beautiful green country, free of pain and pollution. The valley of this beautiful country is covered by any kind of color the nature may produce. The animals grow up very happy in a territory free of offensive smell. For that reason the milk, cheese, bacon, eggs, and so on are very good. The plants and fruits, as the animals of this fantastic territory, are very happy to die for the man taste happiness. But everybody of us knows that this is not the reality; it is very hard and completely free of this kind of fantasies.

The today consumer has loosened every reference with the real food origin and with all the processes staying between the production and the goods. Really the nature and the primary environment where the food come up are very far from the supermarket shelves. It is very hard to trace all the passages staying between the nature cycle and the consumption phase. On the market shelves are placed exciting (hyper)colored objects (products or food undiversified), coming from a reality re-creation planning, filling this new reality by an aesthetic (sur)plus, finalized to make the products fascinating and easy to buy.

When the natural color is supposed to be unwelcome the industry first, and the market after modify the food color introducing artificial coloring (chemical) substances and after with use of adequate lighting. So, in this way, the food is no more a food, but a product as well as any other industrial artifact. The food shown into the food markets or stores is a dead lifeless object, but, in the other hand its simple watch must give pleasure to the potential purchaser. In addition the food must also be beguiling, attention-getting, generate attraction and whet the appetite. From those specialists studying the human behaviour they suggest that the first impulse every animal reach is that concerned with the food eating and/or the sexual attraction. Often the two impulses are complementary. In this context the lighting and the colour of the merchandise as well as the wall container are strategic. In the same way the site where this kind of goods are exposed need to be carefully designed in order to promote wellbeing and attraction for the consumer. This is obtained by an adequate exposure of the merchandise and the recreation of an environment free of negative interferences. So the soft background music is needed, as well as the accurate study of colours. The last ones must be attractive in sense of alimentary colours: meat, milk, bread and so on. Every serious food market is divided into chromatic zones, depending on the product exposed. The light is essential on the re-creation of a good place for the exciting and happy food purchase. No external negative interference must be present, also the bad believing.

But the building where the goods/foods are in the final part of the commercial chain has big importance than the products.

3. EXCITING ARCHITECTURE

In our contemporariness we have loosened every myth, every pretext to celebrate everything outside the market/economy. That means that we don't have any time to wait our trespassing to imagine a better life. Our Paradise must be here, instantly. So no churches are needed, because those we need to be happy are the ones of the immediate personal satisfaction. We cannot wait all our life to hope on a beautiful land where to find what we loosened into that still living. So the today god is here, into every market site, new contemporary temple. This new heathen temple celebrating the food market, but not only this, casket, victual warehouse, food vital spring, is strategic for the new reality interpretation. It's a new reality because completely different from the true real one.

In this contemporariness containers, of goods and people, it take place the rite allowing everybody to get the food with low effort, where a great number of people exalt the sharing of fashion, of messages, of communications and of all the signal apparatus. This new temple needs a specific architectonic contemporary typology: malls and/or covered commercial centres, containers of not only food, but all we need to buy for our common life.

These contemporary coloured covered market centres/malls have opening and presence time-tables surely wider than every other business. So they must live by day and night, under the sunshade and the artificial lighting, they need to be easily visible and identified, because they must be easy joining, eliminating most of the obstacles present in the city, from where they moved away. The historical centre of Verona, similar to every municipality of the Veneto district, has been empowered of the historical function of public market, transferring the little commerce outside the city, into malls or commercial centres. Small food shops have been cancelled by the arrival of new commerce, tourist oriented. The shops we may find into the city centre are not for everyday food. Some supermarkets are waiting to be deleted from the city map. Except in few cases, what is concerned with the food are only restaurants, bars, pizzeria, and kebab shops.

Every city has traffic circulation and car parking problems. A mall, a supermarket, or a generic commercial centre must be free of this kind of problems. It need to be exciting, have friendly appearance, familiar, pleasant, at most banal, a building in which bowels everybody feel well. It must be market pull or marked driven oriented, for everybody tranquility. So the external color of these sites need to have dramatic visibility from far away, to be a people/consumer/user attracting pole, and the interiors need to be a magnet from which you cannot detach, capturing bodies and spirits, driving you along the business designed roads. Temperature and humidity are artificially controlled, in the way that is better to go inside there than stay at home. Into the bowels of these buildings you may find in winter a fantastic warm and in summer a priceless cold. The color used inside is prevalently that of the food, or nature simulating, at most fantastic.

They need to be easily identified from far away, so they cannot be high, but prefer some distinctive element higher than the building, normally divided in no more than two stairs, easily accessible without fatigue. So, mobile stairs or tapis roulants are always present.

The attractiveness of colour is warranted by some contemporary technologies that are showed externally and inside this kind of buildings. Without analyzing the indoor, the outdoor of the commercial centres/malls present in Verona, as clarified to be only a study case area replicable in all the Veneto district, has the skin treated with technologies that need to show no technological innovation (also if hardly introduced), what is happening in many international famous cases where architects of the star system designed original and strange containers. Here the originality is not part of the common people. These buildings must appear similar one to the other, with the introduction of some distinctive elements, which sometimes may be the colour. Normally the chromatic selection is done exposing the material of the enclosure. Usually the external walls are not paint, showing the prefabricated panel's substances or a false brick cladding. So the colours are usually: brick red, what the people living into this part of the word like a lot, or the colour of the concrete prefabricated panels, usually reddish, greenish or concrete grey.

What is of a little interest is the fact that all those buildings are highlighted outdoor. The necessity of night lighting is due for security reasons first, but also to attract potential purchasers. The security lighting is normally obtained by white, high potency lamps, switched on automatically at the sunset. Often, complementary to this lighting, a coloured lighting system give to the night building profile a kind of second nocturnal life. Depending on the seasons and on the local celebrations/festivities/holidays this illumination is variable. The coloured lighting is low tech, compared to the contemporary lighting technologies, but of some fascination. A will to stay in line with the rapid change of our contemporariness is influencing the external spaces where timidly some videowall are starting to be shown over some structures located near the entrances or the access roads. So this kind of buildings, silently, are day by day modifying the people way of life, that consider exciting only what concerns with an easy food purchasing in parallel with the direct confrontation with other consumers. Even the clothing of this people is congruent with a complete loss of indigenous traditions. Here, the contemporariness is novelty disguised by tradition and there is no space for the real change. The people mind is not opened to changes, preferring a reinterpretation of the unknown local history.

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Home sweet home: Is the gingerbread house in Palermo Viejo?

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ABSTRACT

The gingerbread house from the fairy tale *Hansel and Gretel* by the Brothers Grimm and the colours of this symbolic object served as the starting point to the current study. Thus, its palette of fantasy, seduction and edible architecture was established, based on the analysis of several illustrations.

The next step was to move from the fantasy to the reality of Palermo Viejo - Buenos Aires. After Argentina's 2001 economic crisis, Palermo Viejo responded by transforming itself from a residential neighbourhood to a commercial one, brimming with designer shops and restaurants. A significant change of colour accompanied this change of use. Building façades became brighter, and more colourful, resulting in a very attractive destination, akin to the gingerbread house. Therefore, field research was carried out in 2009 to determine the current palette of this neighbourhood, by applying the methods of J. P. Lenclos.

Comparing the two palettes, (both in the NCS system), similarities emerged and the combination of both suggests a new palette, able to generate a sense of attraction. Ultimately, this study raises a further question: could this combined palette translate the emotion of the Home Sweet Home metaphor into reality, and induce a feeling of familiarity?

1. INTRODUCTION

The gingerbread house is the witch's home, located in the middle of the forest in Brothers Grimm's *Hansel and Gretel*. Symbolically, this fairy tale house emerged throughout time as an image of the fulfilment of human desires, a metaphor not only of the satisfaction of hunger but of human needs in general (Bettlehaim 1976). Built with gingerbread instead of bricks, and decorated with all sorts of coloured candies and cream underlining the elements of the architectural façade, it is an attractive feast for adults as well as for children.

This fantastic edible house has been a source of inspiration in architecture. *Hansel and Gretel* is the common name given to the provincial revivalism architectural style, popularized in the 1920's in England and America. Examples can be found in Oakland California and on the *Storybook house* by Richey & Karen Morgan, located in Olalla, Washington (built in the 1980's).

In all the examples mentioned above, the houses were coloured and shaped like the gingerbread house from the beginning. Something entirely different happened in Palermo Viejo. In a period of ten years, Palermo Viejo, which the locals once referred to as part of a grey city (Lacarrieu and Albuquerque 2007), changed into a colourful neighbourhood of Buenos Aires. The similarity between the gingerbread house and Palermo Viejo is mainly the colour appearance of the traditional one-floor buildings.

1.1 Palermo Viejo

Settled in the beginning of the last century, Palemo Viejo is nowadays one of the most popular and fashionable neighbourhoods of Buenos Aires. As an answer to the crisis of 2001, many designers, and architects, attracted by the low renting price of an aged area, started to set up business and open up shops, giving a new look to the façades. Following this trend many bars and restaurants also established in the vicinity.

The traditional architecture of the area is the "caza chorizo", one floor building, with a European architectural influence, and, in some instances, decorated with art nouveau style. Over time the new current architecture spread over the area but the traditional architecture is still very present and where older buildings were rebuilt, these interventions did not damage the urban coherence of the neighbourhood (Varela 2003).

The original façades were covered by a stucco of crushed stone and cement, imitating the appearance of stone in a technique called *simil-piedra*. Not without controversy, the façades are losing this worn pastel surface (nowadays more grey due to pollution), to receive a new skin made of more saturated hues.

2. METHODOLOGY

The palette of Palermo Viejo was set up, based on a chromatic field survey, done in 2009, in a project hosted by the Argentinean Colour Group. In this survey the colours of 264 facades were identified, using the method of Lenclos (2004) by comparing the samples of colour cards noted in the Natural Colour System (NCS) with the colours of each façade. The present palette was constructed using the more frequently identified colours.

In order to establish the palette of the gingerbread house, 35 illustrations of books, websites, one painting, CD's and record covers were collected, mainly from the internet. The pictures of these houses were cut from the illustrations and analysed individually by Photoshop and Image Analyser, a program that quantifies the average percentage of each colour in a given image (Fernandes and Durão 2008), to produce a palette for each illustration. The similar colours from all the palettes were then aggregated to produce a unified colour base. In the gingerbread house palettes, due to their relevant differences, the main colours of the façade were distinguished from those used in decorative elements. The NCS notation of the gingerbread house palette was achieved by attributing to each RGB code, the closest NCS code from the Atlas.

The two palettes were compared taking into account the classes of saturation (bright, intermediate, saturated, dark), and the fundamental hues of the NCS system (red, yellow, green, and blue).

3. RESULTS

Based on the results obtained from the studies previously described, it is now possible to compare the two palettes (Table 1). In Palermo Viejo there is a larger presence of bright colours (25/45), followed by intermediate colours (13/45). The brighter colours are all in a very low saturation (between 05-05 and 10-20, NCS notation). The most present hues are yellows (42%), and reds (27%), and it should be noted that the saturated colours are merely red hues. Considering all the different classes of saturation, it is possible to find different colours in all classes of hues. There is no distinction between the palette of the main colour used on the façade and the palette of the colours used on decorative elements.

In terms of saturation and brightness, in the gingerbread house palette there is a marginal dominance of colours of the intermediate class (23/67), over colours of the bright class (20/67). The saturation of the colours of the bright class is equally distributed, and consequently the bright colours of this palette are a little more saturated and dark than those found in Palermo Viejo. In the same way there is a stronger presence of warm colours (browns, yellows, reds, and oranges), especially due to the intermediate hues used on the biggest part of the façades. Due to the colours of the architectonic elements on the houses of the illustrations, in the end, the palette of the gingerbread house covers all the range of the commonly named primary and secondary hues.

Table 1. Combined Palette. Colours of the palettes of Palermo Viejo and of Gingerbread house.

COMBINED PALETTE	**Colour codes noted in the Natural Colour System**
Palette of Palermo Viejo	
façade and decorative elements	
S0505-R; S0530-R; S0510-Y30R; S1002-Y50R; S0520Y90R; S0502-R50B; S1002-G; S1002-G50Y; S1005-Y; S1005-Y10R; S1020-Y10R; S1010-Y20R; S1010Y30R; S1005-R70B; S1002-B; S2502-Y; S2010-Y30R; S2005-Y40R; S4005-Y80R; S3010-R90B; S2005-B20G; S2020-G90Y; S3010-Y10R; S2020Y40R; S4000-N; S1040-Y40R; S1040-B50G; S1050-B50G; S2040-Y10R; S2050-Y20R; S3040-Y80R; S3050-Y90R; S3050-R50B; S3050-B; S3020-G30Y; S3020-G70Y; S4020-Y70R; S4040-R30B; S2070-Y80R; S2070-Y90R; S2060-R; S5010-Y50R; S6502-B; S7010-Y50R; S7000-N	
Palette of Gingerbread house	
façade	
S0502-R; S0530-R50B; S0520-G90Y; S1010-Y10R; S1020-R; S0510-B; S1030-B90G; S2020-G90Y; S2005-Y90R; S3010-R70B; S3010-R80B; S2010-B90G; S1040-Y20R; S2030-Y30R; S2030-Y50R; S2040-Y70R; S2030-G90Y; S2050-G90Y; S3020-Y40R; S4040-Y60R; S4040-B90G; S4020-G50Y; S3030-G70Y; S4040-Y40R; S4040-Y70R; S3040-R10B; S1080-Y; S1080-Y20R; S1070-R; S3060-R70B; S2070-Y20R; S2070-R; S3060-Y90R; S6010-Y70R; S7020-G50Y; S7020-Y90R; S7010-G90Y	
decorative elements	
S1005-Y40R; S1020-R10B; S1010-R30B; S0530-R80B; S1030-B90G; S0530-G40Y; S2020-Y60R; S2020-Y80R; S3010-R80B; S0550-Y; S1040-Y20R-S1050-R40B; S1040-R90B; S1040-G30Y; S2050-R90B; S2040-B10G; S2050-G90Y; S3050-R10Y, S3050-R50B; S4050-R40B; S1070-Y20R; S1070-Y50R; S1060-G30Y; S2060-Y60R; S2070-R; S2060-R10B; S2055-B10G; S3060-Y30R; S3055-R50B; S4040-G30Y; S5030-B30G; S6010-Y70R; S6030-R90B; S6010-G10Y	

Studying the contemporary palette of Palermo Viejo, and comparing it with the resulting palette of the illustrations of the gingerbread houses, a palette based on the attractiveness of a real palette and on the poetic imagery from *Hansel and Gretel* can be suggested. This new combined palette is generated by the addition of the colour codes of each of the studied palettes (Table 1).

4. CONCLUSION

The palettes of Palermo Viejo and of the fairy tale gingerbread house have been established. The Palermo Viejo palette is apparently less varied in terms of hues than the gingerbread house palette. However, the present palette is still changing and more contamination of colours can be expected to take place as more shops are restored. Even though the Palermo Viejo renovation is neither ruled by any colour plan, nor is a concept of just one architect, some of the contemporary colours introduced by the restorations reveal similarities with the palette of the gingerbread house.

Based on the palettes initially established, the creation of a combined palette was envisioned. The combined palette corresponds mainly to a large use of the intermediate class of colours, and of all kind of hues, with dominance of yellows, reds, and oranges. The use of different colours for decorative elements of the façade, chosen from among a wide number of hues and varied brightness, might lead to a wider visual diversity and rhythm (Mikellides 1980), as can already be witnessed today in Palermo Viejo.

Even though no further studies or applications have been carried out thus far, the combined palette raises some questions. Bearing in mind the power of metaphors and that human thought is metaphor-driven, which in turn affects the way we perceive reality (Casasanto 2008), could a gingerbread house be an acceptable image for the metaphor *home sweet home*? Can we improve the sense not only of attraction but also of familiarity (Küller, in Mikellides 1980) by the use of this combined palette? Are they simply the most attractive colours in every culture? Do they also correspond to the most attractive colours of real food? Could there be cause and effect at play with the palette of children's book illustrations affecting how we perceive the attractiveness of colours as adults? The combined palette raises many questions for further research.

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Food's domestic enviroment, its evolution and trends

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INTRODUCTION

Since the beginning of mankind, spaces related with dealing with food such as collecting, preparation, and eating spaces, have been changing, always related, some way or another, with nature.

The first nomads, had nature as their environment: mountains, valleys, rivers, oceans (Figure 1).

When they needed shelter, these constructions were made of natural materials, such as stone, leather and vegetation (Figure 2).

Colour came to life when man evolved from eating raw food to cooking it with fire. It is around this element that most of their significant gatherings took place (rituals, feasting, etc.).

With civilization, as buildings became solid structures, heat-resistant surfaces and easy-cleaning materials became part of meal's preparation, creating spaces with different colours, all related to nature: black, brown, red, brick-red (Figure 3).

Colours in eating and cooking environments change during centuries 16 to 19 (Figures 4-5). Surfaces that allow easy cleaning and maintenance, such as ceramics, were preferred over other materials, traditionally used. White and blue establish and are actually used (Figures 6-8).

Colour explosion occurs in the 20th century. From then on, fashion dictates what used to be the result of eating and cooking function. Both activities either remain tightly bond, or develop on independent spaces, depending on the socioeconomic and cultural context.

Last century is when colour institutes all around the world begin it's work, orientating and directing us,

Colour and trend in two centuries of Argentinean history. Nowaday's forecasts, where are we headed?

BLUE- FROM THE EAST TO AMERICA

Color blue was originally used for glazed-tiles, in temples and palaces all over the East, and so it reaches Spain through the Arabs, to take part of domestic environments. Maiolica expands rapidly all through Europe (Figures 9-10).

It was used in Argentina, during 1990, combined successfully with natural, selling well (Figure 11), and in the last years, a coating was manufactured, based on a Turkish tile design (Figures 12-13).

20th CENTURY

Wood stoves (Figures 14-15) made of black iron, started to be replaced by gas stoves, (fig16), and cooking environments consisted in tiles brought from Europe, white and blue, both iridescent and in pastels (Figures 17-19).

In 1950, white surfaces in walls, countertops and cooking artifacts (Figures 20-22).

In 1952, Cerámica San Lorenzo establishes in Argentina (Fig. 23), the first big kitchen revetment factory. The 15 × 15 tile predominate in those environments since then, until the eighties.

The ’60 and ’70 decades bring brilliant colors (Figures 24-26), and during the eighties, traditional collections are developed, with absolute domain of neutrals, beige, and in flooring the Cotto, imitating the color of red ceramics (the Tuscan cotto) (Figures 27-29). Primary colors lighted up kitchens, with brilliant surfaces and floral and pottery motives (Figure 30).

Work with Color Associations begin, and forecasts.

During the nineties, globalization and communications lead us to a variety of designs and colors (Figures 31-37).

COTTO, RED CERAMICS

Color in eating and cooking environments was, since the beginning of mankind, that of a reddish earth, until middle ages; it comes back cyclically as a return to the origins, in every food environment. Family gathers around the presence of fire and life (Figures 38-40).

MOSAICS

They were quite popular during the Roman Empire, and Byzantium, and remain until today, in the beginning of the 20th century. We can find them in great Buenos Aires palaces, and in housing; it is the actual trend, made in marble, ceramic or glass (Figures 41-46).

21st CENTURY

A new century is like being reborn, and is represented in simple designs, light colors, bright surroundings and few elements (Figure 47).

The general idea is to go back to the source, eat in direct contact with nature, or contemplating it (Figures 48-52).

The materials chosen are great dimensioned porcellanatos, natural stone, steel and glass.

The trend is to minimize spaces, use neutral colors or white, and brilliant or glazed surfaces (Figures 53-60).

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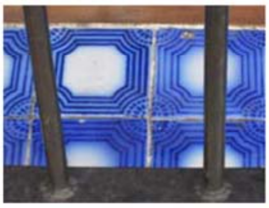
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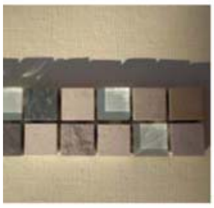
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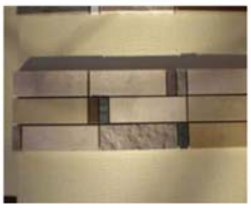
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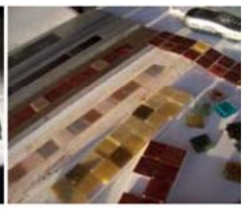
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From garden conscious to color conscious: The rise of the suburban food garden

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Fashion Designer

ABSTRACT

Increased popularity of the organic food garden is mainly due to a declining economy. The suburban sector is leading the personal food garden movement. The experience of growing food brings color awareness. Garden commonalities are color ideas for a new garden generation. Introduced plastics create directional color combinations through gardening practices. Biodynamic gardening can lead to inner thinking and cosmic connections. Food color entertains daily life outside the garden. The current food garden renewal reflects historical color references.

1. INTRODUCTION

Creating an organic food garden at my family's home inspired several of my contributions to the Color Association of the United States. Research finds that the popularity of growing a personal food garden is increasing yearly, as are sales of gardening supplies like seed companies. The status change of food gardening from hobby to mainstream activity can be attributed to several converging factors. They include the obsession with weight and health, the political and social green movement, and especially, the fear of the declining and worsening economy (Pollan 2010). The dissemination of information through gardening websites and blogs has also made the food garden relevant to our time. As people become more garden-conscious they become more color-conscious and this review and update of food garden colors, sourced from three distinct settings, attempts to create awareness useful in marketing and designing for these garden customers.

2. GARDEN SECTORS

The food garden is traditional in the rural landscape where the lifestyle is still tied to the outdoors and accustomed to working the land. A new influence here are the surrounding organic or biodynamic, small to medium sized farms which participate in the 'eat and buy local' movement. These areas have low economic growth and its population, thrifty and thoughtful in their spending habits, tends to buy in cash consequently having low to no credit debt. Food gardening has a sense of isolation in the countryside but now residents can connect to society and share gardening experiences through the Internet.

The urban setting may seem an unlikely place for food gardens but it's actually the forefront of an important gardening movement organized by social activists. They establish community gardens in reclaimed empty lots and abandoned land to eliminate urban blight and feed the inner-city poor. City dwellers with higher income practice container gardening on apartment terraces and building rooftops. Sophisticated and savvy to the most current or experimental ideas in green choices they will try and test them in their urban home context or at their weekend retreat.

But the place of the moment for the personal food garden is in the suburban yard. Iconic in the American tableau the relevance of the lawn is in question by environmental and social issues. While most food gardens are relegated to the backyard there is a radical faction of growers that advocates front yard gardening (Haeg). Here, the food garden takes a dominant position that demands visual attention and overthrows the conventionalism of the middleclass esthetics that favors lawns and flowering plants. Food gardens in themselves send a message to the neighborhood that behaviors and attitudes are changing. As a new integration occurs we witness the rise of the suburban food garden.

3. COLOR AWARENESS THROUGH GARDEN PRACTICES

The foremost maintenance duty to garden organically is to establish a compost pile. Compost enhances the soil with texture and nutrients, feeds the microbes and beneficial organisms that make soil alive, strengthens the plant to combat disease, and eliminates the use of harmful chemical fertilizes. Because composting is also promoted as an activity of recycling, a growing market exists for manufactured plastic composters (Bounds 2009) that add industrial color alongside the organic color of decaying layers that sustain growing food.

With the soil properly prepared it is ready to receive the seeds. An advantage of the home food garden is the freedom to plant heirloom varieties and allow them to fully ripen on the plant unlike the commercial practice of prematurely picking generic hybrids and genetically modified types to ship long distances. The organic food movement and specialized seed catalogues have revived these old strains of foods that offer greater flavor sensations and present more visual excitement from their unusual and exotic heirloom color.

In a chemical free organic garden fencing and netting are essential to protect against the devastation of invading animals and insects and to provide against the elements as sunshades, windscreens and climbing supports. These garden fabrics of recycled plastic are pliable non-woven grids for surrounding vegetable plants or flexible fiber mesh for stretching over fruit trees and berry bushes. Food color maturing behind these fortifying opaque or translucent geometric patterns, in a sense, becomes stronger through contrast.

Home canning extends the sustainable garden through the winter and eliminates food concerns about BPA contamination by the use of glass jars. Above average sales of pressure cookers indicates more home canning, exposing gardeners to the unfamiliar color produced by this process. Since commercially canned food is artificially dyed to keep color visually appetizing (FDA 2010), knowing the health benefits of home canned food, which naturally dulls or discolors, helps adjust to its old-fashioned appearance in our modern diet.

Food gardening can awaken an inner calling to the rhythms of nature and lead to the spiritual science of the philosopher Rudolf Steiner. His 1924 seminal book *Agriculture*, in which he blends the best of an older peasant consciousness with a newer one sets precedent for the biodynamic methodology (Steiner 1993). Much attention is given to its seemingly strange but effective dynamic techniques such as burying cow horns, brewing manure teas, and following moon phases. This 'super organic' farming has been widely adopted by the wine industry helping to legitimize the methods to the broader audience of home gardeners (Asimov 2007). Steiner's theory that color emerges into form indicates that planet forces enter growing food expressed as color. In these teachings and ponderings food color is a mystical experience.

Watching the affects of the weather on the garden and observing the life cycle in plant growth, decay, and rebirth, brings shared understanding to every gardener of the challenges and rewards in working with nature. Recognizing commonalities in gardening practices brings insight to how color becomes associated with groups and periods. As standouts in this gardening time, plastic gardening tools and accessories juxtaposed with organic gardening methods create amalgams in unexpected color combinations. Food garden commonalities across time periods show food color expressions becoming richly layered and sophisticated (Figure 1).

Figure 1. Evolution of color sophistication in food garden.

4. FOOD GARDEN INFLUENCE IN POPULAR CULTURE

Popular culture promotes and develops the awareness of the non-gardener to organic food, color, and ideas, thereby bringing them into the food movement. A real experience with food color is dining-out where cutting edge chefs go straight to their private food gardens to directly supply their organic restaurants. They offer patrons artfully prepared meals that excite eye and taste in upscale décors decorated in a garden mind-set of food color (Blue Hill Farm). At home, food networks and television cooking shows are some of the most watched and enjoyed programming. Some television personalities even try to influence our food attitudes and eating behaviors in order to start a food revolution using food color to incite real action (Oliver 2010). For leisure, print media offers the imagination the hyper-real ideas of food styling and fashion editorials. Magazines feature the food garden as a backdrop theme to express interpretations of designer clothing using photographers who exploit color to reflect idealized notions of the food movement (Walker 2009). In the process of promoting fashion, garden color is documented through the seasons and years, and is glamorized for this day and age. In all of these incidents outside of the garden, food color entertainments.

5. CONCLUSION: HISTORICAL CONTEXT

The power of the gardening suburbanite is the ability to trigger mirror action in their neighbors causing an exponential increase in the popularity of food gardening (Ramachandran 2010). This surge is anticipated by an experimental retail concept, the boutique-nursery, already catering to the suburban gardening lifestyle by promoting it with a stylish image (Shop Terrain). However, all gardeners attuned to the nuances of the ripening food garden experience contribute a color sense of refreshed traditional, updated heirlooms, and directional plastics to this gardening movement in history.

Past gardening eras are defined by unifying themes such as war in the early 1940s or recession in the late 1970s while this gardening movement of the 2010s, driven by heightened awareness from multiple cultural inputs, is still unassociated with one particular factor. Presently, similar past issues of war and recession exist and coincidently, color examples from the 1940s and 1970s appear in our current color range, as if a sum of two pasts. Evolution of color preference represents the way color is thought about, realized in how past eras regard color as ‘solo’ and ‘tonal’ while this era references color in ‘combinations’ and ‘layers’. Also, color is considered season-less, no longer separated into the appropriate spring ‘lights’ and fall ‘darks’ of the past. Where color, like society, was once simple and plain, it is now complex and sophisticated (Figure 2).

Figure 2. Historical food garden eras.

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The use of color in a fishermen's village. Case study: "San Pedro Pescador" neighborhood, Antequeras, Chaco, Argentina

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The main objective of this research is to study the use of environmental color in the houses of "San Pedro Pescador" neighborhood, in Antequera, in the province of Chaco. The aim is to improve the living standards of its dwellers, who are mainly fishermen, by suggesting a visual identification of the neighborhood through color so as to make it a touristic attraction.

The secondary objectives of this research are the following:

- To identify the use of color in buildings, boats and the immediate surroundings.
- To verify the use of colors in their houses (palettes, harmony, combinations and contrasts according to the socio-cultural actors)
- To study the relationship between the culture of a group of people who are engaged in the same activity and its system of symbols as regards color

This topic is of interest since the characteristics, qualities and properties of the materials of the building envelope are of great importance in the peculiarities of the architectural space and its limits; besides, the color, the texture and their articulations are also important to the neighborhood dwellers' perceptions as regards their living standards. In this case, this interest has been fostered by the relationship developed between the fishermen and the university students and instructors.

San Pedro Pescador, placed on the coastal mound of earth of Paraná River, is a neighborhood located at Paraje Antequera (in the province of Chaco) which is on the left side of the interprovincial bridge that joins the provinces of Chaco and Corrientes. Fishing is the main activity and source of living of its dwellers.

The first stage of the research entails working in the neighborhood considering the morphology and urban image in the geographic, social and economic context of Gran Resistencia and its surroundings.

The study of the relationship between the neighborhood dwellers and the use of color in their houses and boats is aimed at highlighting the presence of this fishermen's neighborhood to the inhabitants of the two nearby capital cities: Resistencia and Corrientes, and to turn them into regular visitors of the neighborhood either to buy fish at the stalls or to eat fish at small restaurants to be placed there.

The use of color- as in Vuelta de Rocha or Caminito at La Boca neighborhood- taking into account the differences and characteristics of this case study, implies making this neighborhood a touristic attraction by means of the use of color on the facades, in the urban signs and in the fish stalls.

This research, which started in 2009, has been carried out by instructors and students of the 5th Architecture Workshop from the school of Architecture and Urbanism at UNNE and the theme is "The Optimization of Environmental Resources for the Urban, Productive, Touristic and Recreational Development of San Pedro Pescador Neighborhood – Colonia Benitez Municipality, Chaco". This research has been supported of the fishermen of ASOPECHA

Union, Asociación de Pescadores del Chaco and it has also received the assistance of the "Encuentro por la Vida, Cultura y Democracia Ambiental" foundation.

Figure 1

Figure 2

In the surveys that have been carried out since that date (see Figures 1 and 2) the chromatic simplicity of the boats which were painted with a palette of brilliant colors could be observed. Although the aim was to protect the wood from the deterioration produced by water, they show a spontaneous sense of identity that it is worth taking into consideration.

Figure 3

Figure 4

The street signs would include the name of fish species from the rivers of the region and their pictures (see Figure 5) which are well known by the fishermen but which are unknown by most city dwellers.

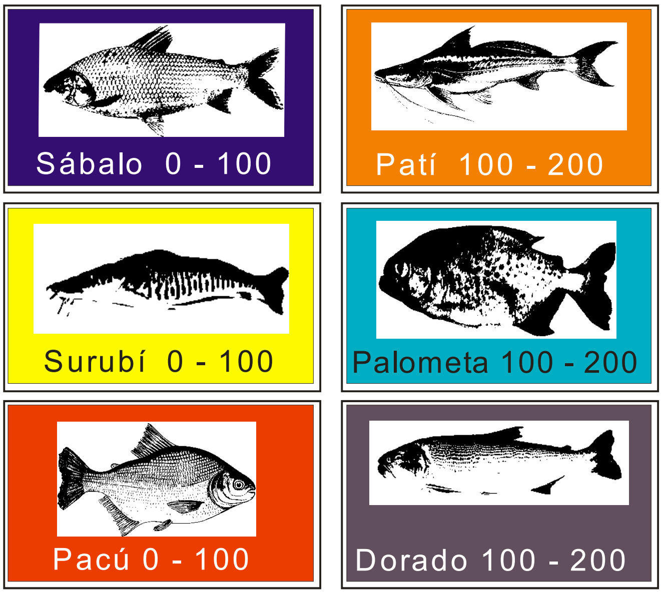


Figure 5. Street signs suggested for the neighborhood.

The survey grids designed to collect information related to the color of the buildings in the neighborhood are shown in Figure 6.

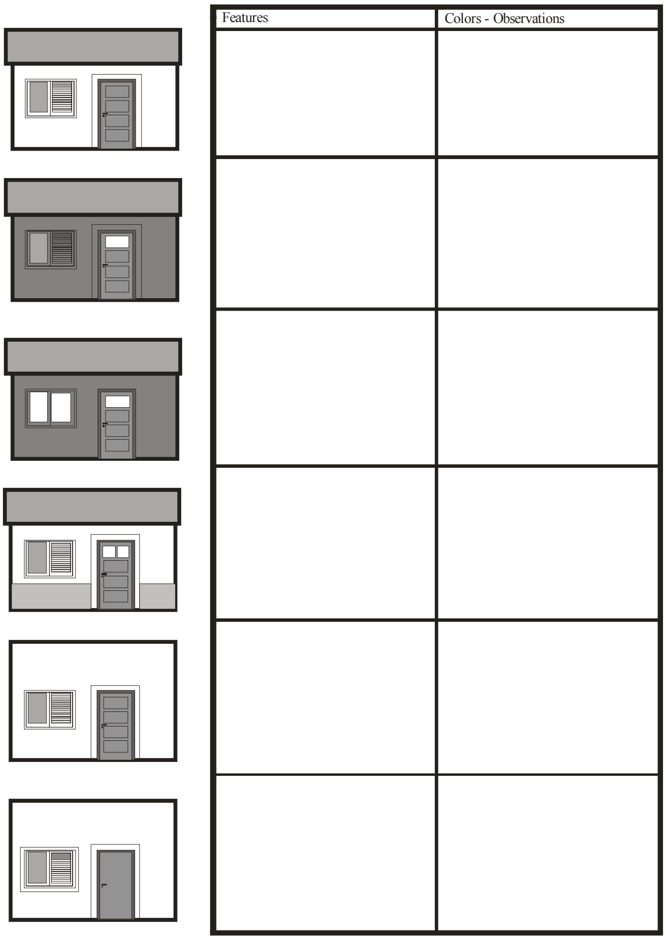
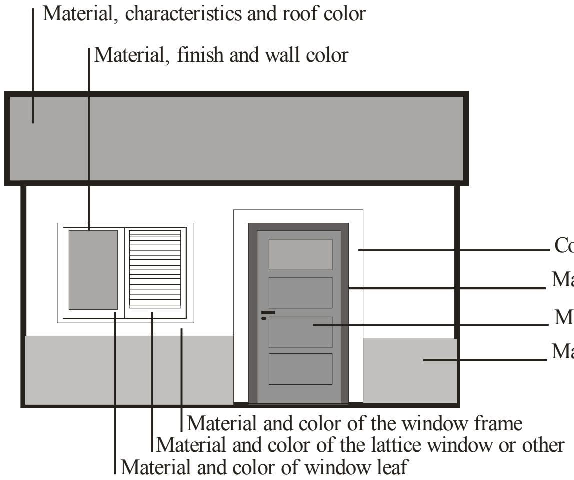


Figure 6. Buildings color survey grids.

Likewise, it is expected that the owners would accept to establish some kind of relationship between the colors of their boats and houses (see Figure 7).



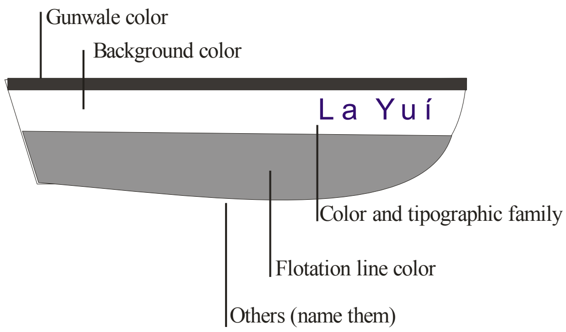


Figure 7. Comparative survey between the colors of the houses and boats.

The first stage of “The Optimization of Environmental Resources for the Urban, Productive, Touristic and Recreational Development of San Pedro Pescador Neighborhood – Colonia Benitez Municipality, Chaco” has been fulfilled and the results have been given to the fishermen of ASOPECHA Union. The upcoming stages in order to comply with the initial project have been also planned during some work meetings.

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Food design: Perception of color and polysensoriality. Color and taste

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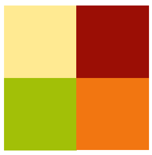
The aim of this paper is to create a bridge among the many perceptual studies of color and polysensoriality referred to food design. In the last decade food acquired a position of absolute centrality in Western society: more than ever we speak of food not only in relation to nutrition but also as a social, cultural, ethic, environmental and political fact. Food culture has permeated countless fields: from general and specialized edition of books to the birth of schools of gastronomy and didactical programs linked to nutrition science, from the plentiful of TV programs dedicated to food to the celebration of the figure of the chef as a true guru of modern life, from the birth of food design as a discipline to the presence of alternative networks of consumption such as slow food, or the discovery and spreading of modalities of feeding from other countries at a massive level. This relevant position of food as an object in our culture produces also perceptible effects in the physical environment in which we live. The logic of food production in all phases of its vital cycle, from crop growing to elimination, transforms the space, modify the landscape, create new modalities of use, model new spatial configurations and induce new perceptions of the environment. The fact is that food is of interest to many disciplines: agricultural sciences, biology, nutrition, production and distribution, and also graphic and industrial design, architecture, urbanism and landscape.



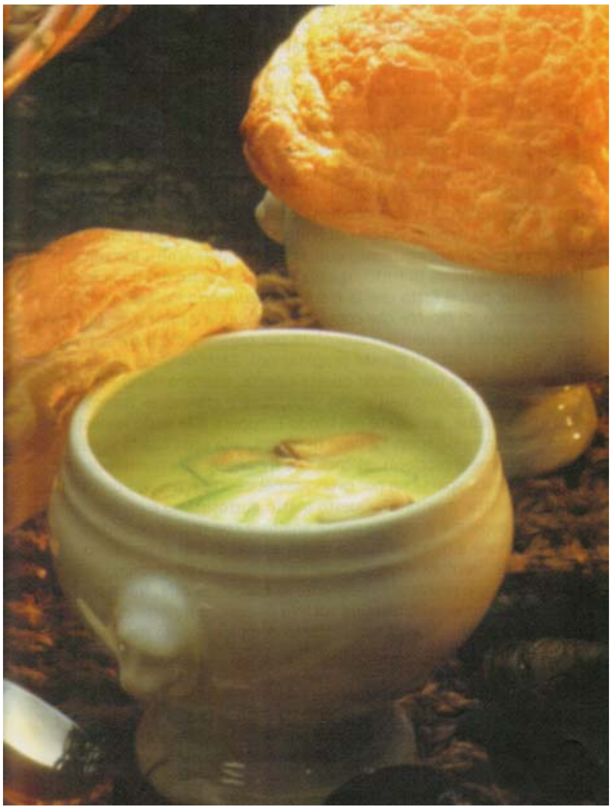
The pattern of a pasta dish combined with vegetables. Its colors transmit energy. The view in this case is the sense that gives way to a polysensorial evaluation.

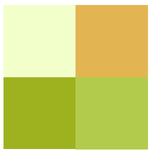
While the studies about perception in general are based upon solid grounds since two centuries, and are conducted scientifically, privileging mainly the architectural, scenic and dwelling environments, the urban environment as well as fashion, products and advertising, food design is still a new and rather unexplored discipline. Also, the problem of color in the presentation of food and in all its sensorial aspects, while being of utmost importance in daily life, has not been sufficiently considered, even when its importance has been recognized by psychologists, nutritionists, dietitians and agricultural scientists.

This situation is changing, with the tendency of developing a new field of research that simultaneously with color laboratories satisfies the gap that has been created, carrying out in a scientific and methodological way the analysis that relates color and food in a polysensorial level. Colour, always associated to taste, is an issue of paramount importance in the massive food marketing.

The meaning of colours changes in some countries, and that's why colour preference varies in our consumption according to the different latitudes. In England, for example, people prefer green apples; Americans and Italian, the red ones. In Western India people buy bananas when they are ripe, of a dark brown colour whilst in Europe, they do so when they are yellow.

Canned beans sold in France are of a greenish grey colour, while English people only buy them if seen green. In Denmark, people not only prefer them green, but they want the preservative liquid to be of the same colour.





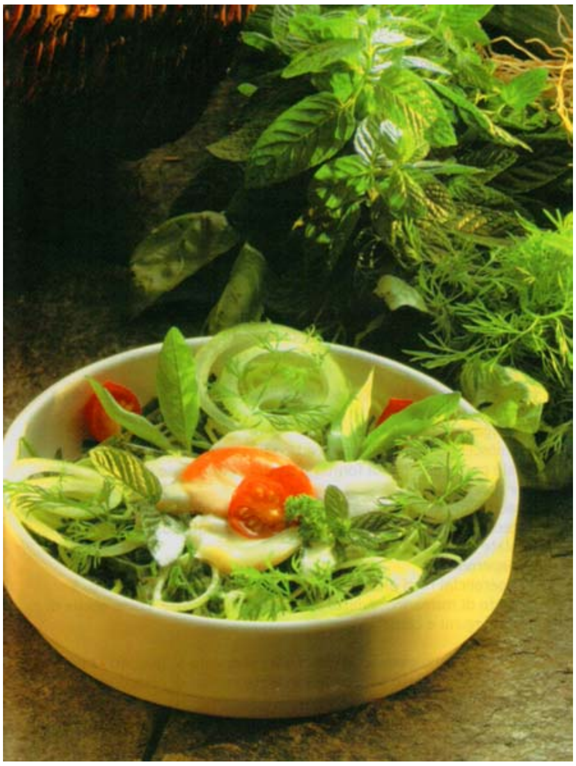
The pattern of color in this vegetable soup, the pale green and the brownish of bread and other ingredients evoke tradition and transmit a lightness sensation.

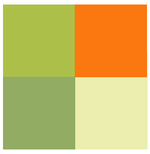
These colour conditions initiated as from a culture acquired during childhood, can be modified through a continuos and determined education explaining the necessary balance between what is healthy and what is bright and colourful. In view that visual perception, associated to taste perception, helps to enjoy food, every people show similar features when prefering very colourful food. The children's answer to colour in food is not conditioned as in the case of adults, and that's why children can consume food without paying attention to the colour; whilst in the case of adults, they can flatly reject food when facing a strange colour. If we offer a cedron flavoured orange beverage to children and adults, both of them will believe they are drinking orange juice. Moreover, for the urban consumer the colour is a symbol of freshness.

There are certain exceptions to this rule, such as the white mold accumulation of some cold meats and sausages, fermented cheeses, etc. The greenish blue colour causes distrust in matured food as it is associated to fungus formation, which in fact speaks about a good age of certain cold meats and sausages; while in the case of non-industrialized products, it can be associated to toxic food.

This cultural conception can be so decisive that several people even reject the possibility to taste certain food, and even less, if it looks blue or if it is not clearly associated to a certain origin (blueberries, fermented cheeses, etc.). Balsamic sweets are an often exception, maybe because they are linked to medicine.

The yogurt industry is trying to modify that trend flavoring their products with berries, which natural colour goes from blue to violet. In this case, if not artificially coloured they would not look attractive.





Pattern of a green salad. Freshness is the main sensation that we try reinforced by its light colors. With just a simple glance, lightness and a crunchy and sour taste is experienced.

Although there is black food in nature, the "black" recipes are not welcomed as tasteful specially if not of an industrial origin, specially in Italy, which has a strong cooking tradition.

On the contrary, in Japan and South America, where black beans can be found, as well as squid ink dishes and certain algae, the black colour is well accepted and is commercialized without inconveniences.

Dishes such as Brasilian feixoada, the Japanese mobi, the Caspian caviar and sepia rice and pasta in Italy, are examples of clear acceptance, even in restaurants recognized due to their lack of industrial processes; their chefs being the ones who balance recipes to reach both attractive to sight and tasteful dishes.

This considerations lead to the demand to understand that there exists a fair relationship between the food perceived and real colour, associating the colour to the expected flavour.

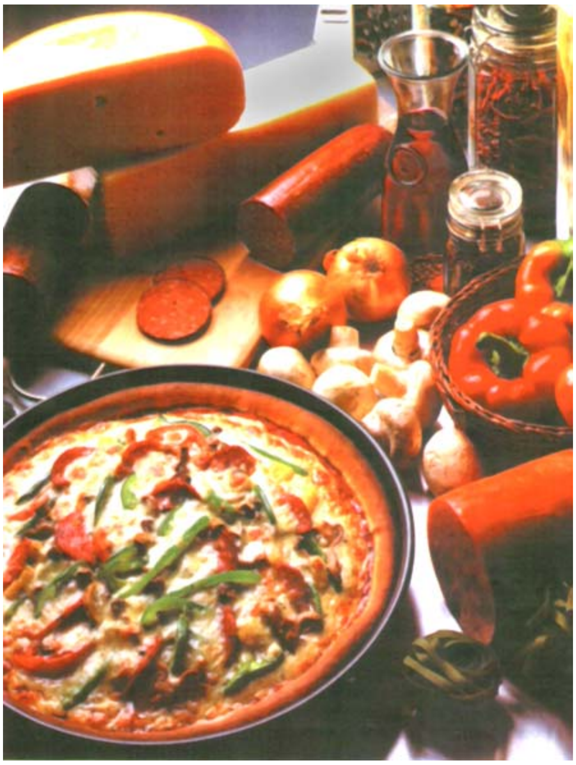
In the origin of times the logical period between the harvest and consumption was simple because the colour was useful –in principle– to distinguish between healthy and unhealthly food.

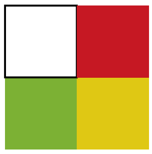
As from the moment food started to be cooked, modifying its nature, the mechanism became more complicated. Both the civilization development and the different social roles, the symbolic-perceptive complexity of food got new roles linked to "social status".

That's why the chromatic perceptive knowledge has been modified and evolved. Nowadays, this complexity has been permanently increased due to the introduction of new and elaborated technologies for the production of food, as well as the incorporation of synthetic preservatives, colorants and flavorings.

All theses facts lead to the fact that the consumer will find a series of codes and acronyms when reading the selected industrial product ingredients, which typify all those additives which commercially enhance the virtue of the selected product, even though they will not reflect its healthiness. In this point, the food regulatory entities should jealously survey not only the aggregated additives, but also the tolerated proportions by the average population for colours and flavors to be attractive but well tolerated.

There exists a real confrontation between flavor and colour industries and the regulatory entities as the trend of the latter is to use natural products, fact which enormously limits the industry ambition.





Chromatic design whose colors synesthesically and figuratively convey the cognitive activity of the other senses.

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French design color wine

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ABSTRACT

Wine in France is a reflection of a space-temporal life cycle of a person, family, nation, country. Wine is drunk everywhere, always and by everybody. Things are used everywhere and always as well. For a Frenchman things reflecting "genius loci" are colored in wine shades. Wine is a result of a sensual union of "genius loci" and grapes. Wine bears a ritual function. Every beginning and termination relative to life and occupation of a person is accompanied by a wine. "Life cycle" of a wine in design is transformed in a life cycle of a thing. The color of a thing shows its "life time" period and its contacts with environment and a person, the character and duration of their skin-to-skin contact.

1. COLOR WINE

Color is the only wine index being appreciated without a real contact with it in distinction from aroma and taste. Color indices include transparency (crystal, clean with brilliance without brilliance, with opalescence, turbid) and its colorings (color). The sparkling wines containing an excess quantity of carbon dioxide are appreciated also using such a parameter as "slight gasiness" –duration and rate of gas evolution, bubble dimensions, foam type.

Wine color depends on the place of a grape culture and type of grape, wine production process, temperature and wine age. The initial wine classification is similar to that of achromatic one and is determined by lightness. Two wine colors are appreciated –light and dark. Achromatic classification includes all color spectrum. French wines have a strongly marked tonality because of the climate conditions.

Wines are classified according to their color: white, red and pink. But according to the general classification adopted by OIV,[1] yellow and green wines are represented as well. Wines color spectrum is extensive (McGovern 2003: 152). Frenchmen say that the white wine is for thirst quenching, the red one is for delight and the pink one for love.

White wines are subdivided into light and dark ones. The light hues include: silver-white, light green, greenish (low acidified wines), diluted herb infusion colors, yellowish, light flaxen, golden, light amber-colored. Dark wine coloration is appreciated between yellow and brown: flaxen, flaxen yellow, light golden, golden, golden yellow, dark golden, amber and dark amber coloreds, ambergris, drawn tea color, brown and dark brown.

Red wines are characterized by light red, dark red, ruby, ruby red, dark ruby, purple red, blue red colors, garnet, almost black, purplish, opaque purple, deep violet, maroon and the list goes on. It's rather difficult to draw the line between dark pink and light red wines. The pink, white pink, pale red, light red, pale ruby colors are typical for pink wines. The pink wines are also marked by onion husk shades with orange and yellow tones predominating as well as by salmon meat shades (Welt der weine 1992: 92-114).

[1] International Office of Vine and Wine.

Yellow wines include natural half-sweet and strong wines like Marsala, Madeira, Tokay, Shato-Shalon, Jerez produced from white varieties of grapes. Their color varies from amber-golden to dark-brown. Green wines are produced from an immature grape and characterized by an extreme acidity. Sometimes the term "green wines" covers some types of wines having green shades or very young wines.

The wine brightness and shade depend on its acid stage, decantation and "life cycle" period. During the fermentation process wines of all types acquire brown oniony, grayish brown, brick red shades. As a result of decantation (the phenomenon discovered in 2003) wines get a more intensive color.

2. LIFE CYCLE OF WINE

Wine color changes considerably in a following succession: birth – maturing – maturity – die – off. Red wine colors become more saturated getting violet or brown hues. But very old red wines may clear up becoming lighter than the white ones. White wines become darker during the "life cycle".

Life time and so the velocity of development processes of different types of wines differ greatly. Maturing of white table wines and Champagne lasts for 3-5 years, of red wines 5-10 years and of sweet ones, 18-20 years. Life period of highly alcoholic and high-sugar (liqueur wines) is long, it can exceed 100 years. A dying wine is characterized by unpleasant taste and smell. The sweet wines life period is longer than that of other wines. Sugar determines the wine life time and a selection of a wine by a man represents his "life cycle" of wishes.

3. DESIGN

To exercise visual and semeiotic analysis of Frenchmen preferences in design, information about annual design competition "Design Obseveur", that has been organized by APIC[2] since 2000 as well as historical chronicles were used. Things that are to be in a skin contact are nominated at the competition. Special nomination was dedicated to color. During 10 years an average volume of "wine color" things is about 40%.

The competition covers all branches of industry that are in contact with innovative design. For example in Design Observeur 03 the following things were nominated: Lafayette Gourmet designed by Saguez & Partners (Galeries Lafayette), the dustbin Poubelle (Company Rossignol), baby buggy Poussette Kart (Ampafrance), vacuum cleaner Aspirateur (Electrolux), etc. In 2008 the "modern interpretation of the classical 18th century French tête-à-tête sofa" designed by Karim Rashid (Veuve Clicquot Ponsardin), rounded shell Max Collection (Whirlpool France), backpack Ura Lite (Lafuma), (Observeur du design 03, 2009).

In 2010 the situation is the same. The following things represented at "Design Observeur 10" had wine colors: Boutique Bleu Ciel D'EDF (EDF), Procarbon, sulky designed by Caiman Design, identité visuelle Le Collège des Bernardins, designed by W&Cie, the tent Base Seconds 4.2 (Décathlon Quechua), thermally insulated container Sherpa (Groupe Matfer Bourgeat), graveur DVD SE-S084C (Samsung Electronics France), Fiber Lite, valise Trolley cabine extensible (Delsey), snow shoes E-Move (Tecnica France), high-tech handheld vacuum cleaner whose DC31 designed by James Dyson, tramway manufactured by MBD Design Et Alstom Transport, etc. (Observeur du design 10, 2009). The Alstom company tramway design agglomerated to Reims is a visualization of wine drinking and advertising of

[2] Agency for the Promotion of Industrial Creation, created in 1983.

weinguts outside of the Champagne territory because “The champagne flute glass shape for a sparkling and colorful design” (Reims tramway, Figure 1). It’s symbolical that the Alstom Company occupies the second place in the world rating of tramway manufactures occupying 22% of market share. It’s planned to start the Reims tramway system in the middle of 2011. It will be ARS-compatible in Bordo. MBD design has been nominated at APCI since the first conceptual projects of 2003 annually.

4. METAPHOR OF WINE IN THE DESIGN

The wine shades in France design didn’t appear at the beginning of the 21st century. In the sixties Barthes wrote: “Who will assert that the French wine – it’s just wine?” (Barthes 1961: 980). All impressionism, expressionism, post expressionism palette is impregnated with wine hues. One of the most popular Renault models at the market is Logan–Expression. Emotional contact with a thing is an obligatory element of design in France. But it should be mentioned that the names of wine hues in a coloristic design of France are practically out of use. Fruit, berry and flower names are widespread (apple, lemon, raspberry, cherry, pink, violet, etc.). At that berry hues are used for red wines –cherry, black currant, raspberry; fruit (pear, apricot) and citrous hues for white wines. By analogy denomination of colors is formed. Thus the color of an aged wine is determined as “cherry”, or color of action, for example, “toreador color”.

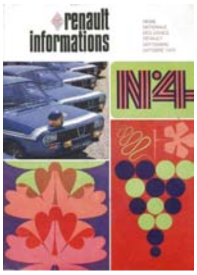

Figure 1. Reims tramway. *Figure 2. Document.* *Figure 3. DeZir concept car.*

At “Design Obseveur 06” the car Logan manufactured by Dacia Groupe Renault with the “red toreador” colored car body was nominated. As early as in Greek culture wine was identified with warriors and battles (Lissarrague, F., A. Szegedy-Maszak 1990: 35). And here we can observe the same parallel connection: wine-battle, opposition and new reality. The car was exposed at the world market in 2005. It was a “warrior” and “seducer” at the same time. At that the wine “taste” theme is characteristic for the past and the future of Renault. The colors of models of seventies are impregnated with white and red wine hues, as well as with green ones (Figure 2, Paris-Match 4, 1970: 1108).

The two concept seater-car DeZir (2010 Paris Motor Show) reflects the brand fidelity attachment to emotional design not to amorousness but to a passion expressed by a sensible line (Figure 3). Nothing is said about the color, but the used one is the red wine color. The idea of “a man’s life cycle” is put into the automobile concept (DeZir concept car 2010). An automobile and a man are joined together in a mutual amorousness. Monterlan would have determined their unity as “a kiss of fire with life”. A thing is artificial but the French people want to see it alive as they see their France – “*douce France*” (sweet-tempered, sentimental, sweet France). Beaudelaire described one’s state after wine drinking in a phenomenal manner: “I’m a soul of my Motherland, I’m a half – lovelace and a half – worrier. I’m a hope of revivals” (Baudelaire 1851). Just such a kind of impression is waited by the French people from a design and just this kind of a design they aspire to create.

5. CONCLUSION

Wine is the only product that unites religiousness and sensuality, malice and holiness, birth and death, marriage and divorce, death and rebirth in “a life circle” and in “a inevitability circle” of a French. Wine is the only product able to create, increase or weaken spirit, behavior and feeling contrasts. The wine life cycle: seed–vine–grapes–wine is characterized by a color spectrum. Wine is a product that symbolizes power, well-being, delight, faith and France at the same time. Wine for France is an event, pleasure, delight, ritual and choice between their reality and irreality (illusion, dream) simultaneously.

The wine color is transmitted to the world of things and gives it sweetness and acidity. Eternity of life and togetherness with France and a woman is given by wine and sweet hues of the world of things. That’s why France is “douce France” (sweet-tempered, sentimental, sweet France) where a woman and an eternity have an equal mark. The desire of a speed is determined by a selection of less sweet dry wines and hues. The use of a green color as an index of a perpetual vogue was perfectly characterized by Breton: “Sugar grains were transformed into a green color and paling feelings”. A green colored thing correspondently means less sensibility and sociability. Green is a color of maturation and expectancy but not of a feeling. Color spectrum: green, flaxen (amber-colored), pink (salmon), red (purple) characterizes life period of a man and of a thing, their age, eroticism and sexuality as well as duration of their “romance”.

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A study on the proper color temperature of LED lamp in space of dining table

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ABSTRACT

The supply of 100W incandescent lamp was totally stopped in 27 countries in EU from September 2009. In addition, the incandescent lamp beyond 75 W will be disappeared from September of 2010. Every incandescent lamp will be disappeared at the store from September 2012. The supply of the lamp with low energy efficiency will be prohibited until 2016 and the demand of the lamp with high energy efficiency will be increased gradually. As such social trend, LED lamp is upcoming because it can lower power consumption and various colors and presentation for the plan of energy reduction effect and eco-friendly lighting technology.

This study is to suggest the result of sensitivity evaluation on the range of color temperature of LED lamp which has energy saving effect and environment friendly effect as an alternative for incandescent lamp, one of the light sources used at the dining place. The one to one comparison has been performed in the same illuminance through installation of the incandescent lamp and LED lamp into two light cabinets respectively. The color temperature of LED lamp was changed in 7 steps in range of 2819~4840 K. The experimental purpose was to evaluate the color rendering, preference and sensitivity evaluation for the food with color range of R, Y, G, P and W depending on color temperature. The subject was composed of 30 graduate students in the lighting major. The average value was suggested for evaluation on color rendering and preference through 7 steps likert scale. The factor analysis on sensitivity evaluation depending on color temperature was performed utilizing 7 steps semantic differential method.

1. INTRODUCTION

The world is confronted with an important situation for the energy supply and environmental pollution. With the social trend, the LED lighting is rapidly emerging as the plan for energy reduction effect and eco-friendly lighting technology because it has lower power consumption and various colors. However, the LED lighting is different from existing lightings in optical and physical characteristics and the evaluations of the LED lighting on the work environment when it is applied indoors are minimal. Therefore a study on the effect of light sources to human beings is necessary.

2. METHOD

2.1 Study method

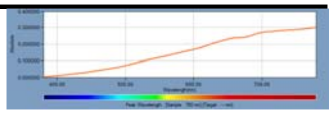
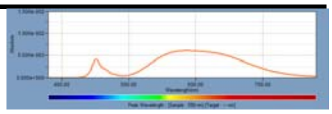
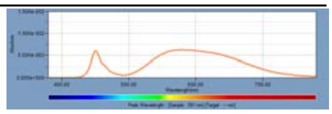
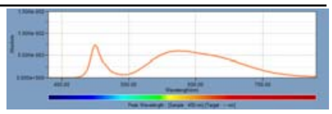
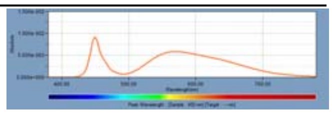
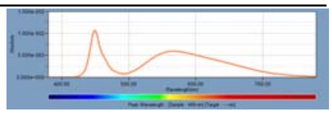
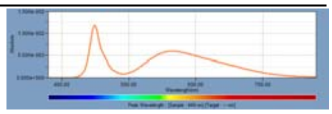
The method of this study is conducted as follows:

1) The measurement of evaluation items and evaluation method were set for the incandescent lamp and LED lamp, and a light cabinet was prepared for simultaneous comparison of the incandescent lamp and LED lamp.

2) The physical characteristics of lighting source were measured by evaluation items to comparatively analyze the incandescent lamp and LED lamp.

3) The evaluation was conducted for the items by the characteristics of the color temperature of the incandescent lamp and LED lamp in the same illuminance, that is, brightness between light sources, color rendering, preference, and emotional images.

Table 1. Physical characteristics of evaluation subjects and experimental variables.

	Light source	Color temp. (K)	Color coordinates		Illuminance (Lux)	Average color rendering index	spectral distribution
			x	y			
Standard stimulus (incandescent lamp)	Reference	2741	0.4602	0.4156	402	98.3	
comparison stimulus (LED lamp)	Test-1	2819	0.4508	0.4089	407	71.8	
	Test-2	3010	0.4235	0.3881	396	72.3	
	Test-3	3425	0.4009	0.371	398	73.8	
	Test-4	3929	0.3758	0.3515	404	73.7	
	Test-5	4415	0.3584	0.3383	399	73.6	
	Test-6	4840	0.3646	0.3291	401	73.2	

2.2 Experimental method

1) The experiments were conducted by using magnitude estimation for brightness evaluation, 7 step likert scale for color rendering and preference evaluation, and 7 step SD method for emotional image evaluation. The evaluation index for each experiment was given by the subjective rating method and the selection of the terms for the image adjectives used in the emotion evaluation was determined by collection of related terms based on the results of the previous research and existing related research.

2) The lighting space where the light source is to be installed was prepared with two light cabinets in 610 × 510 × 550 mm to comparatively evaluate the brightness and color rendering of the incandescent lamp and LED lamp at the same time. The color of the internal wall was fixed with N7.5 of achromatic color to eliminate teh effect of surounding colors. Inside the light cabinet, foods in red, yellow, green, puple, white colors were placed which are often found at dining tables.

3) the light source used for the experiments were 6 kinds in total and there physical characteristics are as shown in Table 1. The experimetns were conducted in a space without windows to eliminate the effect of main light and surrounding lights and physidal characteristics of the light sources were measured with Chroma meter CL-200 and

Spectroradiometer CS-1000A. The average illuminance on the floor of the light cabinet was fixed at 400 [lx] ± 5% to realize a constant illuminance for each light source.

4) Test-takers participated in the experiments are consisted of 20 people who are acknowledged to have perceptual ability in architectural lighting environment including graduate students majoring in lighting and undergraduate seniors in the department of architecture.

2.3 Evaluation experiments

1) Experiments for the brightness evaluation were conducted by comparative evaluation of standard stimulus and comparison stimulus at the same time. Relative brightness of the comparison stimulus was represented in values assuming the brightness of the standard as 100.

2) Experiments for the color rendering evaluation were also conducted by comparative evaluation of standard stimulus and comparison stimulus at the same time. Color reproducibility of the relative comparison stimulus was evaluated in reference to standard stimulus for the 'natural' evaluation items by the 7 steps likert scale.

3) Experiments for preference evaluation were conducted individually for each light source with by the 7 steps likert scale for the preference of the test-takers.

4) Experiments for emotional image evaluation were conducted with 7 step semantic differential method by section of 9 pairs of adjectives corresponding with the purpose of the experiment based on the evaluation terms suggested by previous research for the architectural light sources.

3. CONCLUSIONS

3.1 Results analysis of brightness evaluation experiments

The results of the comparative experiments between standard stimulus and comparison stimulus for the color temperature of 2819 K was evaluated that the brightness of the standard stimulus was higher under the same illuminance. For the color temperature of 3010~4840 K the brightness of the comparison stimulus was evaluated higher under the same illuminance, in particular, it was evaluated highest at 4840 K. In addition, for the light source of color temperature of 2819 K, take takers showed the least deviation on the brightness and the deviation was increased as the color temperature became higher.

3.2 Results analysis of color rendering evaluation experiments

The results of the color rendering evaluation showed that the 6 comparison stimuli had lower color rendering than the standard stimulus as the comparison stimulus was evaluated lower than the reference stimulus.

3.3 Results analysis of preference evaluation experiments

The 6 comparison stimuli were evaluated compared to standard stimulus and all food color in Y, P, G, and W except Red showed value of 4 compared to 5.76 for the standard stimulus. In the experiment 3929 K was evaluated to have the best color rendering with 3.36 from the comparison stimulus. In particular for the red food color, all 6 comparison stimuli were evaluated lower than reference point of 4. For the food color of green and white, 6 comparison stimuli were evaluated higher than the standard higher than reference point of 4. Also 3425 K of the comparison stimulus showed highest preference with 4.90 point.

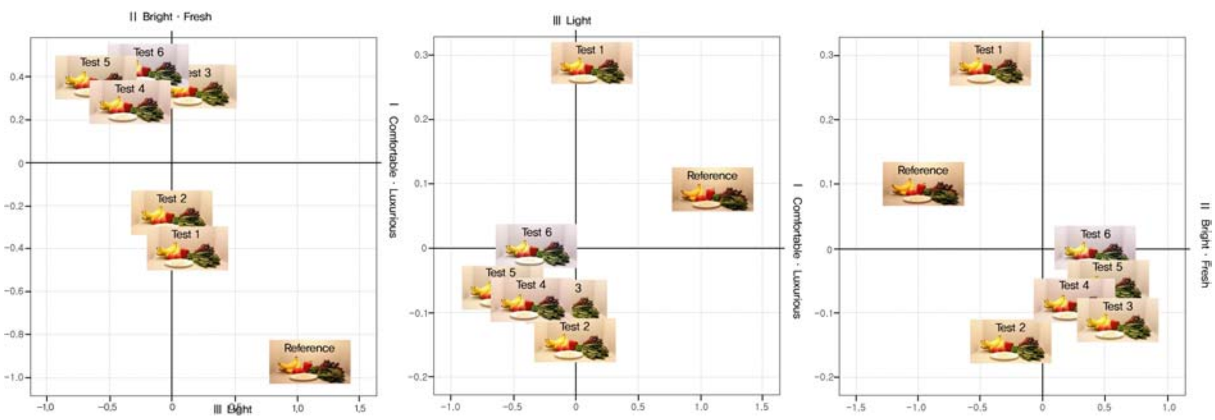
3.4 Results analysis of emotional image evaluation experiments

To investigate the evaluation structure of the emotional image factor analysis was performed using SPSS statistical program. The results are divided into three factor axes as shown in the table below. Factor axis I is named ‘Comfortable Luxurious axis’ as it is consisted of evaluation terms with positive correlations including friendly, comfortable, soft, warm, and luxurious. Factor axis II is named ‘Bright Fresh axis’ as it is consisted of evaluation terms with positive correlations including bright, fresh, and strong. Factor axis III is named ‘Light axis’ as it is consisted of evaluation term with positive correlations including light.

Plot drawings for evaluation items are presented based on the three factor axes derived from the results of the factor analysis. It was evaluated that the light source with lower color temperature is more comfortable and luxurious compared to that with higher color temperature. On the other hand, the light source with higher color temperature was evaluated to be fresh and bright compared to that with lower color temperature. In addition, the evaluation for the item ‘light’ had different results depending on the color temperature: high evaluations at 2819 K and 4840 K while lower evaluation at its comparison stimulus. This is because the emotional evaluation of the ‘comfortable’ feeling for each food color is believed to be an adjective requiring comprehensive judgment.

Table 2. Results of factor analysis.

F a	Evaluation term	Factor			Factor analvsis
		1	2	3	
I	friendly	.868	.042	-.122	Comfortable
	comfortable	.858	.131	-.043	
	soft	.766	-.368	-.065	
	warm	.647	-.418	.062	
	luxurious	.627	.255	-.011	
II	bright	.080	.872	.140	Bright
	fresh	.167	.837	-.138	
	strong	-.489	.727	.150	
III	light	-.074	.049	.983	Light
Eigenvalue		3.167	2.386	1.053	
Contribution rate		35.185	26.513	11.698	
Cumulative rate		35.185	61.698	73.397	



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Colour appearance in LED lighting

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ABSTRACT

The paper shows a comparative study of colour comparison between white LED lamps and conventional ones (incandescent and compact fluorescent). The LED lamps used were a model designed by the direct replaces of halogen incandescent lamps. The technology used for white light generation was based on short waves emitter chips and secondary emission. As result of the experience, significant object colour coordinates displacements in LEDs lighting were observed. As it was predictable from LEDs spectral distribution, orange – red colours were poorly reproduced. However, the subjective experience did not show a remarkable preference to the conventional light sources. Furthermore, several observers qualified the objects under LEDs light as “more naturals”.

1. INTRODUCTION

The development of white solid light emitters (white Light Emitting Diodes, LEDs) with improved light characteristics is helping to spread this new light technology in the domestic and commercial lighting fields. In the analyzed LED lamp model, several individual LEDs are encapsulated together, in order to obtain a shape similar to a conventional lamp (incandescent or halogen incandescent lamp). In this way, a non-specialist user can easily have access to this new technology. He only needs replacing the old lamp without the need of changes in the lighting device (luminaire).

The studied model was a 21 LEDs lamp with dichroic reflector, 220 Volt, 1.5 watt power consumption, warm light. The technology used for LEDs white light generation is based on short waves (violet – blue) emitter chips. This radiation is later changed to white light through a secondary emission of a thin phosphorous coat into the LED encapsulate (Luo and Kim 2006).

The normal use of these lamps is in ornamental lighting and in many cases, the usual applications involve food lighting: bars, restaurants, home kitchens and supermarket stands.

2. EXPERIMENT

In general, the information about the light chromatic characteristics of commercial devices is scarce and it is strongly determined by the properties of the used phosphoric compound. In order to characterizing the colour reproduction of LEDS lamps, the light emitted by samples commercially known as “warm light” lamps was spectrally measured in the visible region of the spectrum using a Mechelle 900 spectrometer (MK Photonics Inc. 2006). Figure 1 shows a used LED lamp together with the measured spectrum.

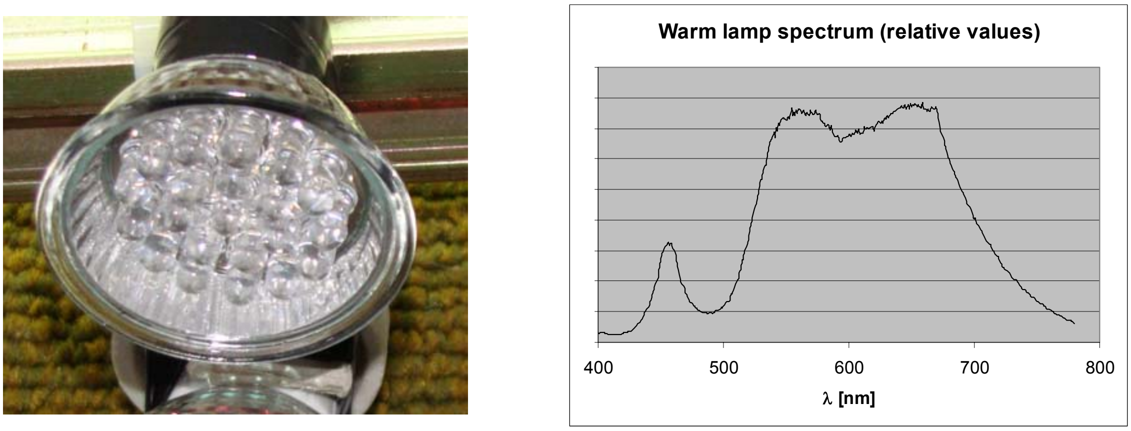


Figure 1. LED lamp used and its measured spectrum.

2.1. Experimental set up

Three similar adjacent compartments designed as showcases were built for the experience. The showcases were 0.60 m wide by 0.80 m deep boxes with white walls and top. Two of them were illuminated by conventional lamps. In the first box, a compact fluorescent lamp (CFL), 18 W, warm light was used. A halogen incandescent (IH) with reflector lamp, 50 W, 2800K was used in the second box. LED reflector lamps were used for the third compartment.

The lamps were mounted in holes made on the box roofs and they were adjusted, using screens and diaphragms, in order to obtain the same illuminance and luminance levels in the three compartments. The illuminance level was adjusted around 600 lux (average level), a typical illuminance indoor value. Figure 2 shows the experimental set up.

Figure 2. Experimental set up.

Different objects, mainly diverse kinds of food (vegetables, fruits, raw and cooked meat) were introduced in the compartments. Then, the colours reproduced by the three light sources were comparatively evaluated objectively and subjectively.

2.2. Chromaticity coordinates evaluation

The CIE chromaticity coordinates x, y, z (CIE 2004, Malacara 2002) were obtained for each object in the boxes using a Pritchard Photometer (Photo Research Inc. 2009). The instrument had three colorimetric response filters that made possible relative and absolute colour measurements. That is why, colour coordinates for each object in the different boxes were obtained. Figure 3 shows the obtained colour changes on vegetables and fruits (lettuce, tomato, lemon, etc.).

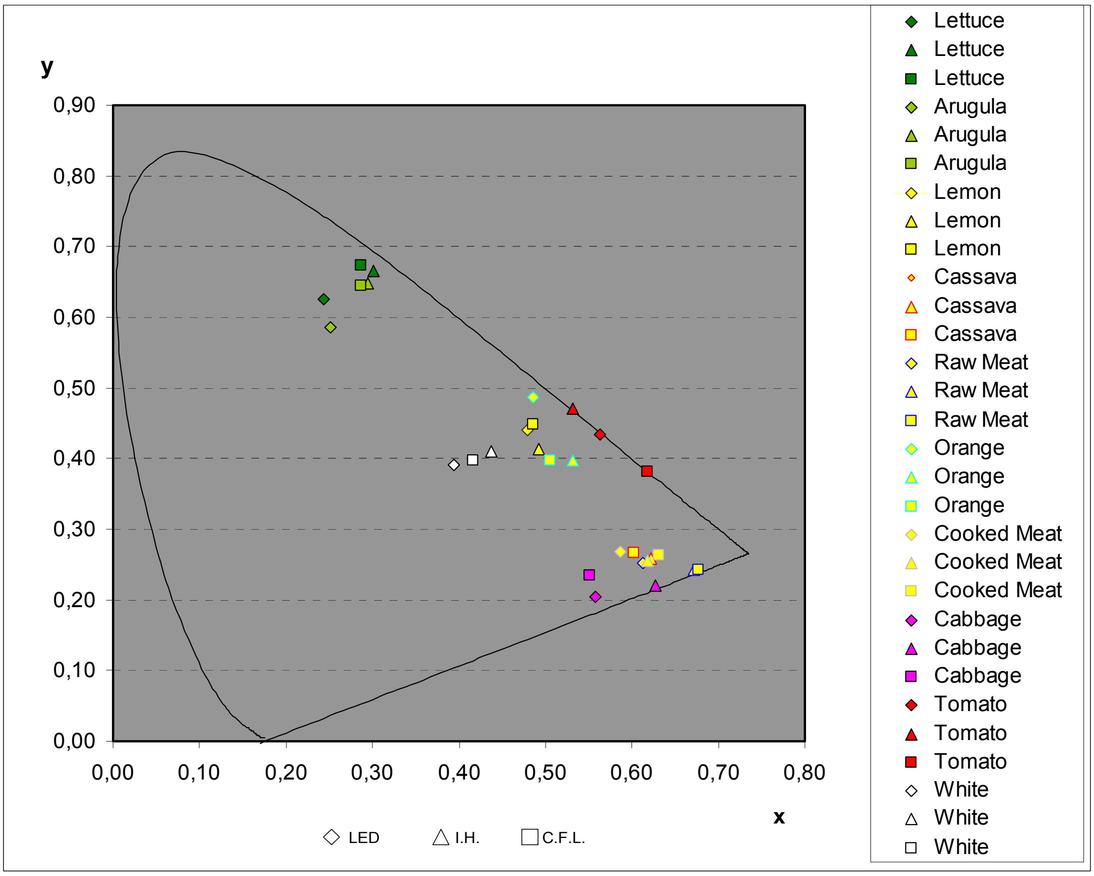
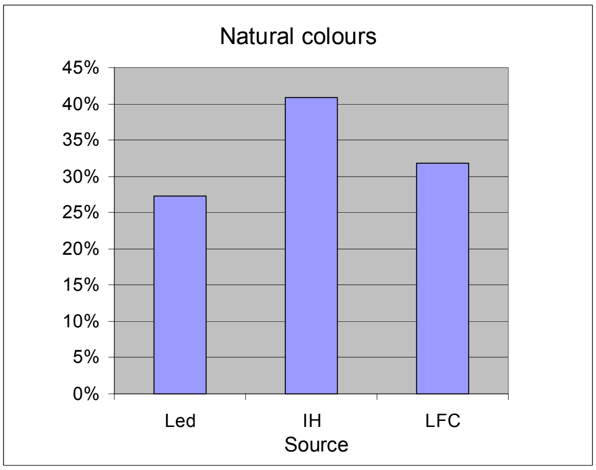


Figure 3. Measured colours by the three light sources.

2.3. Subjective experiment

In this test, a group of 15 observers assessed subjectively the "appearance" of the LED light and illuminated objects. For that purpose, the three compartments, with vegetables and fruits were shown. In a first case, the boxes were lightened one at a time. After that, the observers compared the three display boxes simultaneously illuminated. During the test, the objects were exposed in similar colour groups: green vegetables (lettuce, arugula), red (apple, tomato), etc.

At the end of the test, the observers answered questions, based on their colour perception, about subjective issues, such as "freshness", "appeal", "natural appearance" and "reliability", and the global light aspect. Figure 4 summarizes two relevant aspects: natural appearance and observer light preference. All colour objects were joined in the graphs shown in the figure. Significant changes in the opinions were found when colours were discriminated, mainly in the red and orange zones.



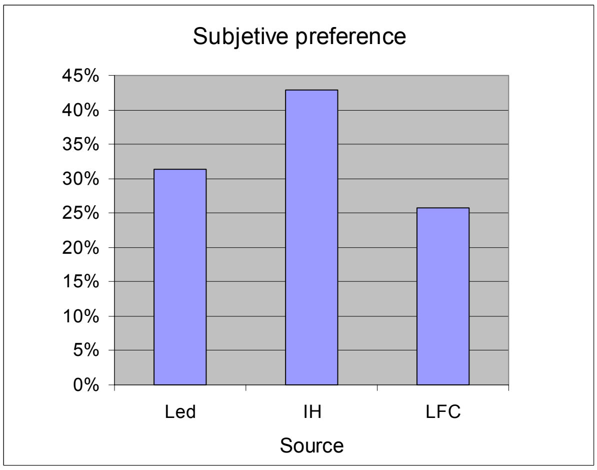


Figure 4. Subjective evaluation.

3. CONCLUSIONS

Significant object colour coordinate shifts in LED lighting were observed, mainly for green and orange objects. Some perceptive mistakes on objects with similar shape under LED light were detected (e.g. orange was confused with lemon). However, in the subjective test, several observers qualified the objects under LED light as "more natural" and the assay did not show a remarkable preference to the conventional light sources.

In opposition to what can be predicted from LED spectral distribution (poor light contribution in blue-green and red zones) LED light was well qualified and accepted, practically at the same level as fluorescent light.

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Illuminant estimation under multiple light sources

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ABSTRACT

This paper proposes a method for estimating the scene illuminant spectral power distributions of multiple light sources under a complex illumination environment. The spectral power distributions including natural and artificial illuminants are estimated based on the image data from a high-dimensional spectral imaging system. We note that specular highlights on inhomogeneous dielectric object surfaces includes much information about scene illumination according to the dichromatic reflection model. When curved object surfaces are illuminated by several light sources from different directions, the illuminant spectrum estimated from each highlight area corresponds to each of the light sources. We present an algorithm to estimate multiple illuminants. The feasibility of the proposed method is shown in experiments.

1. INTRODUCTION

Estimation of scene illumination from image data has important imaging applications, including illumination design, color constancy, image processing, image rendering, and image retrieval. For instance, people are much interested in how light source can enhance the appearance of food, because the color of food at the retail level exerts a strong influence on consumers' buying decisions. The color appearance of food depends greatly on the illuminant spectrum. The scene illuminant estimation problem has a long history. Although, so far, many algorithms were proposed for scene illuminant estimation, most algorithms assumed uniform illumination from a single light source (Tominaga 1996, Parkkinen et al. 1989). Recently, artificial light sources such as various fluorescent lights and light emitting diode (LED) have appeared in our daily life. Then a complex illumination environment is constructed by mixing these artificial and natural light sources.

The present paper proposes a method for estimating the scene illuminant spectral power distributions of multiple light sources under a complex illumination environment. First, a high-dimensional spectral imaging system is realized using a liquid-crystal tunable filter, a monochrome CCD scientific camera, and a personal computer. Then, we can estimate the light spectra (color signals) reflected from object surfaces from the captured image data. Second, we note that gloss or specular highlight on object surfaces includes much information about scene illumination. In Section 3, we describe a method for detecting highlight areas of each object based on the pixel distribution (histograms) of hue and luminance. In section 5, we show an algorithm for estimating the illuminant spectra from the extracted highlight areas. We assume that an object is composed of inhomogeneous dielectric material like plastic or paint. Then, the dichromatic reflection model suggests that light reflected from the object is decomposed into two additive components; the specular and the diffuse reflection components. The spectral power distribution of the specular component is coincident with the illuminant spectrum. Therefore, the illuminant estimation problem can be reduced to detection of the specular reflection component. Moreover we note that, when a curved object surface is illuminated by several light sources from different directions, the illuminant spectrum estimated from each highlight area corresponds to each of the light sources. So the multiple illuminants can be estimated from different specular highlight areas on the curved object. In Section 6, the feasibility of the proposed method is evaluated in experiments using actual scenes containing dielectric objects under multiple artificial and daylight sources. The accuracy of the estimated illuminant spectra is demonstrated.

2. SPECTRAL IMAGING SYSTEM

The spectral imaging system in this study is composed of a liquid-crystal tunable filter, a monochrome CCD camera (Retiga1300), and a personal computer. We represent illuminant spectra with 69-dimensional vectors, where the visible wavelength range [400-700 nm] is sampled at equal intervals of 5 nm, and additionally sampled at eight wavelengths (404, 436, 488, 544, 584, 588, 612, 656 nm), that correspond to the peaks of general fluorescent lights. The total spectral sensitivity function $R_k(\lambda)$ of the imaging system at *k*-th spectral channel is computed by using the filter transmittance and the camera sensitivity function, and the exposure time. We can control the shutter speed from the computer so that we can justify exposure time to be constant sensitivity at each channel.

3. DETECTION OF HIGHLIGHT AREA

Let $Y(\lambda)$ be the observed color signal (radiance of the reflected light) from an object surface at each pixel point. The color signals can be recovered from the outputs of the imaging system by knowing the total spectral sensitivity functions $R_k(\lambda)$. First we compute the luminance value *Y* of the color signals as

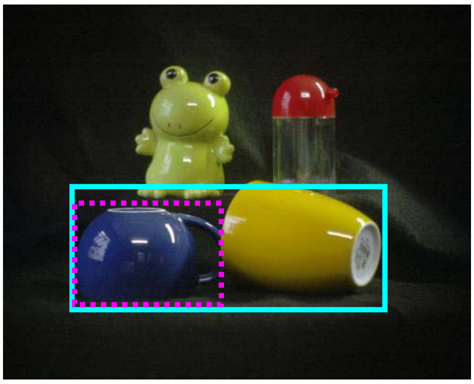
$$Y = \int_{400}^{700} Y(\lambda) v(\lambda) d\lambda \qquad (1)$$

where $v(\lambda)$ is the CIE luminosity function. A simple way for detecting highlight areas is to use a luminance threshold for whole image area. Figure 1 (a) shows an example scene. Figure 1 (b) shows the detection result when we use a low threshold value for the luminance. Highlight areas cannot be detected appropriately by such a simple thresholding.

Here we propose use of the hue component as well as the luminance component. The (x, y) chromaticity coordinates at each pixel are computed from the tristimulus values. Then we define hue angle *H* as

$$H = \arctan(y - y_0, x - x_0) \qquad (2)$$

where (x_0, y_0) is a standard white coordinates. Because we know that the chromaticity coordinates of most scene illuminant is located closely on the black-body radiator, the standard coordinates can be placed on the black-body trajectory on the xy diagram. In practice, experimental results show that the standard light source can be located simply in an arbitrary center like (1/3, 1/3). In this case, highlight areas are detected in two steps. First, different object color areas are detected by the hue component. Second, highlight areas are detected from the respective color area by using the luminance thresholding. Figure 1 (c) shows the detection result by the proposed method. All high light areas are properly detected in different object colors.



(a) example of captured image

(b)with threshold based on low luminance hue

(c) with adopting threshold for similar hue type

Figure1. Detection of highlight area.

4. ILLUMINANT ESTIMATION ALGORITHM

The dichromatic reflection model suggests that light reflected from for inhomogeneous dielectric objects is decomposed into the specular reflection component and the diffuse reflection components. The radiance of the reflected light $Y(\lambda)$ is written as

$$Y(\lambda) = Y_S(\lambda) + Y_D(\lambda) \qquad (3)$$

where suffix S and D correspond to the specular reflection component and the diffuse reflection component, respectively. To express the model in terms of the surface-reflectance functions, let $S_S(\lambda)$ and $S_D(\lambda)$ be the surface-spectral reflectances for the two components, and let $E(\lambda)$ be the spectral power distribution of the incident light. Then the reflected light is described as

$$Y(\lambda) = S_S(\lambda)E(\lambda) + S_D(\lambda)E(\lambda) \qquad (4)$$

For an inhomogeneous dielectric surface, it is assumed that $S_S(\lambda)$ = constant over the visible wavelength. Then the specular reflection component can be used for illuminant estimation.

Figure 2 shows a two dimensional space onto which the image data of the highlight area projected by two principal-component vectors. The pixel distribution (histogram) in this space is divided into two straight clusters (Tominaga and Nishitsuji (1996). One cluster corresponds to highlight pixels by specular reflection, and another cluster corresponds to matte pixels by diffuse reflection. In this case, the principal-component vector of the highlight conform to the vector of the light source. Therefore, the illuminant spectral power distribution can be estimated by extracting the principal-component vector of the highlight cluster and transforming it inversely into the high-dimensional spectral space.

When curved object surfaces are illuminated by several light sources from different directions, the illuminant spectrum estimated from each highlight area corresponds to each of the light sources. Moreover, if the illuminant includes spiky spectra from a fluorescent light, we can identify the fluorescent light source by using the wavelengths of the spike peaks.

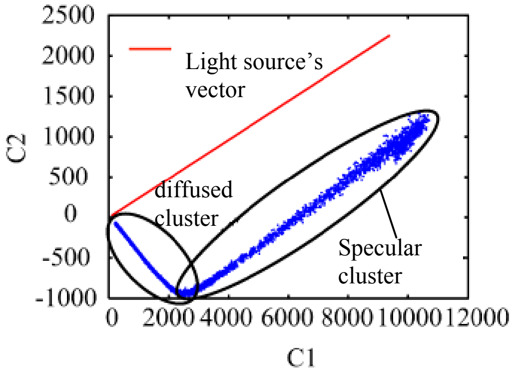
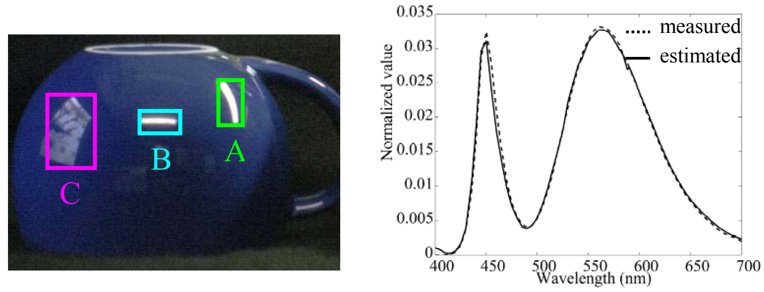


Figure 2. highlight projected onto a two-dimensional space.

5. EXPERIMENTAL RESULTS

We have examined the proposed method for estimating illuminant spectral power distribution under multiple light sources. Figure 3 (a) shows a magnified picture of the dot area in Figure 1(a), where a plastic object is illuminated with a fluorescent light, a light emitting diode (LED), and a daylight from outside. Figure 3 (b) and (c) are the illuminant estimation results. The solid curve is the estimated spectral power distribution, and the dot curve is the direct measurement by a spectro-radiometer. These results suggest the feasibility of the propose illuminant estimation method.



(a)detected highlight areas *(b)estimation result for area A* *(c)estimation result for area C*

Figure 3. Experimental results of illuminant estimation of multiple light sources.

6. CONCLUSION

We have proposed a method for estimating the scene illuminant spectral power distributions of multiple light sources under a complex illumination environment. The spectral power distributions were estimated based on the image data from a high-dimensional spectral imaging system. We used inhomogeneous dielectric objects because the specular reflection includes the information of scene illumination according to the dichromatic reflection model. When curved object surfaces are illuminated by several light sources from different directions, the illuminant spectrum estimated from each highlight area corresponds to each of the light sources. We presented an algorithm to estimate multiple illuminants. The feasibility of the proposed method was shown in experiments using plastic objects in a real scene.

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Color temperature variation for food lighting: A test on user preferences

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ABSTRACT

The way food is presented and how it appears to the final user has a great effect on his/her will to buy or consume it, especially in the case of fresh food. Color and glossiness can be easily manipulated choosing the proper lighting, varying its geometry, luminance level and spectral content. The final visual appearance can make the food appear more or less fresh, ripe, juicy, appetizing, etc. This paper presents an experiment designed as follows. Five light booths have been prepared with 5 different light sources and filters (see Table). The chosen food, from a big retail store, is usually exposed under artificial light directly or through transparent wrapping. The test aims at verify the changes in consumers buying intentions as caused by changes in CCT illumination and consequently appearance. Test has been held in a temperature-controlled room without natural lighting. The subjective preference test has been carried out on 124 subjects (50% males and females) subdivided into different age groups. The chosen types of food have been: red meat, bakery products, fish, fruits and vegetables.

1. INTRODUCTION

The presented research aims at verifying the performances of five lighting system prototypes with different light sources and dichroic filters. The performances have been verified both quantitatively and qualitatively. The five prototypes have been realized arranging different luminous sources and different anti-UV and dichroic filters, as listed in Table 1. The configuration choice has been done in order to use high efficiency discharge lamps with high CRI, using dichroic filters to tune the light spectral properties on the exposed food.

2. THE CHOSEN LIGHTS AND FOOD

The food has been chosen among those normally distributed in large supermarkets directly exposed under light or through a transparent cover. To choose them customers highly rely on their visual appearance (Figure 1). The five chosen food types are the following: 1. red meat: filet, chopped, ham. 2. selection of Mediterranean blue fish, 3. products from the oven: bread, cakes etc; 4. green-yellow vegetables and fruits; 5. orange-red and other colors vegetables and fruits.

Table 1. The five used lighting systems.

n.	lamp	power	CCT	CRI	Filter
1	halogen	150W	2900 K	100	neutral anti-UV
2	sodium white	100W	2550 K	83	neutral anti-UV
3	metal halide	150W	4200 K	96	neutral anti-UV
4	metal halide	150W	4200 K	96	“warm” dichroic
5	metal halide	150W	4200 K	96	“cold” dichroic

Figure 1. Samples of chosen food.

Table 2. chromatic measures of the 4° light system.

Tri-stimulus values CIE 2° (XYZ)	X = 6.745 Y = 5.613 Z = 3.047
Chromatic coordinates CIE 1931 (x y)	x = 0.4378 y = 0.3644
Chromatic coordinates CIE 1960 (u v)	u = 0.2696 v = 0.3365
Chromatic coordinates CIE 1976 (u' v')	u' = 0.2696 v' = 0.5048
Correlate color temperature and distance	CCT = 2639 Δuv = -0.0164

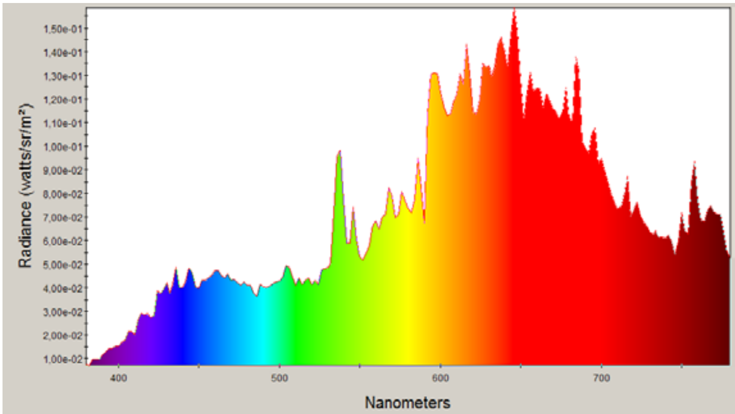

Figure 2. Spectral radiance of the 4° light system.

3. MEASURES

Emitted spectra have been quantitatively verified in a temperature-controlled darkroom measuring the spectral radiance (λ) and the following CIE values:

- *X,Y,Z* CIE 1931 tri-stimulus values;
- *x,y* CIE 1931 chromatic coordinates;
- *u,v* CIE 1960 chromatic coordinates for the CCT computation;
- *u',v'* CIE UCS 1976 chromatic coordinates;
- correlated color temperature (CCT);
- *Δuv* chromatic distance from the Planckian locus in the CIE 1960 space.

As an example we report the SPD (Figure 2) and the chromatic measures (Table 2) of the fourth lighting system.

Figure 3. A view of the test setup.

4. TESTS

Five preference tests have been performed with three multiple light booths. For the first three type of food (red meat, oven products, Mediterranean fish) two identical trays (in the content and the disposition) have been shown under two different lighting system. Both kinds of fruits and vegetables have been shown on identical trays, under three different types of lighting systems. The trays have been placed at 85 cm height, while the lighting systems have been installed at 1.2 m height over the food, in a way to avoid unwanted light mix. A medium achromatic gray has been chosen as background.

Perceptual tests have been performed on 124 persons equally (50%) distributed between males and females and subdivided in several age groups. The subject had to indicate his/her buying choices.

For red meat and oven products subjects had to choose between the following two lighting systems (results reported in Figure 4):
A. metallic halide lamp 150W-G12-4200K – CRI=96, with warm dichroic filter;
B. white sodium lamp 100W-PG12-1-2550K – CRI=83, with anti-UV neutral filter.

For the fish subjects had to choose between the following two lighting systems (results reported in Figure 5):
A. metallic halide lamp 150W-G12-4200K - CRI=96, with anti-UV neutral filter;
B. metallic halide lamp 150W-G12-4200K - CRI=96, with warm dichroic filter.

Finally for fruits and vegetables of the two kinds subjects had to choose between three possible lighting systems (results reported in Figure 6):
A. metallic halide lamp 150W - G12 - 4200K - CRI=96, with anti-UV neutral filter;
B. white sodium lamp 100W-PG12-1-2550K - CRI=83, with anti-UV neutral filter;
C. halogen lamp 150W-E27-2900K - CRI=100, with anti-UV neutral filter.

Table 3. Subjects characteristics.

Age			
	Males	**Females**	
20 to 30	31	31	
More than 30	31	31	
TOTAL	62	62	**124**

5. RESULTS

The objective has been testing the changes in visual preference in relation to various types of lighting system for the three food categories (meat and oven products, fish, fruits and vegetables). Subjects had to compare the same category of products under various illuminations. The number of subjects was 124, 50% males and 50% females, subdivided in two age groups as reported in Table 3.

Every subject has been asked to choose which product would have bought, observing the products for no more than 10-15 seconds at a distance of approximately 80 cm. A supporting person has filled the questionnaire, in order to control the test timing. The question asked was: “Which of the presented products would you buy?”. In the following figures the results are shown.

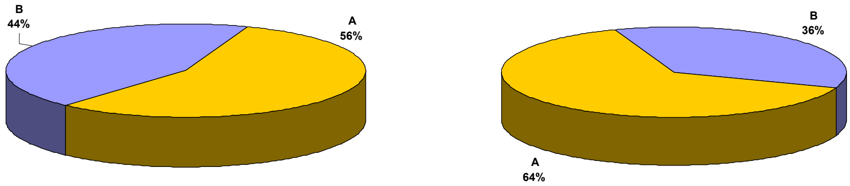

Figure 4. Chose light system for red meat (left) and oven products (right).

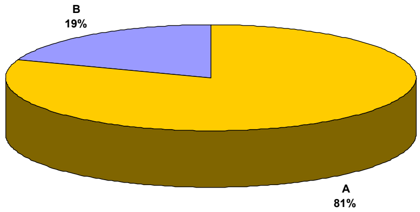

Figure 5. Chose light system for fish.

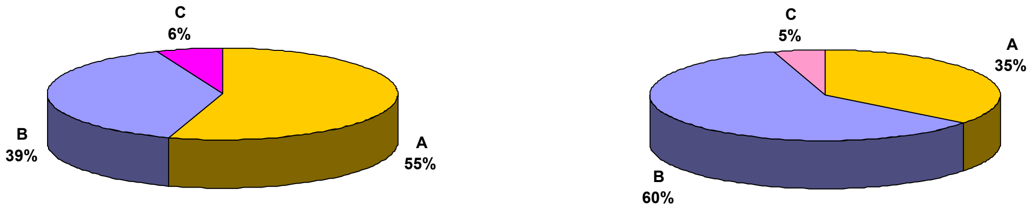

Figure 6. Chose light system for red yellow-green fruits and vegetables (left) and other colors fruits and vegetables (right).

6. CONCLUSIONS

A test on the effect of different lighting systems on food choice has been presented. The data reported here is necessarily a synthesis from a more detailed set. The overall preferences are the following:

- Red meats: metal halide lamp with warm dichroic filter.
- Oven products: metal halide lamp with warm dichroic filter.
- Fish: metal halide lamp with neutral filter.
- Green-yellow fruit and vegetables: metal halide lamp with neutral filter.
- Orange-red fruit and vegetables: white sodium lamp with neutral filter.

Results show that the visual effects of high efficiency discharge lamps with dichroic filters are comparable to halogen lamps with higher chromatic index but lower energetic efficiency.

ACKNOWLEDGMENTS

We would like to thank the scientific director of the laboratory Light & Color of the Polytechnic of Milan, Alberto Seassaro, the Ing Giorgio Castaldi, the technicians of laboratory Cristina Fallica and Andrea Siniscalco, and all the 124 persons who have participated to the test.

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Preferable lighting conditions for the appearance of the dishes in the dining room

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ABSTRACT

The appearance of the dishes is one element of palatability. And for the good appearance of the dishes, the color, the shape and the visual texture are the major factors. Therefore, it is necessary for the lighting in the dining room to make the dishes look tasty according to these three factors. So, this study aims to show the preferable lighting conditions for the good appearance of the dishes. And we conducted the experiment on the subjective evaluation under 43 conditions in total, which combined light source, light color and illuminance of task and ambient lighting. 20 subjects evaluated four factors: "Brightness on the table", "Visibility of the dishes' color and shape and of the tableware's color and design", "Appropriateness of the modeling dishes", and "Preference of the appearance of the dishes". Additionally, they evaluated "Impression of the dining table" using 20 pairs of adjectives of the Semantic Differential method. The results showed that the evaluation under the conditions of fluorescent bulbs was higher than under the conditions of LED bulbs in each of the four factors. And in the evaluation for "Impression of the dining table", there were differences in light color and illuminance.

1. INTRODUCTION

When we have meals in the dining room, it is essential to enjoy the dishes. The appearance of the dishes is one element of palatability. And for the good appearance of the dishes, the color, the shape and the visual texture are the major factors. Therefore, it is necessary for the lighting in the dining room to make the dishes look tasty according to these three factors.

In the general rules of recommended lighting levels issued within the Japanese industrial standard (2010), the value of the horizontal illuminance for task lighting on the dining table is 300 lx, R_a = 80. And the Illuminating Engineering Institute of Japan issued a Technical guide for residential lighting design (2006), in which the value of the horizontal illuminance for task lighting on the dining table is 200-500 lx. But the quality of lighting should also be considered for the good appearance. So, this study aims to show the preferable lighting conditions for the appearance of dishes. And we conducted the experiment on the subjective evaluation, which combined light source, light color and illuminance of the task and ambient lighting.

2. METHODS

Figure 1 illustrates the plan and the section of the experimental space. We placed visual objects on the dining table. In this experiment, the visual objects were food models of

Tempura, boiled greens, rice and miso soup as shown in Figure 2. They are ordinary dishes of the dinner in a Japanese home and they have many colors.

We placed fluorescent lamps (2800 K and 5000 K) on the ceiling as ambient lighting, and placed fluorescent bulbs (2800 K and 5000 K) and LED bulbs (2800 K and 6700 K) above 800 mm from the dining table as task lighting. And we created 43 different lighting conditions in total, which combined light source, light color and illuminance of the task and ambient lighting as shown in Table 1.

There were 20 female subjects, all in their twenties. The subjects evaluated four factors: “Brightness on the table”, “Visibility of the dishes’ color and shape and of the tableware’s color and design”, “Appropriateness of the modeling dishes”, and “Preference of the appearance of the dishes”. These factors were evaluated according to the six steps of the categorical scale. Additionally, they evaluated “Impression of the dining table” using 20 pairs of adjectives with seven steps of the Semantic differential method.

In this paper we showed the results for four factors under 11 conditions lighted only task lighting and for “Impression of the dining table” under 43 conditions.

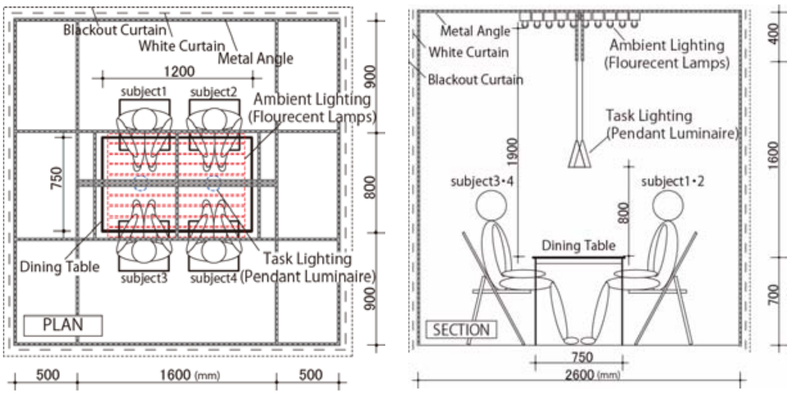

Figure 1. The experimental space.

Figure 2. Visual objects.

Table 1. Lighting conditions.

No.	T : A	Task Lighting	Ambient Lighting	Illuminance(lx)	No.	T : A	Task Lighting	Ambient Lighting	Illuminance(lx)
1	1 : 0	Fluorescent 2800K	_	50	23	1 : 3	Fluorescent 5000K	Fluorescent 5000K	50
2	1 : 0	Fluorescent 2800K	_	90	24	1 : 3	Fluorescent 5000K	Fluorescent 5000K	90
3	1 : 0	Fluorescent 2800K	_	170	25	1 : 3	Fluorescent 5000K	Fluorescent 5000K	200
4	1 : 0	LED 2800K	_	50	26	1 : 3	Fluorescent 5000K	Fluorescent 5000K	360
5	1 : 0	LED 2800K	_	90	27	1 : 3	LED 6700K	Fluorescent 5000K	50
6	1 : 0	LED 2800K	_	170	28	1 : 3	LED 6700K	Fluorescent 5000K	90
7	1 : 0	Fluorescent 5000K	_	50	29	1 : 3	LED 6700K	Fluorescent 5000K	200
8	1 : 0	Fluorescent 5000K	_	170	30	1 : 1	Fluorescent 2800K	Fluorescent 3000K	50
9	1 : 0	LED 6700K	_	50	31	1 : 1	Fluorescent 2800K	Fluorescent 3000K	200
10	1 : 0	LED 6700K	_	90	32	1 : 1	Fluorescent 2800K	Fluorescent 3000K	50
11	1 : 0	LED 6700K	_	170	33	1 : 1	Fluorescent 2800K	Fluorescent 3000K	200
12	1 : 7	Fluorescent 2800K	Fluorescent 3000K	50	34	1 : 0	_	Fluorescent 3000K	50
13	1 : 7	Fluorescent 2800K	Fluorescent 3000K	200	35	1 : 0	_	Fluorescent 3000K	90
14	1 : 7	LED 2800K	Fluorescent 3000K	50	36	1 : 0	_	Fluorescent 3000K	200
15	1 : 7	LED 2800K	Fluorescent 3000K	200	37	1 : 0	_	Fluorescent 3000K	400
16	1 : 3	Fluorescent 2800K	Fluorescent 3000K	50	38	1 : 0	_	Fluorescent 3000K	800
17	1 : 3	Fluorescent 2800K	Fluorescent 3000K	90	39	1 : 0	_	Fluorescent 5000K	50
18	1 : 3	Fluorescent 2800K	Fluorescent 3000K	200	40	1 : 0	_	Fluorescent 5000K	90
19	1 : 3	Fluorescent 2800K	Fluorescent 3000K	360	41	1 : 0	_	Fluorescent 5000K	200
20	1 : 3	LED 2800K	Fluorescent 3000K	50	42	1 : 0	_	Fluorescent 5000K	400
21	1 : 3	LED 2800K	Fluorescent 3000K	90	43	1 : 0	_	Fluorescent 5000K	800
22	1 : 3	LED 2800K	Fluorescent 3000K	200	T :A = Task Lighting :Ambient Lighting				

3. RESULTS AND DISCUSSION

3.1 Evaluation results for the four factors

Figure 3 shows the average values of the results for the four factors under the conditions of only task lighting. In each factor under this experimental condition, the higher the horizontal illuminance on the table was, the higher each evaluation was.

In the evaluation for "Brightness on the table", it was shown that the evaluation under the conditions of fluorescent bulbs was higher than under the conditions of LED bulbs. We can consider that subjects perceived more brightly under the conditions of diffused lighting than under the conditions of directed lighting, when horizontal illuminance on the table were the same value.

In the evaluation for "Visibility of the dishes' color and shape and of the tableware's color and design", it was shown that the evaluation under the conditions of fluorescent bulbs was higher than under the conditions of LED bulbs. Light from fluorescent bulbs included middle and long wavelength as shown in Figure 4, that influenced the evaluation.

In the evaluation for "Appropriateness of the modeling dishes", it was shown that the evaluation under the conditions of fluorescent bulbs was higher than under the conditions of LED bulbs. LED bulbs caused dark shadows on the table. So, we can see that dark shadows were not good for the **v**isual objects in this experiment.

In the evaluation for "Preference of the appearance of the dishes", it was shown that the evaluation under the conditions of fluorescent bulbs was higher than under the conditions of LED bulbs. The evaluation under the condition of LED bulbs (6700 K) was especially low. We can see that the light source which had a much shorter wavelength was not good for the appearance of the dishes. The result of "Preference of the appearance of the dishes" was influenced by the results of "Brightness", "Visibility" and "Appropriateness".

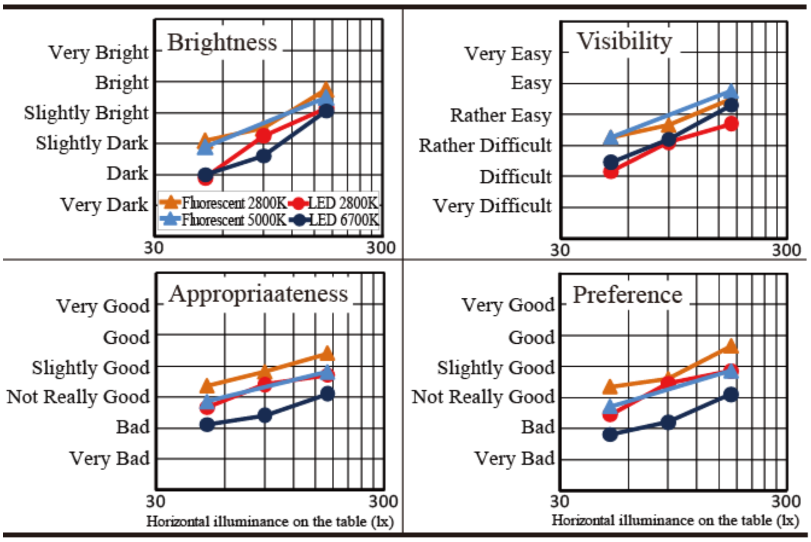

Figure 3. Evaluation results for the four factors.

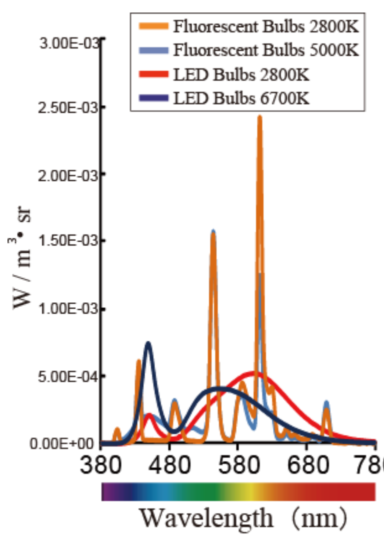

Figure 4. Spectral distribution of light source used in this experiment.

3.2 Results for "Impression of the dining table"

In the evaluation for "Impression of the dining table", three psychological factors were extracted by factor analysis. The first factor is "Activity", the second factor is "Comfort" and the third factor is "Quality" as shown in Table 2. Factor scores for each condition were plotted in the factor space consisting of "Activity" and "Comfort" as shown in Figure 5. The number of plots in Figure 5 means the number of lighting conditions in Table 1. It was shown that the impression under the conditions of high illuminance was more active than under the conditions of low illuminance, and that the impression under the conditions of low correlated color temperature was more comfortable than under the conditions of high correlated color temperature.

Table 2. Factor coefficient.

	Factor		
	Activity	Comfort	Quality
cheerful ⇔ gloomy	1.115	-.050	-.447
uniform ⇔ nonuniform	1.091	.058	-.352
warm ⇔ cold	.948	.103	-.051
natural ⇔ unnatural	.895	.145	-.019
soft ⇔ tough	.888	.007	.151
clear ⇔ vague	.780	.078	.226
lively ⇔ quiet	.764	.347	-.028
familiar ⇔ unfamiliar	.570	.432	.163
open ⇔ closed	-.177	1.105	-.167
light ⇔ grave	.036	.941	.052
excited ⇔ cool	-.061	.927	.185
restful ⇔ restless	.890	-.908	.396
easy ⇔ uneasy	.032	.771	.313
healing ⇔ tiring	.315	.738	.061
loose ⇔ tight	.420	.667	.029
comfortable ⇔ uncomfortable	.472	.618	.039
usual ⇔ unusual	.500	.583	.050
special ⇔ ordinary	.538	.537	.064
luxurious ⇔ simple	-.470	.140	1.115
favorite ⇔ unfavorite	.094	.124	.854

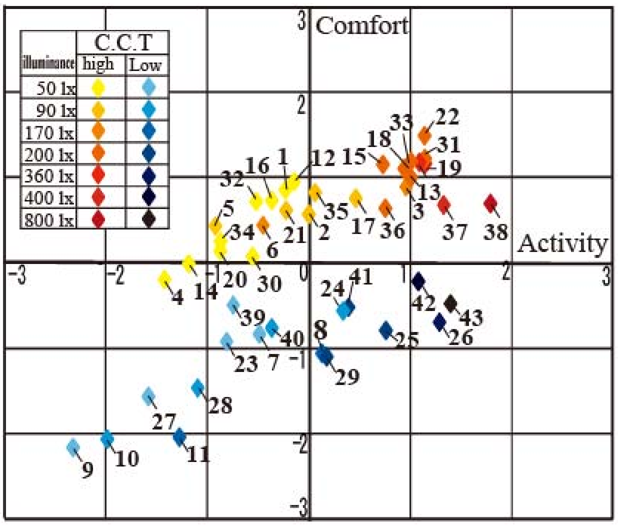

Figure 5. Configuration of factor scores.

4. CONCLUSION

This study aims to show the preferable lighting conditions for the good appearance of the dishes, we conducted the experiment on the subjective evaluation. According to the results, the evaluation under the conditions of fluorescent bulbs was higher than under the conditions of LED bulbs in each of the four factors. And in the evaluation for "Impression of the dining table", there were differences in light color and illuminance.

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"In the green market...": From the poetic evocation to the recovery of municipal markets in Latin America

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1. INTRODUCTION

At the turn of the 20th century Argentina received European immigrants who settled mainly in agricultural colonies. The province of Santa Fe and its capital city played a central role in that context. At that time, an overseas port was inaugurated, and the railways facilitated the transport of goods and passengers who came from the new colonies in the "pampa gringa". This new situation had an impact on consumer habits, and municipal markets replaced the old forms of trade. In the city of Santa Fe, the *Central*, *Norte* and *Sur* markets were built.

Not only are municipal markets important for their role as centres of commercial activity, but also because they are spaces for cultural exchange and social cohesion, which turns their survival, strengthening and modernization into major issues. However, population growth and changes in the economy and in consumer habits have eventually led to the closing or relocation of those public spaces. *Mercado Norte*, for instance, closed down in 2007.

The Government of the city of Santa Fe is currently developing a project to reactivate *Mercado Norte*, funded by the European Union, and operating within a network of municipal markets (Red de Mercados Municipales), through which *Mercado Norte* has become partners with *Mercado Puerto* in Valparaiso, Chile.

The purpose of the present work is to study the visual identity of the different markets listed on the *World Union of Wholesale Markets* (WUWM) website, focusing on the use of colour in the design of their websites, as well as on the types of images they use. The aim is to contribute, by surveying antecedents, to the work being carried out by the City Council, with a view to designing the system of visual identity when *Mercado Norte* reopens in 2010.

2. GEOGRAPHIES *À LA CARTE*

Since this project is supported by the European Union, we put forward a first comparison between different Latin American and European markets websites. The organization of this brief introduction is based on the difference between showing, in general terms, the landscapes the foods come from, which moves away from the predictable codes of the genre, and views of the available infrastructure to receive and commercialize products, and showing, in differential terms, the products, either in a highly abstract way, or through "realistic" representations of fresh meats, fruits and vegetables.

Colombia – France

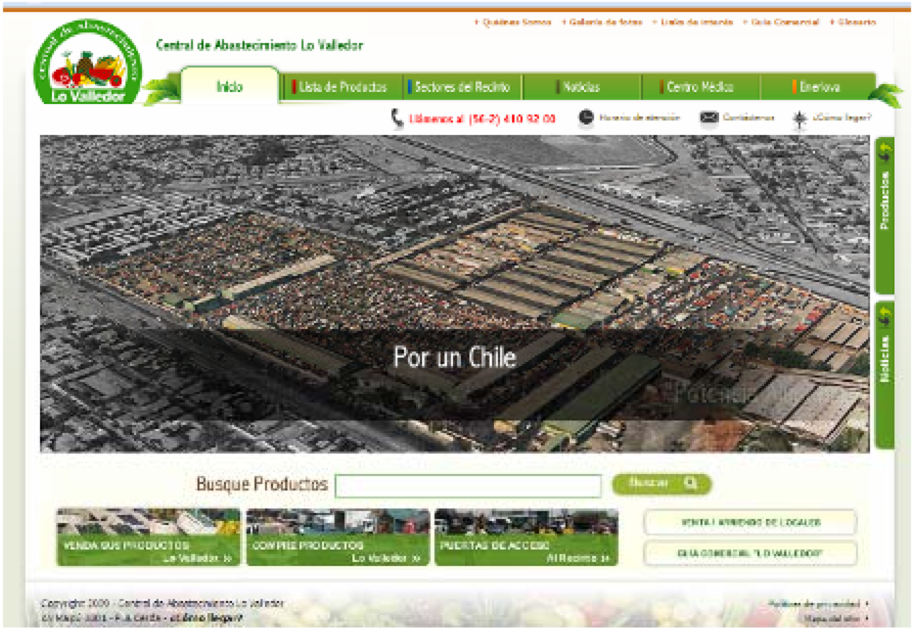
In the case of Colombia, we can get a panoramic view of a rural landscape represented by a minimum number of elements: the sky and a sown field, with a uniform green texture, an image which supports a series of images placed in planes which represent labels. From the raw material represented in the background to man's labour, with the choice of labels as synecdoches for the manufactured product available for its commercialization. A space where rural and urban elements meet. The products are represented alongside the figure of man, both in his role as a producer/trader and as a consumer in a typical market scene. The logo is geometric and rather rigid, with gray and green gradients which evoke the fine nature of steel and support the three-dimensional effect. The typography is geometric, condensed extra bold, and dark green in colour.

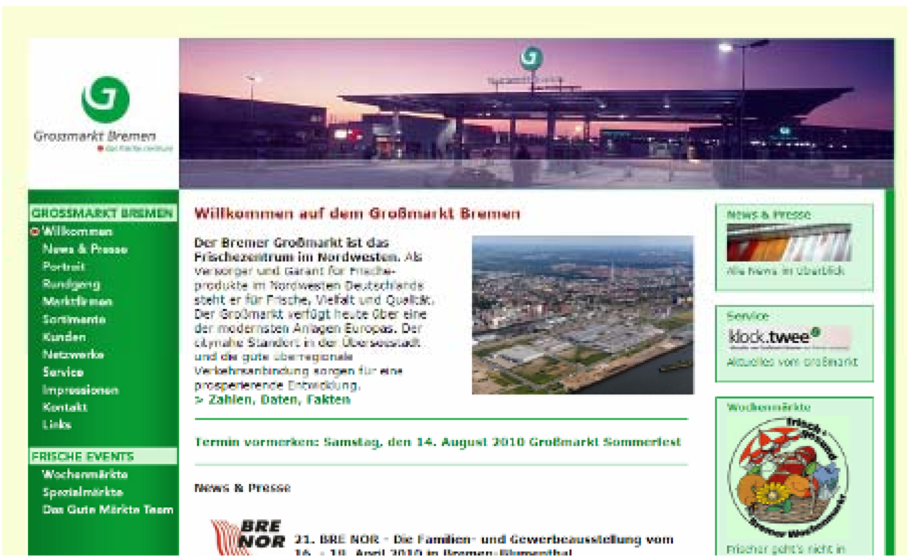
Close but different is the example of France, where there is a strong aestheticization of a more general form of communication. Among the images there are ducks, fish, tomatoes and flowers, next to full wine glasses that call for a toast. All this against a neutral background, which reminds us of the aesthetics of certain pieces of communication used by museums and contemporary art galleries. As Gianni Vattimo (1999: 87-91) points out, at times design and art share the same aesthetic themes in societies of generalized communication, whose central characteristic is their aestheticization. An indefinite action which seems to remain eternal by the use of verbs in the infinitive and the choice of a predictable palette: black, white and orange. The logo is on a black background and, morphologically speaking, it appears to be a abstract image of the sun. The typography is condensed, with a regular tone, and it is supported by the arch at the top.

Chile – Germany

If we contrast the pages described above with the Chile-Germany pair, we can observe that, instead of using products in their representations, they choose to show the infrastructures with aerial images which capture the markets in all their majesty and with a geographical location that goes beyond their specific perimeters. The predominant colour is green, in toolbars and buttons. The colour choice derives from the logos. The difference between them lies in the level of synthesis and abstraction. Both are organized around a circular support.

In the specific case of the Chilean website, the circle is used to contain the illustrative image that shows the wide variety of fruits, vegetables and meats we can find in the market. On the other hand, in the case of Germany, the circle works as a support plane for the initial of the market. The use of an outline font on the plane, in counter form, increases dynamism, outlining an upward spiral, as part of a geometric and abstract design.





3. SYNESTHESIA

The description above, along with a wider but recurring interpretation of Latin American and European municipal markets websites, poses the question about the strategic decisions on design and its possibilities to enunciate the richness of colours, smells and flavours which come into play in all markets. These three elements, which enhance one another, need to be represented. In this sense, colour properties allow us to link certain atmospheres that remain imprinted on our retinas, and which evoke not only a productive present but also a history of labour and diverse identities.

Markets are places where we can find pleasure, singular beauty and enjoyment . That polyphonic and synesthetic space where our grandparents used to go in search for their little treasures (not only out of eccentricity but also because of the relation between prices and family economy), which bound them again with their land of origin and relocated them forever in their land of destination. As part of that family novel Barthes (1978) told us about, I remember my mother's description of some ripe peaches that weighed almost a kilo, of an intense orange colour and a pungent smell that still linger in our memory.

How to name the fresh products of a market after Neruda's Odes or Jacques Prévert's poems? The answers to this question cannot be categoric. Our job is to say these new markets, Santa Fe and Valparaíso, with their histories and times to come.

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Colors of the desert.
The colors of the dishes in north Mexico

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ABSTRACT

The proposed theme is the product of an investigation held by the author with a group of students of Science of the Communication and History of the Universidad Autónoma de Coahuila, located in northeast Mexico. The northeast of Mexico is a desert region in which the ancestral presence of the nomadic Indians was occupied from the second half of the XVI century by the Spaniards and Portuguese. The more representative gastronomical products of the northeast of Mexico, in that triple influence have like common element the being of brown colors, as if it was a peculiar mimicry of the desert ground. Indeed, as well as salty foods (goat, roast of pig, dried meat), candies (burned milk, pulque bread) have similar tonalities and in their sobriety they offer a singular aspect that is hardly found in other sites of the national territory.

To eat is an act not only of nutrition but also an act of human interaction. According to Harris, "in which it is apt for consumption takes part not only the pure physiology of the digestion, but also the nourishing culture of each human group, its gastronomical traditions." (Harris 1985: 12) This way, in Mexico it can be observed that the great variety of dishes historically made and consumed by the settlers has a differentiation marked in each region, due to products available and in the characteristics of the inhabitants. Thus, for example, at the pre-Hispanic time, old the Mexicans of the center of the country had one varied diet, according to observed by the Spanish conquerors in 1521. Even though corn was the supplier of the 80 percent of the caloric ingestion of the natives, its feeding included deer, guajolotes (wild turkeys), rabbits and even dogs, zarigüeyas, as well as armadillos, iguanas and serpents. Also products of the sea and lakes like shrimps, clams oysters and crabs were consumed; besides fish, lobsters, octopuses, turtles, frogs, eels and even serpents, worms of maguey, jumiles (ants) or chapulines.

Among the fruits there were tunas (cactus fruit) and avocados, yellow guavas, white or black zapotes, chayotes, mamey, amaranth, kidney beans, seeds of pumpkin and nuts. In the north of Mexico, the characteristics of the feeding were very different since most of this territory is desert with cactaceous and pastures. In this part of the country the nomadic Indians took advantage of the animal meat like the quail, rabbit, deer and hares, besides corn and pumpkin, tunas, mezquite and quiote of maguey. Being the northeast of mainly desert Mexico, the climate and the vegetation derived from it they conditioned the availability of these nutritional products and favored the form to prepare them.

Although throughout the centuries, and more particularly in the last 100 years, feeding has integrated other products, thanks to processes of migration and mechanisms of supply, in this presentation we focused to study the typical products of Saltillo, a city of the northeast of Mexico, State Capital of Coahuila. These foods traditionally consumed by the inhabitants have a particular relation with the colors of the geographic environment that surrounds the city.

Saltillo was founded towards 1577. It is located in a valley where already lived the native chichimecas. Between the first settlers there were Spaniards and Portuguese and Jews, and a few years later immigrants tlaxcaltecas from the center of the country, that supported the colonization of the northern territory. Each one of the human groups that arrived as of century XVI contributed to the regional gastronomy diverse products and habits in their consumption. To chichimecas, for example, it is attributed to prepare the meat of head of cattle as barbecue, in a way cooked to the interior of a well; to the Jews is attributed the cabrito (goat), cooked in live coals. Besides flour tortillas, to the tlaxcaltecas are attributed the dishes that have as a base corn flour, besides the bread of pulque. Despite the diverse dishes that distinguish the gastronomy of Saltillo they have in common the brown tones, like the colors of the desert ground.

The gastronomy in Saltillo essentially includes dishes with meat, carbohydrates, sugars and fruits. Among the meat is the cabrito (goat), the cow and the pig. With them traditional dishes like the cabrito are prepared, the roasted meat, the barbecue, the roast of pig and the discada (stew prepared in a metal dish). From the corn are the chilaquiles, the red tamales, enchiladas and taquitos. From the wheat flour the flour tortillas and the bread of pulque are prepared. With sugars candies of milk and fruits like membrillo and perón (some sort of peach) are prepared.

Although it is certain, as Eulalio Ferrer says that “Mexico cannot be conceived without the presence and the glare of the color, made multitude and monument” (Ferrer 2007: 69), the traditional dishes of the north of Mexico, Saltillo particularly, do not have the explosion of colors that occur in other regions of the country. In that sense, it would seem perhaps that the idea of painter Rufino Tamayo is still valid: “My painting board is very limited, because the secret of the color does not reside in using them all, but on the contrary, to get to extract all the possibilities to them”. Although the trimmings imply a little color that offers sauces and salads, generally the main plates conserve among them a certain chromatic harmony. The menudo (cow’s intestines) is of dark red color, the roasted meat has a brown tone; the cabrito (goat), dark brown; the pig roast is of an alive red color; in the discada, the brown and reddish tones predominate.

As far as foods of high content in carbohydrates, the predominant colors are also brown or reddish: the enchiladas are of reddish orange tones like the red taquitos; the chilaquiles, to being fried acquire a tonality yellow-brown; and the tamales are of a very pale yellow color The bread and candies also offer similar tonalities: the bread of pulque is of a brown color and the flour tortillas have a whitish tone, like the ground and the sand of some parts of the desert of the north of Mexico. Generally we can observe that the flavor of the regional dishes is predominantly salty and spicy hot.

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Culinary expressiveness in national holidays

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ABSTRACT

Taking a pragmatic approach to the feasts prepared in Frida Kahlo and Diego Rivera's home in Coyoacan during the 1940's, allows for the appreciation of the colors and flavors of Mexican cuisine.

The expressive intentionality using the three colors of the Mexican flag –green, white, and red– reflected Frida and Diego's nationalist disposition. Frida used these three colors on paper flags and shawls for the decoration of their house, as well as in the preparation of elaborated feasts for the celebration of the national holidays during September.

The statement and redundancy of the colors of the flag could be also appreciated in the different meals prepared in Frida's cuisine: three colored rice, chili strips with cream and tomato, the Poblano chili in walnut sauce, fresh fruit water consisting of green lime, white *horchata*, and red *jamaica* which are representative of the variety of vegetables, fruits, and flowers that are still grown and consumed in the country.

Cooking for the eyes, permits the association of these colors with the different textures and the appearance of the dishes placed in artisanal tableware and with a wide range of smell and taste sensations that determine the social and aesthetic codes of the strong Mexican culture. The analogies that the colors –green, white and red– represent denote the national essence present in the flag of independent Mexico since 1821.

1. INTRODUCTION

After the Mexican Revolution in 1910, until the late fifties, the Mural Painting Movement in Mexico was widely spread by the different governments. Diego Rivera was invited by Jose Vasconcelos, the Secretary of Education, and by presidents from the post-revolution governments, to paint murals in public buildings with visual discourses to strength the social changes, and thus shaping the image of the Mexican identity in art expressions.

Parallel to this movement, Frida Kahlo's paintings were characterized by the insertion of the themes of national identity. From the privacy of the Casa Azul in Coyoacan,[1] in her art work, extremely subjective and emotional, she represented icons that relate to popular expressions, defining the model of the "Mexicanity".

> Frida Kahlo must be considered in the close shave because of her marriage to Diego Rivera, as well as her natural idiosyncrasy, that positioned her among the supporters of extreme nationalism... (Del Conde 2001: 26)

[1] Frida Kahlo's Casa Azul (Blue House) is settled in Coyoacan, a south district of Mexico City; the name of the house is due to its outside walls painted in blue (Pantone 2935); it was the place where she lived and worked. Upon Diego Rivera's death in 1957, the house was donated to the Nation and is now a museum with the cultural legacy of Frida Kahlo.

From her personal space, Frida's relationship with the Mexican cuisine was a learned experience from her family house, however her joy and practice for making different dishes came from the unique relationship that she had with Ruth Marin, Diego's former spouse, who taught her the sophistication of the succulent Mexican cooking.

Taking a pragmatic approach to the feasts prepared in Frida Kahlo and Diego Rivera's home in Coyoacan during the 1940's, allows for the appreciation of the colors and flavors of these meals.

2. PRAGMATICS FOR COOKING

In the text, *Las fiestas de Frida and Diego*, Guadalupe Rivera –daughter of the painter– describes in great detail the peculiarities of how her mother Ruth Marin learned the Mexican cuisine from her grandmother –Isabel Preciado– and from a book of recipes, *Recetas prácticas para las señoras de la casa*, volumes I and II*,* published during the late nineteenth and early twentieth century's in Guadalajara. On the other hand, Frida was acquainted with the secret particularities of the Mexican cuisine from her mother's recipes in *Cocina nueva mexicana*, "a collection of instructions, published in the format of a dictionary, to learn how to cook tasty Mexican food" (Rivera and Corcuera 1994: 14).

Guadalupe Rivera inherited these cookbooks and was able to learn the minutiae of the recipes which she portrays in her book. She describes Frida's delight to decorate and set the table along with the preparation of Diego's favourite dishes, selected from the best of the traditional cooking. And in this way, she celebrated "saints days, birthdays, festivals, either secular or religious," as well as the national holidays. Guadalupe Rivera describes one of them: "Since the beginning of the month, Frida was dedicated to buy small flags –green, white and red–, and placed them around the house, pinning them in the fruits that were placed at the centrepiece of the table, in the ones chosen to paint still life or in pots at the corridors and stairways..." (Rivera and Corcuera 1994: 47).

The national festivities began on September 15 evening when the Rivera family attended the Mexican night at the Centennial Garden in Coyoacan, where they tasted the goodies that were prepared by the market vendors and talked with the families of the neighborhood. The next day, the family used to go to the center of Mexico City to attend the military parade and before noon, they returned home so Frida could continue with the preparations for the meal, where they usually invited important political figures and some of Diego's friends, contemporaries of the nationalists struggles (Rivera and Corcuera 1994: 48).

3. CULINARY SYNTAX

In the pages of her book, Guadalupe Rivera expresses enthusiastically how were the national holidays celebrated in 1942 at the Casa Azul, where Diego's daughters –herself and Ruth– lived with Frida and Diego, and describes the dishes prepared for this occasion. Frida had the assistance from the cook of the house, Eulalia; and what came natural to the painter was "setting the table with the best of their wares, the Puebla-edged white with cobalt blue and monogrammed with the initials F and D of the same color. The blue blown glass vessels and several jars of the same style with water made out of fresh fruit that matched the patriotic colors..." (Rivera and Corcuera 1994: 49).

The statement and redundancy of the colors of the flag could be appreciated in the different dishes prepared in Frida´s cuisine: three colored rice, chili strips with cream and tomato, the Poblano chili in walnut sauce, fresh fruit water consisting of green lime, white *horchata*, and red *jamaica* which are representative of the variety of vegetables, fruits, and flowers that are still grown and consumed in the country.

In September in most of Mexican markets, there were sold green, white, and red *tuna* –the apple fruit from cactus. In that occasion, Frida made a natural still life with Mexican flags, and fruits, sweet and juicy limes, and two pomegranates and other fruits in halves. This center piece composition was immortalized in one of her paintings: *Still life with parrot and flag*, oil on masonite, 28 × 40 cm, dated 1951.

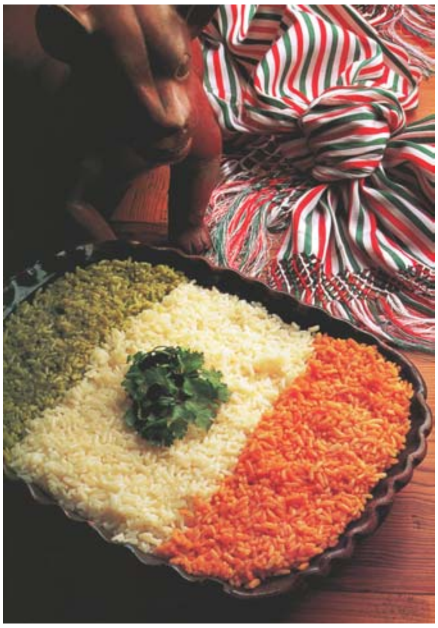
Following it is described a recipe to prepare rice, specifically the green rice.

Rice recipe

First part
1 cup rice
2 tablespoons corn oil
½ small onion, finely chopped
1 / 4 cup water
1 ½ cup chicken broth
½ squeezed lemon
Salt to taste

Second part

Green rice
add 3 poblano chilis deveined
ground with ¼ cup water
¼ cup chopped cilantro leaves
(Rivera and Corcuera 1994: 56)



Photograph by Ignacio Urquiza.[2]

Here is a detailed explanation of the cooking procedure:

> Fry the rice for a little more than one minute, add the chopped onion, and when the rice sounds as sand, add ground chillies, then add the chicken broth, the cilantro, lemon juice, and salt. When the broth begins to boil, cover the pan and lower the heat, let it boil during 15 minutes until rice is cooked. (Rivera and Corcuera 1994: 56)

4. SEMANTICS OF COLOR

The analogies of the colors –green, white and red– denote the national essence present in the flag of independent Mexico since 1821. The norms for the use of these colors were determined in the 1917 Mexican Constitution, and since then, the flag has had minor changes in size and color tones; nevertheless its meaning, defined during Juarez presidency, has remained unaltered: green (Pantone 3425c) for hope; white for unity; and red (Pantone 186c) for the blood of heroes.

These colors of the flag, used in the Mexican cuisine, articulate the semiosis of the visual signs with a wide range of smell and taste sensations of the meals that characterize the strong

[2] In Rivera and Corcuera (1994). Adapting recipes by Laura B. Carazo Campos.

social and aesthetic codes of the national culture, built with the culinary traditions of the ancient Mesoamericans, with the Spanish colonial inheritance, and with the innovations disposed in modern life –cooking devices, growing procedures, and distribution of goods.

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The ever-changing color of apples

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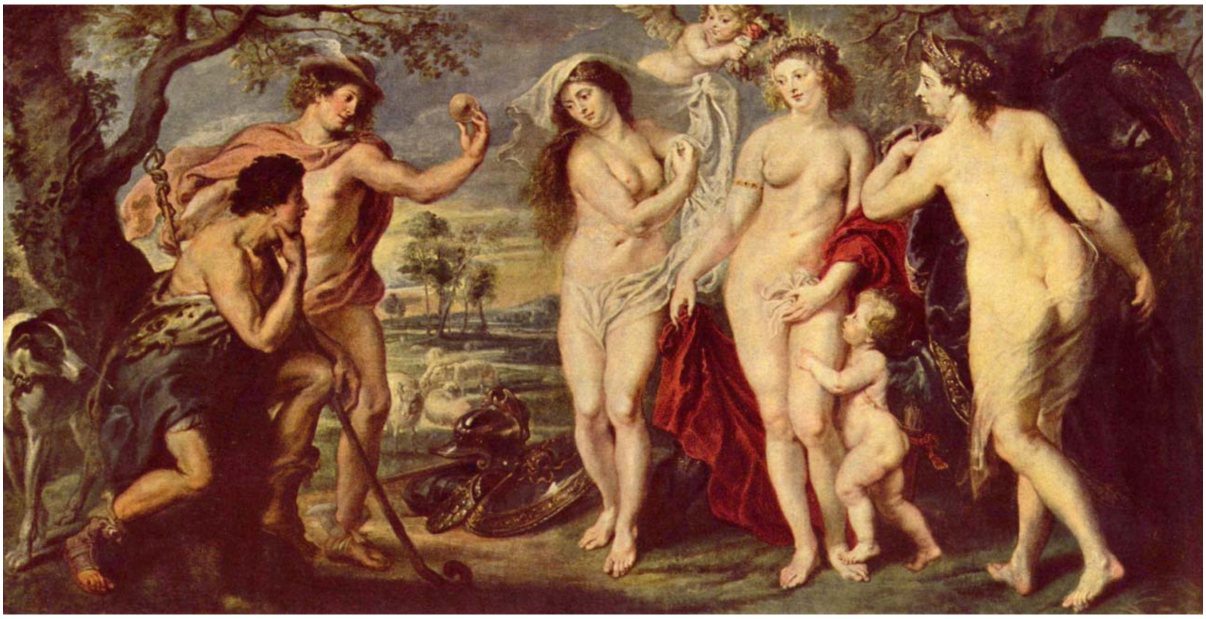
Throughout the times of pictorial production the protagonist has undoubtedly been the human figure. It can be found in nearly every painting except, of course, in geometric abstract works or the art form known as informalism. Thus, to refer to the human figure in painting would be almost too obvious.

However, have we ever pondered or estimated how many times the representation of apples appears in pictorial iconography?

This precious fruit is represented as both food and ornament, and even as a symbolic icon of mythology and biblical history. From Adam and Eve's epic with the forbidden fruit to still lifes, fruit garlands, among other examples, the apple appears time and again all throughout pictorial events.



P. Rubens: Venus and Ares.

To begin with, let us see the morphologic and chromatic characteristics of actual apples: It is the fruit of medium-sized trees, native to Europe, West Turkistan and southeast and central Asia. Nowadays, the countless varieties of apples grown all over the world include: Golden Delicious, Kinsei, Fuji, Elstar, Braeburn, Royal Gala, Rubens, Winesap, Starking Delicious, Pink Cropps, Morgent Duft, Granny Smith, Jonagold, and Idared. Here, in Argentina, the more popular varieties are: Royal Gala, Fuji, Granny Smith, Rome Beauty, Red Delicious and Golden Delicious among other varieties not as well known.

That is to say, colors may range from yellow, brownish yellow, green, light red to dark red. Depending on the variety, apples may be of one solid color, others present red, green or brown specks, or pink, red and white short stripes. Apple pulp varies from bluish to yellowish white, and it may be more or less translucent.

What has prompted the presence of the apple in art? On the one hand, it has surely been its being a vegetal entity so frequently visible in our historical roots and its wide spreading all over the world. On the other hand, however, the mythical narrative attached to this fruit has certainly played a role. For instance, in Eastern Europe, to give a golden pippin shows love interest; in Greek mythology, the myth of Paris and Aphrodite involves a gold apple, object of conflict presented by Eris to create discord among the goddesses, as it read "*for the most beautiful*". The golden apple also appears in Hippomenes and Atalanta who succumbed to the temptation of picking up the three apples of pure gold tossed at her feet; and in Acontius and Cydippe, he casts an apple inscribed with a love promise.

The literal translation of the Latin phrase *petere malis quandam* may be "throwing apples at someone", but its actual meaning is "to declare one's love for someone" or "intent to woo". Thus, the apple was an erotic symbol which appears later on in the Romanic period as a symbol of Paradise and represented in Christian iconography as such: Virgin of the Apple; Virgin and Child with the apple. This representation continues well into the Renaissance with the same meaning, coexisting simultaneously with the biblical myth of Adam and Eve. In the Garden of Eden the apple was the forbidden fruit, which Eve took tempted by the serpent and thus became the symbol of Paradise lost. Although the Holy Scriptures do not actually mention the species of the tree of knowledge, where Eve can often be seen offering Adam a fruit, the word *malum* in Latin means both "apple tree" and "evil", thereby deducing that it was an apple tree.

What color is the apple each time it appears in art works? Does it correspond to the current index color of the typical 'red delicious', today's referent of 'apple color'? Does it relate to aesthetic criteria? Is its figure recognized by the narrative context in which the apple is represented?

The apple appears in Roman Art frequently as an ornamental fruit in painted gardens (e.g. Lyvia's house, Rome) and again in decorative enameled ceramics in renaissance Florence. In these cases, the color of apples was not red, but that of golden pippins, that is to say, yellow.

In the Romanic period, the Virgin was often represented with the apple of Eden in her hand, usually red in color (polychromatic Romanic sculpture); whereas in the Renaissance the apple was in the Child's hand and the color was yellowish or neutral red.

It is in the Baroque and Rococo period (16th and 17th centuries) where in mythological representations as still lifes, the apple appears repeatedly, and the color varies according to the stylistics. Thus, Rubens' apple is yellow, while Caravaggio's is similar to the yellowish red of the Annurca apple or the current Fiji. During the nineteenth century Naturalism, G. Courbet paints his apples and pomegranates in an esthetics way exaggerating the redness of the fruits. Whereas, in Delacroix's Odalisque (Romanticism) the apples in the background are red with shades of green also in an aesthetic way.

So far the color of apples had varied from yellow to red, with more or less brown and black tones. Not until Delacroix does the color green start to appear in apples. Later in the twentieth century, the color yellow would disappear and Magritte and others would depict apples as green, thereby giving rise to the popular color name "apple green".

Impressionists, such as Renoir and Cezanne, treated apples with referential and aesthetic color. The Pop movement (Andy Warhol, 1985) represented the fruit as referential and aesthetic, even to the point of depicting it in a totally aesthetic way where the apple appears completely different in color and shape from its natural form. In Design, the art form of the twentieth century as Munari calls it, the apple reappears, even in tattoos. Nowadays, we find ephemeral art where the apple and its original color give rise to constructed images.

Thus, we construe that the color of the apple as it appears in art can be classified as seen in the chart below, where the referential and aesthetic items prevail. And as color-chromatic sign in images (Manganiello 1996). The notion of apple can be generated by a color formal proposal (from red to the idea of apple), or it can be a consequence of shape (a series of apples of different colors), or it can arise univocally from the conception of the idea (red apple).

	Referential	Analogical	Symbolical	Aesthetics	Index color red, current apple
Rome Lyvia's house	●			●	
Romanic Virgin of the apple	●		●	●	●
Renaissance paintings		●	●	●	
Renaissance ceramics	●			●	
Baroque Rubens	●		●	●	
Baroque Caravaggio	●			●	
Naturalism Courbet	●			●	
Romanticism Delacroix				●	
Impressionism Renoir, Cézanne	●			●	
Surrealism Magritte	●			●	
Pop Art Warhol			●	●	
Design various	●			●	●

	From red to the idea of apple	From the shape of apple to color	Univocal criterion
Romanic Virgin of the apple	●		
Naturalism Courbet			●
Romanticism Delacroix	●		
Impressionism Renoir, Cézanne	●		
Surrealism Magritte			●
Pop Art Warhol		●	

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Communicating through color and health

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INTRODUCTION

Nutrition is a substantial process for all human beings as it provides all the necessary elements inherent to a healthy life. The rate of absorption of nutrients depends on the freshness and color of the food. According to its origin, food can be classified into three groups:

- Vegetal origin: including vegetables, fruits and cereals.
- Animal origin: including meat, milk, and eggs.
- Mineral origin: including water and mineral salts.

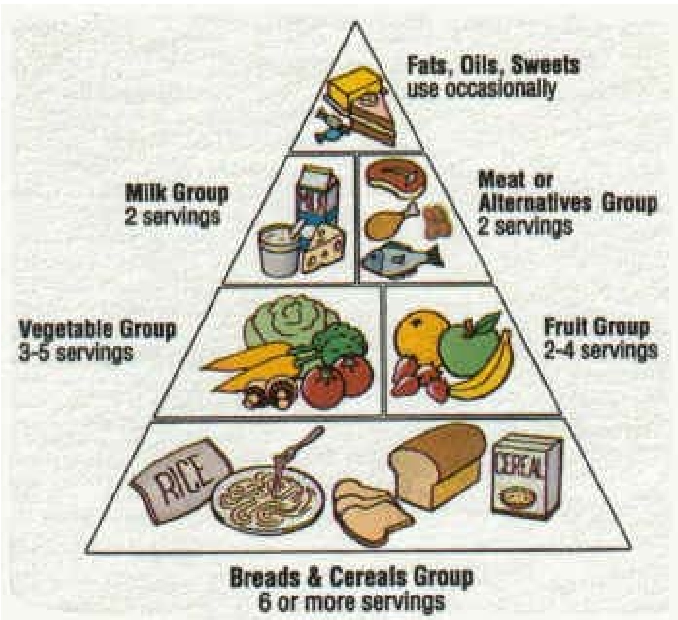
Each one of these categories of food provides our organism with substances that are essential for its functioning and development.

These substances include the following:

- Hydro-carbons (bread, flour, sugar and pasta), which are high in energy.
- Proteins (meat, eggs, dairy and legumes), which are necessary for the formation and growth of tissue.
- Lipids (fat and oil), which are energy producers.
- Water and mineral salts, which balance the functions of the organism.
- Vitamins, which are essential substances for the organism's good health.

A good nutrition should be balanced and complete; i.e. all the above mentioned groups must be present to cover the needs of the individual.

To be healthy, people need to ingest different kinds of foods and liquids. The pyramid of basic nutrients provides a visual representation of the quality and quantity of nutrients that are needed for a daily balanced intake.



LET'S GIVE SPECIAL ATTENTION TO VITAMINS

A vitamin is an organic compound required as a nutrient by an organism. Vitamins promote health and are essential for the normal growth and development of a multicellular organism. Let's take a look at the most important vitamins:

Vitamin A: Vitamin A is a fat-soluble pale yellow unsaturated alcohol derived from carotene. It helps form and maintain healthy teeth, skin, mucous membranes, skeletal and soft tissue, sight and reproduction. One of the earliest and specific manifestation of vitamin A deficiency is impaired vision, particularly in reduced light-night blindness. Vitamin A deficiency can also lead to dry skin, impaired immunity and dryness of the conjunctiva as the normal lacrimal and mucus secreting epithelium is replaced by a keratinized epithelium, an important source of child blindness in developing countries. Vitamin A can be found in carotenes, present in many vegetables such as carrot, pumpkin, spinach, kale and sweet potato.

Vitamin B1: Thiamine or thiamin is a colorless crystalline substance that is important in carbohydrate metabolism. Yeast and pork are the most highly concentrated sources of thiamine. Some other foods rich in thiamine are liver, heart and kidneys, eggs, green leaf vegetables, whole grains, oatmeal, nuts and legumes.

Vitamin C: The richest natural sources of vitamin C are fruits and vegetables such as citrics, strawberries, grapefruit, pineapple, guava, broccoli, Brussels sprouts, tomato, spinach, kale, green pepper, cabbage and turnip.

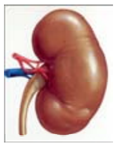
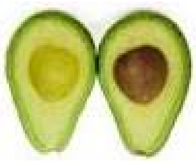
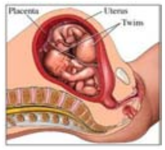
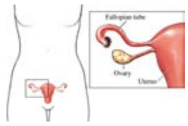
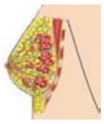
Vitamin D: Vitamin D is essential for the development of normal bone integrity and promotes the absorption of calcium and phosphorous. Natural sources of vitamin D include eggs, liver, tuna and milk fortified with vitamin D. Vitamin D is also naturally produced by the human body when exposed to direct sunlight.

Now that we have acknowledged that only a balanced meal by way of an adequate selection of food provides our organism with the basic needs for its proper functioning, vitamins have become more and more important to ensure a good nutrition.

Vitamins would not be needed if we guarantee to ingest all the foods and liquids that our organism requires to function in a proper manner. Please take a look at the following cases of some fruit and vegetable, provided they are fresh and have the right color:

NATURAL FOODS, COLOR AND NUTRIENTS

A slice of carrot looks like a human eye: the pupil, the iris and the radiant lines look just the same as a human eye. Science has demonstrated that carrots improve the blood flow and the functions of the eyes.		
A tomato has four chambers and is color red. Human hearts have four chambers and are red as well. An investigation shows that tomatoes are full of nutrients for the heart and the blood.		
Grapes grow in a bunch that has the shape of the heart and each grape looks like a blood cell. Current investigations have demonstrated that grapes are good for both the heart and blood.		
A nut looks like a tiny brain as they both have a right and a left hemisphere and upper and lower cerebellums. Even the lines or pleads are present in both, the nuts and the brain. We know that nuts help to develop more than three dozens neurotransmitters.		

Beans heal and help to avoid renal failure and they look very alike to human kidneys.		
Celery, rhubarb and Bok Choy, among others, look like human bones and they have proved to help strengthen them. Bones contain 23% of sodium and these vegetables contain 23% of sodium as well. If a diet lacks sodium, the body uses the sodium of the bones and this makes them weak. These vegetables refill the skeletal needs of the body.		
Eggplants, avocado and pears relate to the health and well functioning of the matrix and cervical neck and they clearly look like these organs. Current investigations have demonstrated that when a woman eats avocado during the week, she balances her hormones, looses weight and avoids cervical cancer. Surprisingly, avocados take exactly 9 months to grow from a flower to a mature fruit. There are more than 14,000 photolytic elements in each one of these foods (modern science has only studied and named 141).		
Olives help to keep ovaries healthy and functioning properly.		
Tangerines, oranges and some other citric fruits look like the woman's mammary glands and it has been proven that they help keep breasts health.		
Onions are very similar to the cells of a human body. Currently, it has been demonstrated that onions help clean the body's cells. They even cause tears, which clean the eyes.		

When choosing these foods we need to ensure their quality. We must be aware that their consistency and freshness is guaranteed by the intensity of its colors.

When we refer to a color, we must take into account its meaning. Color is a common feature to humanity and, for the purpose of communication, all civilizations have tried to define colors.

Two American anthropologists, Brent Berlin and Paul Kay, carried out a detailed study on the names of colors in 98 languages and reached to the conclusion that many aboriginal languages in Central America only have names for five basic colors.

Thus, we understand that communicating through the color of food should currently be understood as a universal classification; and not a casual classification arising from a language and a concept granted to each civilization throughout the years or by its relation with other civilizations.

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Color and feeding, a compromise between necessity and desire: biological and cultural semiotic processes

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ABSTRACT

Food, and everything around the act of eating, configures one of the most elaborate, culturalized and codified kind of semiosis (the process of signification), with a long history in mankind. And the visual sense, particularly color vision, plays a key role in this semiosis, perhaps even more important than the senses of taste and smell, because while these are anchored exclusively in food itself, vision and color are present both in food and in all the complex network of relationships that have feeding as its axis.

Even when feeding is a basic need for our survival, because we are living organisms, this act does not escape from the social frames that regulate and codify every human action. As an activity that is executed in various instances along a day, every day of our life —a good deal of time in our life is devoted to eating and their adjacent activities—, it acquires sense because of being a social act tied to the history of every culture.

COLOR IN FOOD: NATURE OR CULTURE?

The social discourses that describe and prescribe food are numberless: from medicine to economy, from religion to industry, from the discourse of subjective preferences to the scientific discourse. In parallel, food has been functional to culture. The rituals about eating impose taboos, the prohibition of eating certain things or in certain contexts imposes a social law that organizes, by means of this activity, the way in which a social group functions. Cultural anthropology, whose paradigm is represented in Lévi-Strauss' *The raw and the cooked* (1964), explains how cultures are organized starting from tabooing behaviors relative to the basic needs, such as sexuality and feeding. It is possible to organize systematically a cultural typology according to the prohibitions around consumption of food. In Figure 1, the culinary triangle (whose vertices are raw, cooked and rotted) shows the possible relations (Lévi-Strauss 1968 [1981: 428]). If we consider the chromatic transformations that are involved in those processes, we can think in taboo colors (non-edible chromatic stages of food). For instance, the excessively reddish coloration in cooked cow meat is interpreted as *raw*, and for this reason is rejected by the diner. On the contrary, the course towards rotted in the case of the blue cheese is accepted and appreciated by the gourmet, while the same coloration is rejected in bread or other food.

Culinary art, gastronomy and other regulations such as nutrition and diet are born at certain stage in the culture. Everything presupposes an order and a logic to introduce a control. With time, culture has become more complex, the act of feeding turned out to be an spectacle, and the "food-sign" is consumed independently of the "food-object". The discourses of marketing and media show the activities related to eating as an spectacle: think for instance in gourmet TV channels. An economic law is imposed as a regulating means, abundance and eccentricity are in opposition to extreme famine. Then, the limit appears articulated from the medical and aesthetic discourses that introduce the culture of diet. It is a rational hunger, self-imposed as a sublimation of the excess (the lack of measure understood as sin, gluttony). The pathological manifestations associated with food would be bulimia and anorexia, on one extreme, and morbid obesity, on the other one, documented by cultural and historical definitions.

At the basis of the discourses about feeding, as a veil, it seems that the intention is to exert a control on the pleasure of eating, a function associated to nutrition. Whether or not the eating person recognizes the color of the food does not change its nutritious properties at all. Color has an informative, emotive, evocative, playful function, motivating the consumption of food; this is the reason why food color is so relevant for industry and marketing.

At the beginning of human life, shapes and colors are not relevant for the satisfaction of hunger. The baby cries, and he calms down when receiving the signals from his mother-food: he smells and touches her skin, hear her voice and the beating of her hearth. Since his vision is deficient, the olfactory, auditory and tactile signals are fundamental for survival. The newborn baby does not know the color of his food; infant milk formulas imitate this color, but it is not a relevant information for the consumer, it is relevant for the adults, for whom the similarity facilitates the substitution in terms of verisimilitude.

Feeding involves a complex set of semiotic processes: physiosemiosis, biosemiosis, and cognitive semiosis, three stages that appear recursively in a chain of events in which color works as a sign. In physiosemiosis, radiation interacts with foodstuff, producing physical and chemical processes that determine the material characteristics of food. In biosemiosis, living beings interact with foodstuff, reacting primarily to their sensorial aspects, basically seeing it. In cognitive semiosis, food is recognized, categorized and evaluated by its sensorial aspects, and more elaborate signs are created from this (Figure 2).

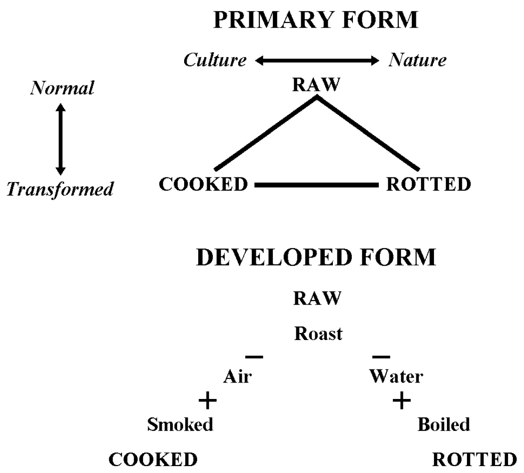

Figure 1. Lévi-Strauss' culinary triangle.

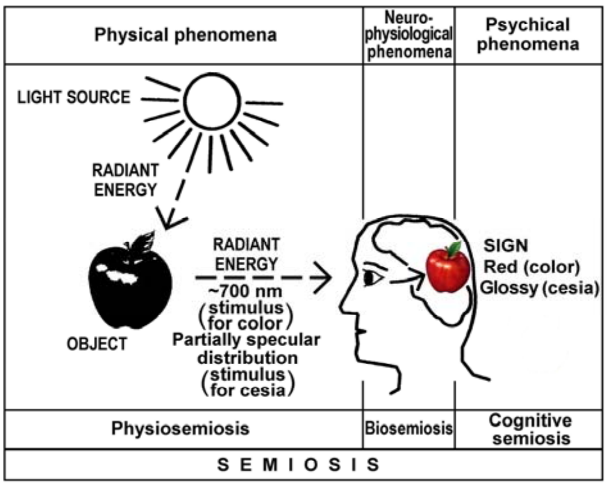

Figure 2. Stages in semiosis.

All the processes implicated in biosemiosis and cognitive semiosis are shared both by human beings and other animal species. One difference, however, is the nature of the biological processes, because different species have dissimilar kinds of vision systems, reacting to radiation reflected or transmitted by foodstuff by seeing color in a different way. Another difference is the nature of the cognitive processes, because species use different kind of languages or sign systems and have singular cognitive competences, with which they categorize the external world and communicate their experiences and knowledge mainly in a intra-specific way. All this results in the fact that color, as a useful sign for finding and selecting food, works differently for every species. But let's concentrate on human semiosis.

Within the field of anthroposemiosis, that is, semiotic processes confined to human beings, the representation of food is a highly relevant issue. Intentionality and the weight of culture, with their codified meanings, cross over all the stages, covering with their influence and transforming the basic act of feeding (a biological need) into a very complex and sophisticated semiotic process that has countless particularities along the history of human culture. But color is important from the most basic stages, not only in the sophisticated forms of cultural codification of food and eating in nowadays (Figure 3). The interpretation of a meal will depend on the interpreter, on his subjectivity, like or dislike inclinations, the social frames that regulate the act of feeding in every culture and the contexts that frame eating as a symbolic performance.

Everything confirms that we never eat an object, but a complex, sophisticated sign, even when it is just a simple red apple (and before thinking about the biblical emblem of sin).

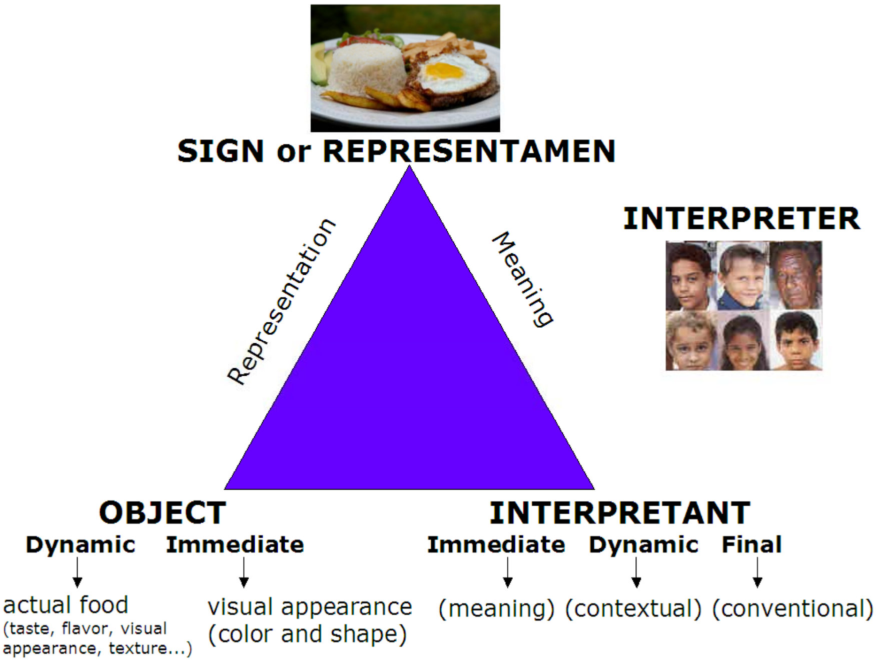

Figure 3. Semiotic triangle showing the process of interpretation, adapted from Peirce (1931-1935).

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Multi-sensory culinary colours: Shifting hues from green to blue

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ABSTRACT

In the past culinary colour codes and applications evolved slowly over time as general cultural phenomena. Since the 1990s, however, colour has increasingly become one of the most important features in the invention and marketing of new products in the food – as well as cosmetics – industries. Indeed frantic competition has lead to using colour in a manner that goes beyond tolerable standards and limits. In order to attract, surprise and even shock consumers, producers are breaking all previous colour taboos especially through excessive artificial innovations. Designers and promoters not only aim to sell specific products, but also to change consumers' basic conceptions of foods. This paper is based in a joint research project of the *Comité français de la couleur* and *ad chroma* associations that are both based in Paris and have been collaborating since February 2010. Reflecting on the boundaries of colour concepts for food, the particular aim here is to explore the work of culinary designer and co-researcher Muriel Grosjean who considers her field as 'sensory design' (*design sensoriel*), i.e., inventing and elaborating special visual, tactile, aromatic and sonic aspects of products such as chocolate bonbons, confectioneries and other delicacies. Her objectives include enhancing how a product is perceived by consumers such as making it appear exotic or emphasizing qualities that stimulate sensual arousal and fantasy.

1. CHROMO-GUSTATORY GREENS AND BLUES

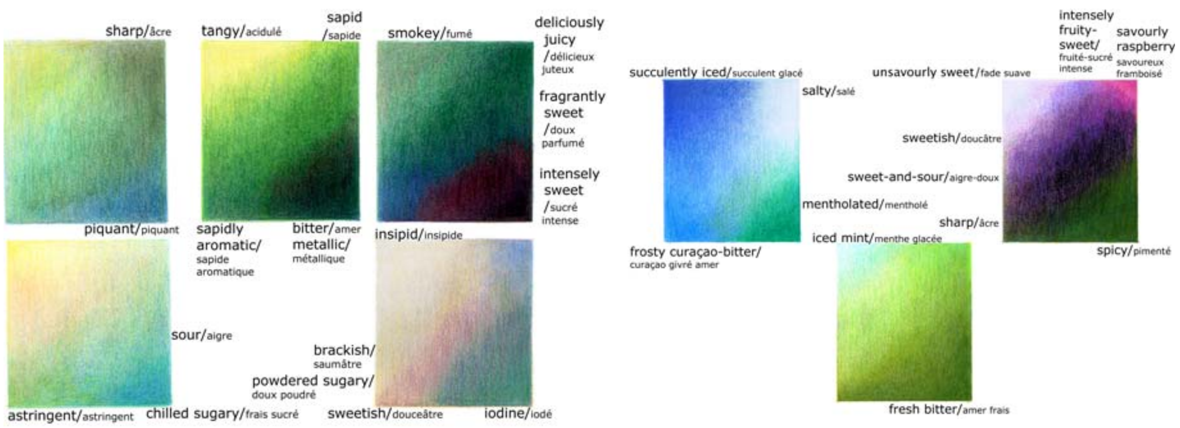

Fig. 1. Intersensorial descriptors and chromo-gustatorial modulations. Visuals by F. Cler.

A major concern of the joint project is the multi-sensorial development of innovative design. The study focused first on colour-taste associations. Considering vegetables, fruits, beverages and sweets that range in colour from green to blue that are traditional among fresh and uncooked food –but excluding edible flowers used in trendy gastronomy– the result of the study is a reduced palette with colours ranging from yellowish green, green, green-blue, blue to purplish blue that appear rather 'cold' than 'warm' (Figure 1). As is evident from the chart above, establishing chromo-gustatorial descriptors based on a study of West European culinary cultural tradition is a challengingly complex endeavour. Any single colour can correspond to a wide range of different tastes and just a few of many relevant determining factors not only include the product's specific character, but also its particular culinary context and the highly subjective nature of personal colour and taste perception. Thereby any manipulation of a product's colour not only changes its appearance but also the taste attributed to it is never reducible to any one aspect.

2. OBSESSION – GREEN AND BLUE SENSORY APPETISERS

Culinary designer and co-researcher Muriel Grosjean deals with the multi-sensory qualities of food products (Grosjean 2010), investigating how colours can produce a mysteriously vibrating, electric effect and how far the colour of a specific product can be shifted from a familiar hue (e.g., green) to an uncommon one (e.g., bluish green to blue). In the joint project Muriel Grosjean shared with us her expertise in the art of making dazzling food creations. *Obsession*, her exquisite collection of individually-moulded appetisers, demonstrates how familiar foods can become eccentric and extravagant by modifying their colours to intense fluorescent emerald greens and turquoise blues (Figures 2, 3). The resulting surreal touch serves as further inspiration for fascinating cocktails or delectable finger foods and 'state-of-the-art-futurist' appetisers.

Fig. 2. Zalgue – Menthe à l'eau iodée [Iodine Mint Water]. Design, realisation and photo: Copyright © Muriel Grosjean, Paris 2006.

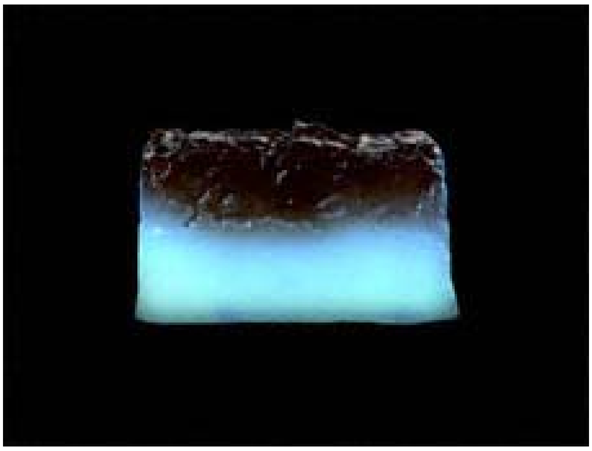

Fig. 3. Stratosphère – Menthe glaciale [Iced Mint]. Design, realisation and photo: Copyright © Muriel Grosjean, Paris 2006.

An integral aspect of innovative food product design is the aim to intensify consumers' demand for the products by evoking the senses, emotions and imagination through various means including giving the products unusual names. One main question in this field is: Where is the chromatic threshold or limit within which products are still recognizable and identifiable as edible and delicious? For example, when a brilliant green *Zalgue – Menthe à l'eau iodée* [Iodine Mint Water] (Figure 2) is modified in colour to an electric fluorescent blue *Stratosphère – Menthe glaciale* [Iced Mint] (Figure 3) the otherwise identical product is perceived as tasting deliciously refreshing and sweet. This demonstrates how colours can define consumers' expectations and psychologically affect their perception of a product's taste. In particular culinary traditions certain colours, e.g., blue, are simply not used for food as they are considered unappealing or unacceptable. Such a practice establishes a kind of general cultural block. However, for a decade or more designers and industrialists alike have been pushing the boundaries of tolerance and acceptation towards newly frenetic and excessive levels of experimentation and application of extreme colours as well as developing dual or complex tastes and materials with cooling and heating effects.

3. NATURALLY BLUE: A NEW COLOUR TREND FOR FOOD PRODUCTS

Multi-sensorial culinary events exploring colour and taste have been organised by *Comité français de la couleur* since 1998, e.g., special colour-and-food-related discovery walks in Paris explore the relationships of the food and cosmetics industries to concepts of luxury, beauty and pleasure. During an experiment in 2002 the *Comité français de la couleur* invited people to taste blue fried potatoes, turquoise oysters and violet mozzarella. The result was a gustatory and visual shock that was a repulsive experience for many and some persons even got sick (Cuvillier 2002). If special coloured lights would have been used to modify the unusual colours of these foods to 'normal', the foods would rather have been perceived as tasting just fine. In this same experiment some especially fanciful participants imagined the blue fried potatoes and turquoise oysters as having been fished from the hidden depths of the Atlantic Ocean, i.e., the fantastic colour served to trigger their imaginations and inspire unrealistic suppositions as if the food itself had a hallucinogenic effect (C. M. 2001). In general, people get in a blue funk when they encounter blue, turquoise or violet food! Such a reaction confirms how strongly taste is affected by conventions.

Fig. 4. Natural Blue? Obsiblue – Raw Blue Caledonian Prawn.
Photo: markeaprawns.com

Fig. 5. Natural Blue? – Raw Obsiblue Available in France since 2009.
Photo: Ze Kitchen Galerie Paris

Fig. 6. Cooked blue prawns turn from blue to a pale pink colour tinged with blue.
Photo: www.buzzswharf.com

Will blue become a familiar food colour in the future? Generally any uncooked prawn is called 'green', yet an uncooked obsiblue, the new Caledonian prawn (Litopenaeus stylirostris), is always blue! (Figures 4, 5 and 6)

A high quality product grown in New Caledonia's freshwater farms since 1983, the blue prawn is free of any food colouring. It can be eaten raw or cooked. It is famous for its balanced sweet taste and succulently firm texture. This exclusive product is said to be 'sustainable' and is competitive with comparable products from China, Thailand and Indonesia. When the obsiblue is presented to potential consumers without any background information the most common reaction is to reject it as being inedible. Another blue shellfish, the blue lobster is uncommon. Its bright blue colour is the result of genetic mutation; when cooked, however, it turns bright red. Will natural blue appeal to consumers in the future? For example, will blue rice naturally coloured with red cabbage become a familiar dish or is it just too banal?

4. ABOUT THE COLOUR ASSOCIATIONS

In 1959 Fred Carlin founded the non-profit colour association *Comité français de la couleur* to explore colour applications in the textile industry. In order to be able to forecast colour trends industrywide, the CFC creates a colour palette once a year. Since 1963 this association has been a member of the international association *Intercolor*. Today *Comité français de la couleur* is concerned with colour in many other fields including cosmetics, leather goods, luxury goods, interior decoration, architecture and design. The association organizes multi-sensorial and pedagogical workshops, as well as colour events for a broad public.

ad chroma, a non-profit colour association founded in Paris in 2003, is concerned with dynamic aspects of light, colour and materials within our private and public environments. The objective is to identify converging interests in using colour and colour appearance as a trans-cultural language in research, practice and communication via an open-minded and critical perspective.

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Of imaginary and fantasies/phantasms: A critical view of the relationship between colour and food

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ABSTRACT

Through industrialization what was once an exceptional fashion has now become standard practice: as a marketable aspect increasingly the colour of food is something that can neither be believed by eyes nor tongue. Is it cynicism, egoism, scientific naivety, commercialism or even a new utopia-ism of health care that aims to produce 'desirable' fruits and vegetables by manipulated colour appearance? A typical example is the tomato. As cultivation and processing methods were increasingly mechanized, colour, shape and size differences disappeared. Eventually the ripening process was eradicated from the consumer's view and a well-defined perennial permanent-red haunted the fantasies of business-oriented practices. The red tomato became the genetic mask of a 21st century prototype; an industrial icon with no content; a signified without signifier; a pure mental concept recognizable and accepted by global markets; and a visually perfect appearance with no taste.

Today, however, the monochromatic colour appearance –and insipid taste– of the tomato is seemingly being displaced by a plethoric evolution not only in colour and taste, but also in size and shape. The aim of this paper is to inquiry into colour uniformity and variegation of fresh and industrially-processed food products. In particular the history and new trends of the tomato will be considered. Thereby the results of field investigations concerning common and new colours of the tomato and tomato products will be presented with critical remarks as to how innovative technologies and scientific research have served in changing notions and the colour of food over the last few decades.

1. INTRODUCTION

Facts and figures on hunger and poverty around the world are alarming. Poor water and sanitation, climate changes and profit-based monoculture policies, as well as civil conflicts and war increase the risk of hunger, disease and early death. Against this background 'Colour and Food' is not a priority, e.g., for those people and countries that suffering from famine. Therefore just raising issue of 'colour and food' is intended as a critical provocation within the larger context of food-related discussions.

In recent history concerning colour application in the food industry, i.e., since the 1950s, it is important to consider that product engineers were engaged in inventing more and more high protein, industrially-processed, edible products. Low in cost they are manufactured by turning different fresh products into flour, powder or paste. In the end the final products all have the same standard or 'neutral' colour appearance that is no longer evidence of any intrinsic quality or ripening process, but rather an abstraction. Astronauts' food is a commonly known example of this development.

2. TYPICAL TOMATO RED

The transformation of colour in food cultivation and production is also interestingly reflected in the history of the tomato. Once upon a time the tomato was a wild, small hairy, green and bitter fruit. Already cultivated by indigenous Americans, it is first mentioned in Italy by the herbalist Matthioli in 1544 who writes about the *pomo d'oro* (golden apple), a tomato approximately the size of a fist and bright yellow in colour. By the 1600s high society people were calling it the 'love apple' not only because of the tomato's reputation of being an aphrodisiac, but also because of its red colour. During the 1800s the tomato was being eaten throughout Europe and in the 1830s–1840s it became popular in North America leading to a 'tomato mania'. As cultivation and processing methods were increasingly mechanised, however, colour, shape and size differences of the tomato seemed to disappear. Eventually the ripening process was eradicated from the consumer's view and a well-defined perennial permanent-red haunted the fantasies of business-oriented practices. The red tomato became the genetic mask of a 21st century prototype; a visually perfect appearance with no taste.

2.1 Method

As a demonstration of the correspondence between the so-called natural and artificial in food colour, the typical red (Figure 1, left) of uniform tomatoes commonly available in supermarkets in Paris (central) was compared to the red of conventional pureed tomato paste in tube, brick and ketchup forms (right). This was achieved by measuring the various reds against the standards of the Natural Colour System (NCS, second edition) under sunlight using the naked eye at a distance of approximately one meter.

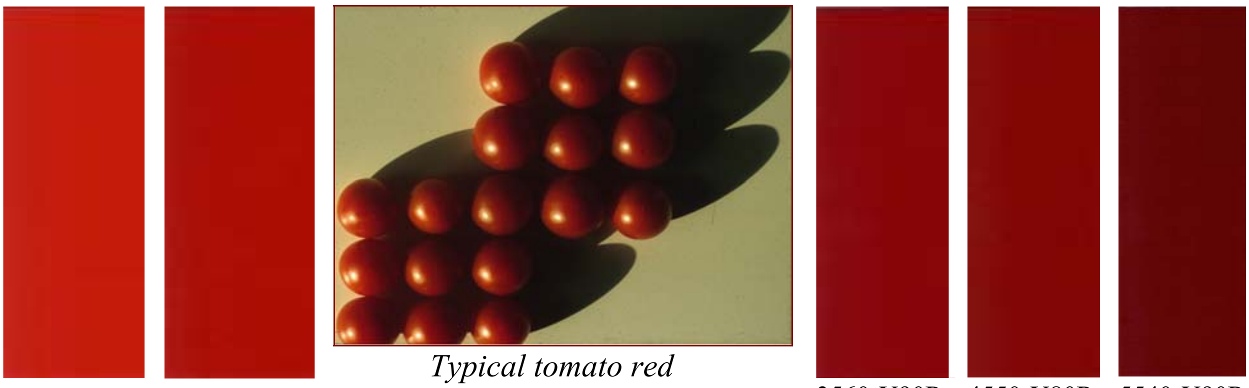

Figure 1. Demonstrating the correspondence between so-called natural and artificial reds of typically available tomatoes (left) in comparison to the reds of pureed tomato paste products.

Although the glossiness of the tomatoes' skin made the exercise rather difficult, assessment in relation to NCS standards was possible by examining the same object from different angles. Thereby in shifting the view the result was two nuances or differentiations of red, as shown in Figure 1 (left) depending on the angle. Despite the two shades one can surmise that the typical colour of tomatoes purchased in grocery stores is a slightly darkened, saturated yellowish red. Comparing the red of the fresh tomato with that of pureed tomato paste products, a darker, less chromatic and less yellowish red is apparent, as shown in Figure 1 (right).

Today, however, the monochromatic colour appearance –and insipid taste– of the tomato are seemingly being displaced by a plethoric evolution, not only in colour and taste but also in size and shape.

3. CONTEMPORARY TOMATO COLOUR VARIEGATION AND PALETTES

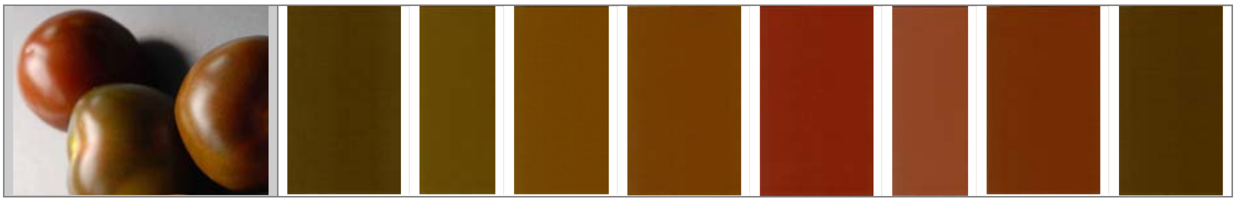

Fig. 2a. NCS 7020-Y, 6030-Y, 6030-Y20R, 6030-Y30R, 5040-Y70R, 5030-Y60R, 6030-Y50R, 7020-Y10R

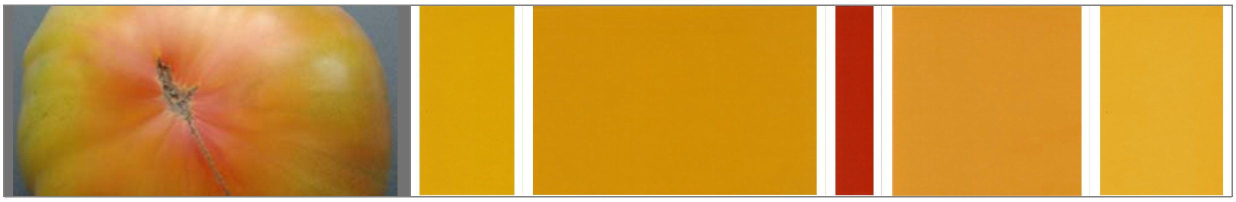

Fig. 2b. NCS 2070-Y10R, 2070-Y20R, 2570-Y70R, 1080-Y20R, 1080-Y30R

Fig. 2c. NCS 2070-G70Y, 3060-G50Y, 3060-G60Y, 3060-G70Y, 3065-G60Y, 3560-G60Y, 5040-G40Y, 5040-G50Y

Figure 2. Colour variegation of tomatoes offered at the open market, Paris, June 2010.

Looking more closely we find the ‘Kumato’ (Fig. 2a), a greenish to reddish-brown type that is considered a gourmet tomato; the ‘Pineapple Tomato’ (Fig. 2b), a yellow and reddish fruit that is streaked with red both inside and outside; as well as the ‘Green Zebra’ (Fig. 2c) with its characteristically green and yellowish-green stripes that was bred by the fanatic Tom Wagner of Tater Mater and commercialized only in 1983. In fact, Wagner’s philosophy is to create diversity from a few varieties and then allow these to multiple to create millions of future offspring. What has happened? How do these many types meet the –only recently established and currently being displaced– culturally defined standard expectation of the ‘red’, i.e., alluringly ripe tomato?

In fact a new colour vocabulary is emerging as part of a new trend that is so pervasive that soon the ‘natural’ red will most likely be perceived as ‘unnatural’. New tomato phantasms are haunting food product developers, as well as food science and health researchers as they create hybrids through artificial selection and experimental breeding. The results are tomatoes that look off-colour, unripe and even artificially coloured, although their appearance is the ‘natural’ result of development programmes to not only improve disease and pest resistance, but also accentuate shape, flavour and colour qualities. In short, in the search for even more fanciful and colourful fruits artificial crossing has become standard practice and the signifying role of colour as a sensual aspect in food preference has become an extremely complex field. A major component in making food (newly) appetising is the deconstruction of traditional culturally-defined expectations and culinary habits, e.g., a green tomato is no longer an unripe one, but a gourmet option.

4. PROVISIONAL CONCLUSIVE REMARKS

When it comes to food shopping a false idea of fruits and vegetables in the countryside still pervades the consumer’s fantasy. In reality the industrial tomato grows *hors sol*, i.e., in the greenhouse without sunshine, selectively-bred, generically-manipulated and sprayed in order to be as firm as a tennis ball, i.e., excellent for shipping, but as a result also insipidly tasteless. In the past profitability and year-round availability turned the tomato into a banal product; however, times are changing. The European Research Programme EU-SOL boasts fifty-six laboratories from fifteen different countries attempting to enhance the tomato’s flavour, colour, nutritional value and beneficial dietary and therapeutic strengths! The most important medicinal component of the tomato is lycopède with anti-oxidising properties. Potential health benefits include amelioration of cardiovascular disease, prevention of cancer, diabetes, osteoporosis, etc.

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Environmental colour design and synaesthesia in food-related contexts

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ABSTRACT

This paper presents the key issues of an on-going research project 'Synaesthesia in Environmental Colour Design' which is a subtopic of the current main research project of the Study Group on Environmental Colour Design of the International Colour Association (AIC). The starting point of our collaboration is Juan Carlos Sanz's outline 'Synesthesia as a Basis of Color Design' that was presented during the informal ECD meeting at AIC 2008 in Stockholm (Sanz 2008). Underlying the paper is a reflection on the relevance or predominance of some senses in experiencing the urban environment. It seems self-evident that the senses of sight, hearing, movement and time prevail over those of smell, taste and touch/somatic sense. Yet from an innovative and holistic point of view, understanding multi-perceptual sensation and synaesthetic experience can be critical in designing and evaluating urban environments. The theoretical basis of this research project is extensively discussed in Sanz's *Lenguaje del Color: Sinestesia cromática en poesía y arte visual* [Language of Colour: Chromatic Synaesthesia in Poetry and the Visual Arts], 2009. In short, the basis of the research concerns processes of colour perception and systems of designating, categorizing and specifying colour. The key areas of investigation are different synaesthesia-related concepts and colour definitions in the arts and sciences as determined through cognition, linguistics and iconicity. A sub-project of the on-going research project and the main topic of this paper 'Environmental Colour Design and Synaesthesia in Food-Related Contexts' is the investigation of genuine synaesthetic and pseudo-synaesthetic phenomena with respect to 'colour and food' environments.

1. CHROMATIC SYNAESTHESIA

Generally synaesthesia is the simultaneous perception of different sense sensations in response to a triggering stimulus. A frequently occurring form is when music not only elicits a tonal sensation, but visual perception as well, e.g., when music triggers a perception of colour or form. Whenever there is more than just a single synaesthetic sensation, e.g., when colour causes the sensation of a sound accompanied with a taste or the sensation of smell, the synaesthetic experience is described as 'pluri-sensorial'. Another very common synaesthesia is related to concepts of time like 'day' or 'season' that are experienced as a colour. This response is then both visual and temporal, rather than purely temporal. The respective synaesthetes experience this sensation of colour as the basis of their sense of time.

Although there are a great number of different possible synaesthesias and the field is highly heterogeneous, there are two main categories: First, genuine synaesthesia –as observed in synaesthetic perception– is neurologically-based and is defined by the occurrence of sensation/s in an other sensorial system/s or part/s of the body than the system or part actually stimulated. Important differentiating aspects of this category are that the synaesthetic response is involuntary, constant and consistent. This means, e.g., when a synaesthete, as described above, experiences a colour while smelling a scent they cannot turn the colour off and the perception of colour does not change. In considering the particular topic and field of synaesthesia in relation to colour the term used is *genuine chromatic synaesthesia*. This is defined as a sensation of colour being stimulated by other senses than the sense of colour vision, such as hearing, smell, taste or touch (Sanz 2009: 25). Colour sensations can also be pluri-sensorial when more than one sense is involved, e.g., colour sensations can elicit a specific smell and the experience of pain (somatosensory modality).

The second main category of synaesthesia entails associative and eidetic or visual properties of perception. It is called pseudo-synaesthesia or 'cognitive' synaesthesia. In considering the topic and field of pseudo-synaesthesia in relation to colour the term used is *cognitive chromatic synaesthesia*. This is defined as a colour sensation experienced through cognition within a cultural context. (Sanz 2009: 25) The term cognitive or pseudo-synaesthesia is used to denote artistic or literary associations or a combination of a mental or intellectual idea and a sensation. As well, it can refer to the simultaneous perception of multiple stimuli in one general experience like a multimedia experience.

In effect, four different groups of synaesthetes can be established: (1) specific synaesthetes refers to the inciting of only one particular synaesthetic perceptional system in response to a particular stimulus, e.g., as when smelling an aroma incites a colour sensation; (2) unspecific synaesthetes; (3) pseudo-synaesthetes as described above; and (4) non-synaesthetes who do not experience any form of synaesthesia.

2. CHROMATIC SYNAESTHESIA IN ENVIRONMENTAL COLOUR DESIGN

The research project 'Synaesthesia in Environmental Colour Design' aims to establish a general perspective on the most crucial criteria and concepts in applying chromatic synaesthesia in environmental design. This study is based in a diverse number of approaches, yet is also intended to uncover an underlying coherence in the different ways of exploring, describing and interpreting the related phenomena. The project focuses on planning, conceiving and realizing colour concepts for multi-sensory environments based on the phenomena of synaesthesia as experienced by genuine synaesthetes. Here two different types are to be distinguished: 'introceptors', who detect stimulation in the mind or body as perceiving their surrounds with the 'eye of the mind'; and 'projectors', who project their synaesthetic experience onto their surroundings.

A further important consideration in studying chromatic synaesthesia in environmental colour design is the investigation of the various means and modalities of multi-sensory experience (Caivano 2008). This includes exploring uni-modal experiences, such as colour-form synaesthesia in which colour and form belong to the same sense of sight; multi-sensory experiences; inter-modal or cross-modal interactions, e.g., colour-smell or colour-smell-taste synaesthesia.

As well the project discusses environments resulting from synaesthetic associations or eidetic cross-combinations including multimedia. In this case the project explores how under certain conditions or the influence of a specific mood non-synaesthetes may also intuitively or sensually experience the pluri-sensorial stimuli of chromatic environments. Other important aspects of this kind of perception to be considered include conceptual processes of abstraction and relationships between signs and symbols, e.g., as investigated in semantics, symbolism and the study of metaphors. A key quality of this research project is its focus on the application of criteria and concepts discussed in the cognitive sciences, such as the psychological aspects of perceptual qualia or properties of the subjective quality of conscious experience in philosophical terms.

3. CHROMATIC SYNAESTHESIA IN FOOD-RELATED ENVIRONMENTS

The main concern of the sub-project ‘Environmental Colour Design and Synaesthesia in Food-Related Contexts’ is the investigation of genuine synaesthetic and pseudo-synaesthetic phenomena with respect to ‘colour and food’ environments. Indeed awareness of –or even a preoccupation with– the multi-sensory properties of food, such as its appearance, smell, taste, texture sensation, etc., is commonly self-evident in alimentary contexts. Yet often the experience of such phenomena is treated in an isolated manner. The study is not only interested then in the investigation of synaesthetic perceptions of ‘colour and food’ in terms of isolated aspects, but it also explores the implications of genuine synaesthetic perception of ‘colour and food’ as an immersion in the overall surroundings. Key questions include: What might be the specific transfer or interaction between isolated sensations related to colour and food and the perception of the surroundings? In what way and to what extent do genuine synaesthetic perceptions of ‘colour and food’ correlate –and differ– from cognitive or pseudo-synaesthetic forms?

Considering first an isolated genuine synaesthetic experience of ‘colour and food’, e.g., how the smell of spices in a market induces smell-colour synaesthesia and how the image conceived on the basis of the spices’ scent elicits saturated colours on a black background, this study goes on to develop and describe different particular types and profiles of inter-modal synaesthesia, such as ‘colour-smell’, ‘colour-taste’ and ‘colour-texture’ and their implications in creating and assessing ‘colour and food’ surroundings.

For example, the inter-modal synaesthesia ‘colour-smell’ can be differentiated by pleasant and unpleasant odours. The terms aroma, fragrance or perfume are used to describe pleasant odours, whereas the terms stink, stench, foulness and fumes are used to describe unpleasant ones. In genuine synaesthesia these bad odours constitute stimuli that can elicit a kind of ‘smelly noises in discordant colours’. Similarly, in such a genuine synaesthetic experience of pleasant odour/s the response can usually be said to correspond to parameters of a continuous colour model with characteristics such as hue, saturation and value. The ‘olfactory tone’ or quality of an odour determines the intensity –weak or strong– of an odour. Generally it is related to hue and value of a smell-colour synaesthetic experience, whereas the ‘odour density’ stands for the odour concentration –dense or diluted– corresponding to colour saturation.

Considering the inter-modal ‘colour-taste’ synaesthesia, there are five different kinds of taste sensations: sweet, salty, bitter, sour and savoury (umami). Their synaesthetic correspondence to colours varies from one synaesthete to another. In gastronomic contexts in urban and natural environments, e.g., farmers’ markets, *gelateria* or street or plaza restaurants or dining places on the beach, ‘smell-taste-colour’ are closely interrelated and the perception of ‘colour and food’ takes place through an overall spatial immersion. This results as a synthesis of perceptive modalities and a kind of chromatic synaesthetic ‘landscape’ or multi-sensory context is constituted. As well, in studying the interrelation of synaesthetic sensations and food-related urban environments, it is also essential to draw attention to other less obvious inter-modal types of synaesthesia such as ‘space-colour’, ‘form-colour’, ‘movement-colour’ and ‘time-colour’.

4. OUTLOOK

Understanding the principles and concepts of synaesthesia can serve in differentiating chromatic environments and ambiances in urban space and food-related environments in particular. This study features the relevance of the senses and sensed experience in urban space. It seems evident to non-synaesthetes that the senses of sight, hearing, movement and time take precedence over those of smell, taste and touch or the somatic sense including sensations of pain. Synaesthetic persons and/or artistically creative professionals may be able to further a better understanding of some of the key features and measures in environmental colour design necessary to enhance the quality of life, especially of those who are suffering from pain and to support persons with somatic problems caused by unhealthy environments.

In the last twenty-five years more and more features of taste-colour synaesthesia have been contributing to colour design in food-related environments such as in publicity, packaging, bars, restaurants and other establishments as well as in the industrial production of candies, sweets and confectionery altered by natural or artificial flavourings and edible colorants.

It is worthwhile to further investigate how creative approaches to 'colour and food' synaesthesia can be introduced in the process of planning and designing urban environments contributing to both harmonic and diverse environmental colour design.

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"Man does not live by bread alone…" Attractors in a platter. Art and production

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1. INTRODUCTION

We have always taken care of connections: curricular, inter-departmental, inter-professional, inter-community and of inter-institutional investigations connections. Everything is interrelated. It has been proved.

Somewhere, there is always a contact point among roads. Strict parallelisms only exist in the field of classical geometry.

Having organized the Strategic Plan of the Department of Ceramics of the Faculty of Fine Arts of the UNLP (National University of La Plata), our first objective has been to outline the network of routes and of project meetings justified by the strategies: on the one hand, the Strategic Plan of the University and, on the other, our SP (Strategic Plan.)

The investigations which have been done, as well as those in progress, or being thought of for the future, are also articulated into some point and, usually, several fragments. Strategy number 3 of the SP shows how the role of the institution in the educational community is emphasized, which gives the Area of Extension of each academic unit a committing status in wider and more responsible projections, which are basically dialogic.

Theories referring to the urgent opening of educational institutions for the community are gone. Year-by-year concrete events have paved the way for a philosophy that must sustain them. A double look should be demanded from the different levels of the education system:

- inwards (focusing on the product's quality)
- outwards (following the needs of the society, by capitalizing its proposals, integrating its human resources into flexible incorporations of specializations in their curriculum).

We should teach our students to respect people with knowledge of topics ignored by the academy (such as the integration of the macrosemiotics of the experiential into the microsemiotics of the institutional.)

Fortune and risky games of possibilities have helped improve these autodidacts' learning. They possess a kind of knowledge which will never be publicly known because they have established a romantic and jealous relationship with it.

We must stop, watch, get closer, listen, and meaningfully communicate with each other. Offer and receive.

Small and big industries prioritize research in their production area. They experiment, generate changes and apply them.

Supply is sometimes the answer to a hidden demand. This demand might be perceived by intuition, reflection or insight.

Traditional centers of specialization widen their scope richer and more diverse. They incorporate new areas and expand their own.

The analysis of the causes takes us to a complex list that goes beyond this topic and is situated in the sociological field.

Our group carries out the research 11B220 and our experiences result in contributions framed in the topic of the Congress.

Three steps sum up this presentation:
1) Initial reflections and a conceptual frame
2) Justification and profile of *Valleverde Alimentos*, a Patagonian company of gourmet products.
3) Production in the workshop of delivery dishes. Expressive mixes related to the two prioritized artistic techniques: SERIGRAPHY AND PHOTOCERAMICS (with third firing, modeling, bas-relief and high relief, collages, etc.)

Food and color is the recovery of a fragment which restricts us and makes us be concrete. In this case, we deal with a qualified contribution of products which, in spite of not constituting a full meal, complement food and add, apart from color, textures, simple appealing forms and selective and nutritious gustatory attractors, specific of each vegetable and its preparation. Carefully conducted quality controls are done by the maker and their team.

¿Why did we choose Valleverde?

- Because in the globalized post-modernity regionalisms acquire an appealing added-value, which is closely related to the pleasure of travelling.
- Because a personal emotional relation is added and makes us focus on the company.

2. WELCOME TO *VALLEVERDE*!

In Patagonia is the city of San Carlos de Bariloche, inside the National Park Nahuel Huapi- a protected area because of its equilibrium with nature. On the lake's shore, among snowy heights is *Valleverde*, a small family company whose passion is the making of mushrooms and preserved vegetables.

With the intention of achieving excellence and transmitting simple life pleasures, we started to ask for secrets. Nights spent at mountain shelters, where camaraderie is present in all conversations; horse-rides on the arid and wild steppe, where the wind leaves its mark of simplicity and hospitality on the dwellers' wrinkled faces; camping with friends; endless fires with joyful stories and anecdotes; lunches on the snow; adventures on ski; walks in the woods and fishing trips, just to name a few, were our sources of recipes.

Traditional recipes with each individual's experience, which made it unique, full of magic and charm, and a treasure to be shared.

Faithful to their origin and completely natural, with no additive or coloring added, our preserved vegetables keep all their ingredients' properties.

Intense colors, pure tastes, charming scents will give your table a touch of unique distinction, which will make you proud.

In *Valleverde*, in the heart of Patagonia, we work everyday to bring our region's freshness, quality and purity closer to your family. Our areas include:

- Raw materials selection
- Gourmet use
- Color-taste relation
- Research
- Marketing
- Packaging

We do not use additives or preservatives during the smoking process, neither. For this purpose, we have designed a special oven. With regional wood, selected because of its low resin content and controlling the conditions, our smoking is high-quality.

3. PRODUCTION OF DELIVERY DISHES

Valleverde products, dressings, pâtés, preserved vegetables, and their color attractors motivated the plastic transposition by the *Colectivo artísico/cerámico "delivery"*: a series of ceramic dishes which re-signify food images through the use of photoceramics and vitrifiable serigraphy made by *Colectivo CC XXI* (Tedeschi, Del Prete, Grassi, Podestá, Ciocchini.)

Little Red Riding Hood: "What big eyes you have"
Wolf: "All the better to see you with"
Little Red Riding Hood: "What a big mouth you have"
Wolf: "All the better to eat you up with"
"Little Red Riding Hood" Short Story

At an early age we discover and conquer the world through our mouth; then, through our hands in the immediate space; and, at the same time, through our eyes.

The perceptive phenomenon engages all our senses. Sometimes, some sensations have more participation and, in other, more important situations, memories, related experiences and involved emotions play an important role and explain this complex process.

Color and food…"Man does not live by bread alone…"

Food provides nutrients and much more. It satisfies a basic need, as well as other vital needs in a person's life.

What does it look like? How and where is it eaten? With whom? When? What? A long list of causes and consequences. Contextual variables may lead to different results, different conclusions and enable a projection to a fantastic, fictional world. Generalizations are out of the question, each analysis gives a different result.

For Umberto Eco the list's poetics has invaded contemporary culture: from Warhol's soup cans to the World Wide Web, "all lists' great mother." According to the semiologist, it is the one that offers a catalog of information which makes us feel rich and almighty, "at the risk of not knowing which of its elements refer to data from the real world and which do not, with no distinction between the true from the wrong" (*The vertigo of lists).*

Food awakens long dormant memories and our feelings give an aura to the visions of dishes, pots, meals of special moments of our life. In these cases, flavors are stressed (for more pleasure or some rejection). We feel nostalgic for our grandma's pasta, chocolate milk at the zoo, dad's barbeque…

We start to eat with our eyes and to recognize a language which is analogous to the colloquial.

The gastronomic language is also enriched. The food-language with its diversity of designations: Fashion imposes words from here and there and many times we do not know exactly what language they come from.

Color is the stress, the first attractor. It might be the generator of dialog with its attraction. It's a call from the eyes, it anticipates pleasure, and once the dish is set in front of the diner, other participants and variables intervene.

- aroma/s
- texture
- humidity or dryness
- temperature
- contrasts, simple appealing forms, opacity.

Analog relations may widely vary and increase expectations.

The spectacle is previewed. Stress, routes, designs, risky games of equilibrium.

The producer, between pots and pans, creates each work with the delicacy and hard-work of a message that must be decoded with sensuality.

Cooking adds to the private structure of a painting or a sculpture the character of an offer prepared to be assimilated and disappear, to be torn. It's an ephemeral piece of work. On each dish, the same criteria as used in art are applied: genre, space treatment, compositions and codes. Classical, traditional, baroque, minimalist dishes.

In food there is an immediate deconstruction:

- Firstly, speculative
- Secondly, gustatory
- Thirdly, conceptual

Tasting closes the circle of perception and goes beyond any of the variables we consider.

Doubts and certainties about the influence of color in food. Personalisms are imposed.

Artistic and scientific gastronomy are interrelated: tridimensional spectacle which catches our eye, stimulates our saliva and explodes in our palate. Molecular gastronomy applies methods and data derived from lab research.

Even today, in sophisticated cooking, there are well-kept secrets, just as there used to be in some art fields before.

Abductive reasoning is applied in the atelier as well as in the workshop-kitchen. Indications and anticipations come and go.

Color's double game: indication among other indications and variables among other variables. For example, indication of a cooking point: medium, overcooked, out of time. Variable of quality-work of art. Intertwining of indications and variables.

This, the Congress topic, is a "painted" issue to be dealt with from a semiotic perspective; although we will never think about it with a dish in front of us, especially if we're hungry.

Only an expert in process of evaluation, with a moderate appetite, could first analyze carefully and taste afterwards.

Semantics and syntax get ready with the menu on our hands.

For the diner, the pragmatic point of view depends on different conditions:

- if there's a biological need, there's avidity and urgency
- if it's part of everyday routine, many variables are crossed out (there's indifference, mechanical activity)
- if it's about a sybarite's exquisiteness, there's high alert, the taste's mystic, a search for the flavors that mean knowledge

Alchemy's magic seems to appear.

Since the uncooked food-and-color pair is impertinent, we resort to the re-presentations which accuse our way of perceiving the world and we come across formal and chromatic alternatives, working with the graphic, and the fictional-expressive discourse, giving photoceramics and serigraphy a hierarchy, by interacting with other languages.

Technology and art go hand in hand in our explorations from the point of view of ceramic color and contemporary semantic criteria to offer pieces of work that show, though not always perfect, always happy transitions.

The corpus of *delivery dishes* offers a production of photographic and serigraphic images in which the sense of reality is sometimes displaced by artifice.

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Culture, food and wine: A sensual trilogy of colour

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1. CONCEPTUAL FRAME

Only when you combine culture, food and wine in a perfect equilibrium, you obtain the variety and quality of good flavours.

This paper intends to show the characteristics of different cultures from opposite points of our planet which are considered important referents in the field: Latin America, together with Mexico and Argentina at the top; the South of Europe; the Mediterranean Culture in which Spain, Italy, France and Greece are forerunners, and the Oriental Culture with China, Japan, etc.

Each culture with its typical views, weather and architecture gives birth to a gastronomy, with all the enchantment of the food and the traditional colours and flavours of a region. In the history of places there are different ways of cooking, with the typical dishes that better define the regions and their people. These meals always go together with a wine culture that goes through different climates and landscapes searching for privileged ancestral places for their production. Most of us feel attracted towards meals that come from an origin different from ours. Their flavours, colours, aromas and spices catch the attention of our senses. Eating is a fundamental practice for each culture. It is the result of social relationships and at the same time a promoter of such practices. The pleasure of eating and drinking is expressed in the presentation of dishes, and in the design, shape and colour of the packaging of wines and food which have turned them into visual rather than material products. The outburst of new elements and ingredients, and the constant training in their appreciation have spread individual enjoyment.

Here we will try to analyze the cultures above mentioned together with the characteristics of their natural and artificial backgrounds in relation to the typical food and wines in them, focusing on the harmonious search for flavours and colours, elements which give birth to this 2010 AIC Meeting.

2. CULTURAL AND CULINARY CHARACTERISTICS

Mediterranean, Latin American and Oriental cultures are the most popular ones. They teach us that it is possible to combine good flavour and nutrition. Taking the best habits of these cultures we can enjoy variety, colours and tastes.

The Mediterranean world is an intersection of cultures, religions and societies, a mix of civilizations living together in time. It is a space of great complexity from different points of view: the physical world, the societies, the cultures and the ethnic composition of the populations. Coast countries in the Mediterranean enjoy a different weather from the rest of the world. They give a great variety of fruits and provide the inhabitants of the place with a refinement in their culinary aspect.

Italian gastronomy is extremely varied: It is very common for Italy to be known by its most popular dishes such as pizza and pasta. However, it is a cuisine where lots of aromas and flavours from the Mediterranean coexist. It is a cuisine with a strong traditional character, separated into regions, heir to long traditions.

Spanish cooking is so varied as complex, which is understood in the different Mediterranean spaces of Spain with different shades and peculiarities. Catalonia counts since the Middle Ages with a delicious and refined cuisine that comprehends the plain, the sea and the mountain. A cooking from the coast with a variety of fish, while in the interior it is worth highlighting porrindger and barbecues, stock and stew made of hunt meat, which have rice as the starring product in a wide variety: dry, watery or in paella. Depending on what prevails, shrimps or squid, that is sea food or cold cured meat like pork sausage or pork and chicken meat, you can combine with a Californian Chardonnay, with buttery, creamy or other dry fruits, all of them giving their tones and brights, and afterwards a Merlot or a Cabernet or a tempranilla, a dark Spanish grape, with a blueberry, caramel and spices flavour. Murcia is also part of this sea food characteristic.

French cooking is worldwide known for its quality and variety. Delicious food, wines, spices and a long culinary tradition combine their power to make one of the most elaborated and delicious cooking in the world. It always uses eccentric and hard to find ingredients and is the one that represents France around the world. French wines are the best wines in the world and they have a milenary tradition to support them. Among the most popular French wines we can mention: Champagne: it is a sparkling wine from which we already mention its outstanding characteristics, and Burgundy which is produced from selected grapes, reason why the amount produced per year is really low compared to other French wines.

Greek food, because of its geographical location and its history, is typically Mediterranean. Of course, Greek cooking is obviously influenced by countries like Italy, the Middle East and the Balcans. Greek cooking is not refined at all, actually, refinement is considered an enemy to this style of cooking. In their dishes olive oil is the oldest and most typical ingredient. Wheat is the main crop with which they produce flour, but they also grow barley and use sesame grains to sprinkle different pieces of bakery. The most important vegetables are tomatoes, potatoes green judias, aubergines and onions. The mostly used meat in Greek dishes is sheep meat, because it is a territory appropriate for that. Fish is very common in the coast regions and their beautiful and legendary islands. Wine is the protagonic drink in the country and in any Greek tavern (Cabernet Sauvignon, Merlot, Cabernet Franc grapes, or rosè, white, fruity, dry or sweet Chardonnay, Sauvignon Blanc grapes).

Mexican culture: To describe current Mexican culture is not so easy, because it is a culture rich in traditions and contrasts, product of history and at the same time of modernization. The Mexican is naturally happy and a party lover, they feel passion for music and dancing, for food and drink. Their food, internationally recognized, has a wide range of ingredients and colours that conquer even the most strict and critical palates. It has always been characterized for being a kind of food with strong flavours, very much related to hot and spicy dishes, suggested to be accompanied with wines with low alcohol level. This gastronomy is delicious, of a great variety and also aphrodisiac because most of the dishes are prepared with roasted seafood, shrimp, octopus, squid and a variety of fish from the Pacific.

Argentinian culture: In the Argentinian culture the roots are mainly European and this is shown in its architecture, music, literature and lifestyle. Eating well is almost a worship. The variety and quality of food produced in the country and the abundance in the Argentinian field, make eating and drinking an excuse to meet and enjoy for a lot of Argentinians. It is the result of a delicious synthesis, product of the melting of dishes from different migration trends, combined with the typical food of the native land. Argentinian meat is the best and probably the favourite dish for foreign people visiting us. It is the main element in Argentinians's diet, which everyone knows is an unforgettable experience. Other traditional dishes are empanadas made of knife chopped meat, humita (corn), locro (made of white wheat with pork sausage), tamales (wheat wrapped in a leaf of corn), carbonada, meat and potatoe pie, lamb from the Patagonia and roasted goat, sweet cakes, fried cakes and mazamorras. Argentinian wines, specially red wine Malbec, made of a big red Argentinian grape of sumptuous texture, colour and aroma, are among the best wines in the world, specially those produced in Mendoza where also the best champagne in the country is produced. Wine production and export of the region constitutes one of the most important in South America together with Chile's.

The Oriental culture of China and Japan is the result of a historical process that begins with the migratory waves in the Asian Continent and the Pacific Ocean islands. Gastronomy has a long culinary past that has developed in a sophisticated, refined and specialized way in each season. Food is based on five groups rich in carbohidrates: rice, wheat and oats, bean and mijo. In oriental cooking the company of wines with a particular aromatic range is claimed. Many traditional alliances can be applied to these dishes, but in general it is convenient to choose special wines that offer a precise contrast for sweet-and-sour flavours. For the amazing contrasts of sweet, salty and fruity aromas, a possibility would be an Australian Shiraz, a grape variety with great personality, full of aromas, flavours are fruity and the predominant colour is lively and sparkling prune tones. Or a Zinfandel, a powerful red wine with mature plum and black pepper aromas, and plums and wild mulberries colours, more pink with the soft tones of a late harvest. Or Californian Merlot, which flavour and colour are related to black cherries, black currant fruit, plums and vanillas. Pinot Noir is perfect for duck, which is given floral attributes, and combine a range of aromas, fruity flavours, roses and blueberries, cherry and bilberries and truffle, with a silky texture, more and more exotic with the time. Other possibilities: a young fruity white wine, a Gewürztraminer with sort of agressive and suggestive flavours: lichis, roses, ginger and an exotic variety of yellow and ochre cinamon. Also a Blanc de Blancs, a kind of light and creamy champagne made with a 100% of Chardonnay, highlighting its crystalline and fresh yellow is a good option.

Chinese cuisine, sweeter than the Japanese, generally combines perfectly with a regularly sweet white wine, such as a good Riesling, an extraordinarily aromatic grape with flavours and colours that comprehend from all kinds of fruits to honey, minerals and a garden full of colours.

The connection consists of finding the best combination between the menu and the wine. This union is a game of equilibrium and instinct, in which a pinch of gastronomic knowledge and good taste are necessary, without the need of competence between them.

The basic principles are stated. White wine should be drunk with fish, and red wine with red meat. The colour of the wine is not enough to decide its place in the meal, since we have to take into account the power, acidity and aromas typical of the variety. To choose the appropriate wine for each dish is difficult, even for experts. Wine tastes differently when you drink it with food, it is like a spice or condiment. Acids, tannins and sugars present in wines interact with food to provide different flavours and sensations. Wine can highlight flavours in a dish.

We can distinguish two kinds of unions: 1) complementation, 2) contrast. Great unions are and exceptional mixture of flavours, colours, textures and intensity.

3. HARMONIZING FLAVOURS, COLOURS AND TEXTURES

Flavours: intense, intermediate, soft
Colours: dark, intermediate, light

The union between wine and food is a big topic and an area where it is difficult to establish rules that can be applied to all cases. The reason why this happens is simple: there are thousands of different wines and the same occurs with food. Besides, each person has his own senses and individual tastes which differ from one person to another. The person who appreciates good food can not avoid accompanying it with a good wine. Both are the perfect couple in gastronomy. Nowadays the trend is to unify flavours and colours. This means that no flavour should cover the other. Delicate tastes should go together with drinks with the same characteristic to balance the meeting. No one competes and both stand out in the same way.

Do I listen to a colour? What does red, blue, etc. taste like? This is possible because of a strange illness that literally crosses our senses called *synesthesia*. This is the reason why most of the restaurants and places where food is sold are painted in orange, yellow and green. Because our brain associates colour with food. This has its origins in our ancestors, who associated yellow, orange and red with riped fruit ready to be eaten. Dishes must fulfill three criteria: colour, fragance and taste. All these natural and necessary reactions, which also form part of a personal development learnt together with the cultural background, are codes or messages to be understood according to the conditions of the place where we are or according to our weak or strong tendency towards certain values in the chromatic scale. Colour and food are deeply connected since we all expect fresh and attractive colours to match with the flavour and quality of food. Chromotherapy is in charge of settling the rules regarding the effects food colours have on people.

4. CONCLUSION

Natural food colours are the way in which nature communicates to us the nutrients they have. The main objective is to compensate flavours and textures and, why not, colours. For this purpose *aesthetics* is fundamental. We know a good presentation has far more acceptance in general terms than a presentation which is not, even when flavours do not differ much. Cooking is art, thus aesthetics must be present: colour affects our lives. It is physical: we see it. Colour communicates: we receive information in the language of colour. It is emotional: it awakens feelings and specific emotional responses, there is no need for an oral or written language.

Varied and complex traditions, exotic tastes of food offered by the best international cuisine and delicious and tasty wines from diverse regions, are combined in an aromatic trilogy in which colour is the protagonist as the object of desire looking for a complete equilibrium to amaze customers with enjoyment and a sophisticated and glamorous image.

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Orange juice colour: Visual evaluation and consumer preference

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ABSTRACT

The objective of this study was to determine the colour attributes (lightness, chroma and hue) quantified by trained assessors in orange juices (OJs) from nine varieties and the colour preference evaluated by consumers. OJs were evaluated by image analysis and the chromatic parameters were calculated (DigiEye System). Those juices, which ΔE^*_{ab} exceeded the threshold for visual discrimination were selected for the visual assessment of preference. The trained panel consisted of eighteen panellists. All of them were asked to classify the samples in increasing order of hue (yellowish-reddish), chroma (dull-vivid) and lightness (clear-dark) and to score the colorimetric parameters on a continuous scale of 10 cm, anchored at the ends. Results showed that judges were able to order the OJs correctly based on hue and lightness, but only 17% of them ordered the samples properly according to chroma. The consumer panel consisted of 111 panellists recruited among students and staff at Universidad de Sevilla. The consumers were asked to order the samples according to their colour preferences. A significant preference was observed for the variety with intermediate hue and lightness values (Valencia Midnight), while the least preferred was the variety with the higher value for lightness and hue value, the most yellowish (Navel Foyos).

1. INTRODUCTION

Citrus juices are among the most widely consumed fruit juices because of their combination of desirable flavour, appealing colour, and health benefits (Russell et al. 2009). In this sense, some studies revealed that colour of citric beverages in general, are related to the consumer's perception of flavour, sweetness and other characteristics in relation to the quality of these products (Tepper 1993). Thus, instrumental measurement of colour within the orange juice (OJ) industry is very important for quality control purposes (Meléndez-Martínez et al. 2005). Orange juice colour ranges from pale yellow at the beginning of the season to red-orange at the end of the season. Apart from the stage of maturity, colour of citrus fruits in general depends on several factors, such as, species, variety and climate, among others (Casas and Mallent 1988). The objectives of this study were to characterize the colour of the OJs from nine different varieties and to determine the correlation between the colour attributes (lightness, chroma and hue) determined by a digital system and by trained assessors. The consumer preferences in orange juice colour were also explored.

2. MATERIAL AND METHODS

Samples: Orange juices were obtained from nine orange varieties: Navel Foyos (NF), Fisher (F), Navel Powell (NP), Fukumoto (FU), Navel Lane Late (LL), Valencia Midnight (VM), Rohde Late (RL), Navel Rohde (NR), and Valencia Delta (VD). For the sensory analyses, five samples of orange juice were chosen based on their colour differences ($\Delta E^*_{ab} < 3$) (Meléndez-Martínez et al. 2005): NF, F, NP, VM and RL.

Colour measurement: The DigiEye imaging system (Luo, Cui and Li 2001) was used. This system includes a digital camera Nikon D-80 previously calibrated, coupled with a controlled illumination cabin of VeriVide DigiEye® (Leicester, United Kingdom). We used a standard light source D65 (CIE 1978). The samples were measured in 75 mL transparent plastic rectangular bottles (5 × 7.5 × 2.5 cm).

Sensory analyses: Visual analyses of the samples were carried out within a well-illuminated room provided with two cabins (70 × 70 × 55 cm), with white walls. The 75 mL plastic bottles were used. Each series contained the different samples of OJs, which were placed randomly. Before each visual analysis all the bottles were vigorously shaken to avoid pulp sedimentation. The trained panel consisted of eighteen panellists, aged between 30 and 45, with normal colour vision and experience in both visual assessments of colour and tristimulus colorimetry concepts. All of them were asked to classify the samples in increasing order of hue (h_{ab}) (yellowish-reddish), chroma (C^*_{ab}) (dull-vivid) and lightness (L^*) (clear-dark). They were also asked to score the colorimetric parameters on a continuous scale of 10 cm, anchored at the ends.

Consumers preference: The consumer panel consisted of 111 panellists (78 female, 33 male) recruited among students and staff at Universidad de Sevilla (Table 1). They were grouped in six categories based on gender (male and female) and age (<20, 20–29, and >30 years old). The consumers were asked to order the five samples previously selected, according to their colour preference. The ranking decision was based only on the colour juice, without giving consumers information about them. OJs were presented in the same bottles and within the same cabins as in sensory analyses.

Data analysis: Friedman test (O'Mahony 1986) *($p < 0.05$)* and Page test *($p < 0.05$)* were used to analyze the sensory data. For consumer preferences, the Fisher test was applied. These analyses were performed using the Statistica program for Windows (version 8) (StatSoft Inc. 2007).

3. RESULTS AND DISCUSSION

Colour measurement: Figure 1 shows the distribution of the samples in the a*b* diagram. The ranges for the colorimetric parameters were: 56.09-61.34 for L*, 8.40-21.61 for a*, 49.52-59.70 for b*, 54.03-60.29 for C^*_{ab} and 66.43-81.9 for h_{ab}. ΔE_{ab}^* values were determined for the different OJs varieties and those with $\Delta E^*_{ab} > 3$ were selected for visual analyses: NF, F, NP, VM, RL. Table 1 shows the colorimetric parameters of the OJs selected for consumer preference test.

Sensory analyses: *Order test:* The results of the trained panel showed that judges were able to order the OJs correctly based on hue (h_{ab}) and lightness (L^*), in fact, correlation between panel scores and DigiEye data were significant for L^* and h_{ab} ($r^* = 0.96$ y $r^* = 0.92$ respectively). For hue (yellowish-reddish), all samples were correctly ordered by panellist, excepting F and NP which Δh_{ab} was 2.04. For L*, the samples with $\Delta L^* > 0.663$ were correctly ordered by 83% of the panel, while the resting 17% were able to order all the samples correctly.

However, according to chrome (C^*_{ab}) only 17% of the OJs were ordered properly. This may be due to the low chroma differences among samples (ΔC^*_{ab} ranged 1.03-2.77).

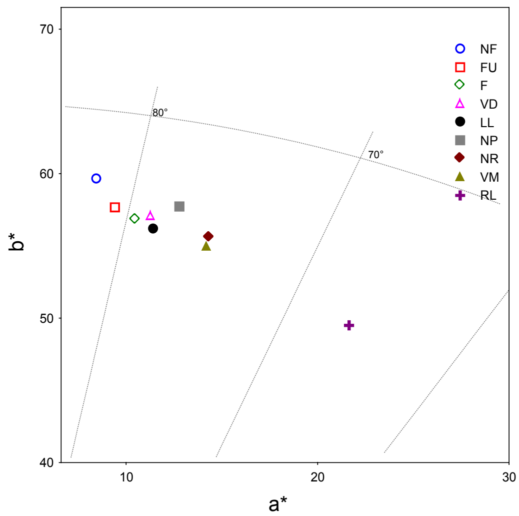

*Figure 1. a*b* diagram of orange varieties.*

Table 1: Colour coordinates of OJs samples selected for sensory analysis.

VARIETIES	L*	a*	b*	C^*_{ab}	h_{ab}
NF	61.34	8.40	59.70	60.29	81.99
F	60.43	10.48	56.87	57.84	79.57
NP	59.77	12.77	57.73	59.12	77.53
VM	58.75	14.17	55.01	56.81	75.55
RL	56.09	21.61	49.52	54.03	66.43

Score test: Table 2 shows the average scores given by the panellists to the different samples, according to different colour parameters. The judges scored significantly different all the OJs according to h_{ab} (from the most yellowish (NF) to the most reddish (RL)), and L* (from the highest (NF) to the lowest lightness (RL)).

Table 2. Mean scores for the colorimetric parameters given by the panel.

	RL	NF	F	VM	NP
h_{ab}	7.88[a]	1.55[b]	4.27[c]	5.63[d]	2.97[e]
L*	7.98[a]	2.34[b]	4.39[c]	6.12[d]	3.92[c]
C^*_{ab}	5.65[a]	5.89[a]	4.76[ab]	3.64[b]	4.67[ab]

[a-e] Different superscripts within row indicates statistically significant differences ($p < 0.05$).

Consumer preference: The results of the ordination test are shown in Table 3. A significant preference *($p < 0.05$)* was observed for the OJs with intermediate h_{ab} and L* values: VM and F (Table 1). On the other hand, the least preferred OJ was the one with the highest lightness and hue values, the most yellowish, the NF variety, clearly different from the rest. According to gender, it was observed that the most preferred variety in both groups was VM followed by RL in men, and F in women. Women and men under age 20 did not find significant differences between samples, but men preferred RL, while women preferred VM. In the age group of 20 to 29 years, men and woman preferred VM, followed by F variety (women) and RL (men). At last, in the group of older than 30 years, women preferred VM again, this time followed by NP and men showed higher preference for RL. Significant differences were observed in preferences between regular and non regular consumers of OJs. While the first one significantly preferred VM variety, the second one did not showed a significant preference for one variety, but three of them F, VM and RL were similarly preferred.

Table 3. Acceptability data: Rank sums grouped by age, gender and consumption habits.

	n	NF	F	NP	VM	RL
All	111	2.05 [a]	3.35 [b]	2.89 [c]	3.66 [b]	3.05 [bc]
By gender						
Women	78	2.10 [a]	3.46 [b]	2.92 [c]	3.67 [b]	2.85 [c]
Men	33	1.91 [a]	3.09 [bc]	2.82 [c]	3.67 [b]	3.51 [b]
By gender and age						
W < 20	15	2.53 [a]	2.93 [a]	2.87 [a]	3.40 [a]	3.27 [a]
M < 20	4	2.00 [a]	2.75 [a]	2.75 [a]	3.50 [a]	4.00 [a]
W 20-29	50	2.00 [a]	3.62 [b]	2.78 [c]	3.72 [b]	2.88 [c]
M 20-29	24	2.04 [a]	3.13 [bc]	2.88 [c]	3.67 [b d]	3.29 [cd]
W > 30	13	2.00 [a]	3.46 [bc]	3.54 [bc]	3.77 [c]	2.23 [a]
M > 30	5	1.20 [a]	3.20 [bc]	2.60 [b]	3.80 [bc]	4.20 [c]
By consumption habits						
Regular Consumers of OJ	86	2.16 [a]	3.28 [b]	2.90 [b]	3.71 [c]	2.95 [b]
Commercial OJ	19	2.37 [a]	3.00 [ab]	3.11 [ab]	3.47 [b]	3.05 [ab]
Fresh Home squeezed OJ	63	2.17 [a]	3.37 [b]	2.84 [c]	3.78 [b]	2.84 [c]
Any	4	1.00 [a]	3.25 [b]	2.75 [b]	3.75 [b]	4.25 [b]
No regular consumer	25	1.64 [a]	3.60 [b]	2.88 [c]	3.52 [bc]	3.36 [bc]

Ranking preference: 1 the lowest, 5 the highest. [a-d]Different superscripts in rows indicates statistically significant differences ($p < 0.05$).

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Optimization of sensory analytic methodologies applied to heterogeneous vegetables

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ABSTRACT

A panel of 8 assessors was screened and trained in descriptive analysis (DA). Broccoli samples with different storage times were used for appearance evaluation. Samples were presented in trays. The assessors evaluated the samples using four descriptors: dark green, green, yellow and brown colour. A month after having used the DA, the panel was trained in sensory quality methodology (QM). The panel used a 6-point degree of quality scale. Real trays' photographs were taken under the same standardized lighting as used by assessors to evaluate it. The assessors measured the appearance quality of the digital photographs, using the QM. Measurements were by duplicate.

DA method showed high dispersions between assesors' duplicates on the same samples and the average scores were not always correlated with storage time. Assessors' duplicate scores on the same samples for the QM showed low dispersions and the average scores were highly correlated with storage time. Analysis of variance showed that there were no significant differences between evaluations of the real tray and the corresponding photograph.

The QM would be advantageous for the sensory evaluation of appearance of hetereogenous products such as broccoli and this method could be used with digital photographs instead of the real product.

1. INTRODUCTION

The appearance of some fruits and vegetables like mangos and brócoli are heterogeneous and this leads to difficulties in their sensory evaluation. An alternative for the sensory evaluation of these foods is quality methodology (QM) which is widely used for fish and pasta (Hernández-Herrero et al. 2002, Ugarcic-Hardí et al. 2003). QM has been used to evaluate vegetables but it has received little attention in the literature (Ku and Wills 1999, Siomos et al. 2005). Therefore QM was developed to be applied in heterogeneous vetetables like broccoli. Also QM was compared with conventional descriptive analysis (DA).

Visual inspection is used by food industry to evaluate quality (Skrede et al. 1989). Computer machine vision systems (MV) have been developed as an alternative to visual sensory evaluation. MV use digitalphotographs, which are then analyzed with special computer software (Balaban et al. 2005, Balaban and Odabasi 2006). Balaban et al. (2008) obtained good correlations between MV and a sensory panel evaluating the same digital photographs. However, the panel did not previously evaluate the real products so it is notknow if the evaluation of the digital photograph represented the real product. Thus an additional objective of the present research was to verify if the sensory evaluation of a digital photograph is equivalent to the sensory evaluation of the real product.

2. MATERIALS AND METHODS

2.1 Vegetable material for descriptive analysis (DA) and quality methodology (QM)

Broccoli' inflorescenses (*Brassica oleracea* L. var. Italica, cv De Cicco) were stored in PVC wrapped trays at 10 ± 2 ºC. Storage times were: 0, 4, 6, 11 and 26 days. As storage times were completed the trays were frozen at –18 ± 2 ºC until their evaluation.

2.2 Digital photographs of vegetable material

Trays of stored broccoli (0, 4, 6, 11 and 26 days) were photograph with a Sony DSC-W55, 7.5 pixels digital camera. The photographs were taken under the same standardized lighting as used by assessors to evaluate the broccoli trays.

2.3 Monitor's calibration

To evaluate the photographs a Philips LSD monitor was used. It was calibrated automatically and visually with 3 objects that differed in colour. These objects were photographed with the digital camera under the same conditions as described above. The photographs were opened using Microsoft Office Picture Manager (Microsoft Office 2007). The photograph on the PC monitor was visually compared with the real object. This comparison was carried out by 4 trained sensory assessors. The photographs were calibrated using the "Publishing image – Colour: Improving colour" tool.

2.4 Sensory panels

A panel of 8 assessors was screened and trained in DA following the guidelines of the ISO 8586–1 Standard. The samples were evaluated by appearance, which was defined as the critical attribute in a previous work, using four descriptors: dark green, green, yellow and brown. Each colour was evaluated using a 0-100 scale. A month after having used the DA, the same panel was trained in QM. The panel used a 6-point degree of quality scale. A week after having evaluated the real trays using the QM methodology, the panel evaluated the appearance quality of the digital photographs on PC monitors. Measurements were by duplicate in each trial.

2.5 Statistical analysis

Analysis of variance was applied to the data considering assessor as a random effect and sample as fixed effects, in DA and QM method. In digital photograph sample*method was considered as fixed effects. Statistical analysis was performed using Genstat 10th edition (VSN, International Ltd. Hempstead, UK).

3. RESULTS

3.1 Comparison between DA and QM

The average scores for DA were not always correlated with storage time and the average scores for QM were highly correlated with storage time (see Table 1).

DA method showed high dispersions between assesors' duplicates on the same samples while assessors' duplicate scores on the same samples for the QM showed low dispersions (see Table 2).

Table 1. Comparison of average scores for DA and QM.

Samples (storage time)	Method DA (0-100)				Method QM (1-6)
	Dark green	Green	Yellow	Brown	
0	70	30	0	0	6.0
4	82	12	0	6	4.5
6	54	6	2	38	3.3
11	44	14	2	40	2.3
26	16	4	6	74	1.1
LSD	13	11	3	12	0.4

Table 2. Assessors' duplicates for 2 broccoli samples in the evaluation of brown colour (DA) and QM method.

Assessors	Samples with 11 storage days				Samples with 26 storage days			
	Brown (0-100)		QM (1-6)		Brown (0-100)		QM (1-6)	
	rep		rep		rep		rep	
	1º	2º	1º	2º	1º	2º	1º	2º
1	35	45	3	2	95	60	1	1
2	0	60	2	3	35	70	1	1
3	70	0	2	2	95	65	2	1
4	30	60	2	3	80	80	1	1
5	30	60	2	3	85	60	2	1
6	30	50	2	2	95	60	1	1
7	50	50	2	2	97	70	1	1
8	40	60	2	2	80	70	1	1

3.2 Digital photograph

Analysis of variance showed that there were no significant differences between evaluations of the real broccoli tray and the corresponding photograph. Figure 1 shows that differences were minimum.

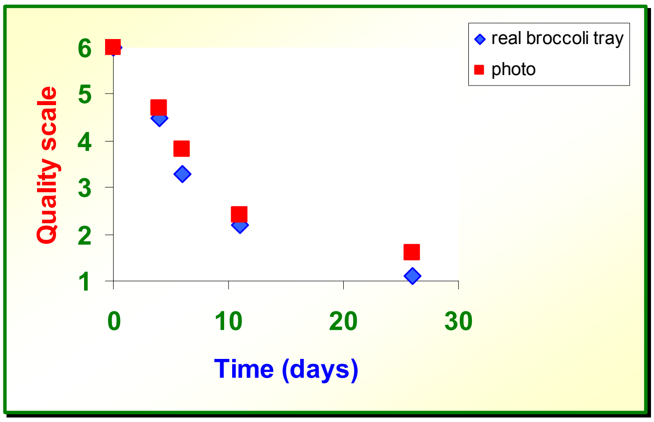

Figure 1. Real broccoli evaluations and digital photograph evaluations.

4. CONCLUSIONS

The QM was found to be adequate for the sensory evaluation of appearance of heterogeneous products such as broccoli and this method could be used with digital photographs instead of the real product.

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Assessment on relationships between color and tenderness parameters in different steers breeds

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ABSTRACT

Consumers identify tenderness as one of the most important attributes of meat quality (Miller et al. 1995, Boleman et al. 1997) demonstrated that consumers are willing to pay a premium for improved tenderness and Savell et al. (1992) found that there is a strong relationship between price and tenderness. The aim of the present work is to assess color parameters as costless predictors of tenderness. Ninety steers were used of three different phenotypes (British, Holstein and Indicus) of a general cattle population. Warner Bratzler shear force was assessed and HunterLab parameter was measured by a Colorview-model 9000-Colorimeter (BYK-Gardner, USA) Minolta. Samples were obtained from *Longissimus dorsi* (LD) at 10º - 11º rib after 24 hours post-mortem. Samples were vacuum packaging and frozen. At the evaluation, samples were thawed in a refrigeration chamber (2 ºC ± 0.5 ºC). For Warner-Bratzler shear force analysis (WBS) portions of LD of 2.5 cm thick were cooked in a heated pan without oil up to 40 ºC in the cold spot of the piece, then turned to the other side and cooked until that 70 ºC were reached (AMSA 1978). Ten cores of 1.25 cm in diameter were obtained from each beef in the direction of muscle fibers. HunterLab and CIELAB color parameters were measured with a Colorimeter Colorview-model 9000 (BYK-Gardner, USA), illuminant D_{65}, geometry 0°, L / L* (Lightness); coordinate a / a*:- a/ +a green-red, coordinate b / b*:-b / +b blue-yellow on raw meat. The relative amounts (%) of meat pigments were calculated in the muscle surface according to Feldhusen et al. (1995). Statistical analysis was performed using procGLM, the averages compared by Tukey, and correlations using procCORR of SAS. The results showed significative differences ($p < 0.05$) in tenderness among phenotypes Holstein and British vs. Indicus. In color evaluation, parameter a (redness) did not show differences among phenotypes. Parameter L (lightness) showed significative differences ($p < 0.05$) between British and Indicus and b (yellowness) showed significative differences among Indicus vs. Holstein and British ($p < 0.05$). Significative correlations were found.

1. INTRODUCTION

Consumers perceive meat quality through different attributes, and tenderness has been identified as one of the most important (Koohmarie et al. 1995). Meat price should be in accordance with its quality and it was demonstrated that consumers agree to pay for tender beef (Boleman et al. 1995), and that there is a strong relationship between price and tenderness within a meat cut (Savell and Shackelford 1992). Meat color is also an important meat quality attribute, physical appearance, other than leanness, is often determined solely by brightness of lean color (Jacobs et al. 1977, Berry et al. 1978). Some research were carried out to determine relationships between objective measurement of meat color and tenderness that can be used to classify beef carcasses by tenderness (Wulf et al. 1997, Purchas 1990, Jeremiah et al.1991, Watanabe et al. 1996). Swan et al. (1995) also found significative differences in HunterLab color parameters, contributing to determine meat color variability considering the country of origin.

2. MATERIALS AND METHODS

Samples were obtained from *Longissimus dorsi* (LD) at 10º - 11º rib after 24 hours post-mortem from ninety steers of three different phenotypes (British, Holstein and Indicus) of a general cattle population. Samples were vacuum packaging and frozen. At the evaluation time, samples were thawed in a refrigeration chamber (2 ºC ± 0.5 ºC). Samples were vacuum packaging and frozen. For Warner-Bratzler shear force analysis (WBS) portions of LD of 2.5 cm thick were cooked in a heated pan without oil up to 40 ºC in the cold spot of the piece, then turned to the other side and cooked until that 70 ºC were reached (AMSA 1978). Temperature was monitored using T-type thermocouples attached to a data logger (Fluke, Hydra model 2625). Ten cores of 1.25 cm were obtained from each cooked sample in the direction of muscle fibers and assayed for WBS. Color Hunter Lab and CIELAB parameters were measured with a Colorview-model 9000-Colorimeter (BYK-Gardner, USA), illuminant D_{65}, geometry 0°, L / L* (brightness); a / a* color parameter:-a / +a green-red, b / b* color parameter: -b / +b blue-yellow on raw meat. The relative amounts (%) of meat pigments were calculated in the muscle surface according to Feldhusen et al. (1995). Statistical analysis was performed using procGLM, the averages compared by Tukey, and correlations using procCORR of SAS (SAS 1987).

3. RESULTS AND DISCUSSION

Table 1 shows the results obtained for tenderness (WBS), color parameters relative amounts (%) of meat pigments for each phenotype. British and Holstein phenotype were significative different ($p < 0.05$) from Indicus in WBS. Huffman et al. (1996) reported that consumers at home or restaurants were 98% satisfied with steaks that had WBS values of less than 9.02 lb. According to this results, British and Holstein steers meat of this study would be widely accepted by consumers. Their results suggested that acceptable level of beef tenderness for the consumers could be determined and WBS values could be used as criteria for determining which steaks would be considered acceptably tender to consumers before distribution to retail outlets. Regarding recent studies (Shackelford et al. 1997), British and Holstein animals in this study could be classified as "Guaranteed Tender" while the Indicus could be considered as "Probably Tender" (Koohmaraie et al. 1995). Huffman et al. (1996) reported that consumers at home or restaurants were 98% satisfied with steaks which had WBS values of less than 9.02 lb. The WBS values reported in this work are coincident with those found by Wheeler et al. (1990), but higher than those reported by Wulf et al. (1997). When data were classified by a correspondence with a hedonic scale and shear force values produced by Gállinger (personal communication), it can be seen that the total number of the British steers (100%) can be classified as "very tender" to "tender"; only 45% Holstein in "tender" to "somewhat tender" and 15% Indicus in "somewhat tender" to "somewhat tough" reporting that the rest of the animals can be placed it within "somewhat tough" to "very tough". Meat color parameters analysis did not show significant differences in L and L* (lightness), (Table 1).

Color parameters: a / a* (redness) and b / b* (yellowness) shown significative differences ($p < 0.05$) between Indicus vs. Holstein, and Indicus vs. British and Holstein, respectively.

British and Holstein steers presented higher L and L* values and b and b* values than Indicus. The a and a* values are higher than the results obtained by Wulf et al. (1997). Indicus phenotype tended to be darker (less yellow and less red) than the others; its means that British and Holstein cattle had a more *"saturated"* red color. Significative correlation values ($p < 0.05$) were obtained between color parameters and WBS of the different breeds (Table 2). The MMb (%) and Omb (%) of British breed were significative different of Indicus breed and Mb (%) value was significative different of Mb myoglobin Holstein breed amount (%).

Although it is difficult to predict meat color consumer perception by means of objective color measurements, dark meat might be considered by consumers as low quality meat.

Table 1.

Parameters\ Breeds	***British***	***Holstein***	***Indicus***
WBSF (lb)	8.42 ± 1.29a	8.70 ± 1.50a	10.54 ± 1.93b
L	25.17 ± 3.28a	24.67 ± 2.84 a	23.75 ± 2.21a
a	13.91 ± 3.28a	14.38 ± 2.32	12.28 ± 2.71
b	9.08 ± 1.53a	8.92 ± 1.21	7.65 ± 1.30 b
L*	30.20 ± 4.01a	29.64 ± 3.51a	28.80 ± 3.30a
a*	18.18 ± 2.61ab	19.79 ± 2.61a	17.28 ± 3.15b
b*	16.25 ± 2.60a	17.30 ± 2.48a	14.44 ± 2.52b
Mb (%)	0.77 ± 0.08b	0.83 ± 0.04a	0.75 ± 0.11b
MMb (%)	1.41 ± 0.09a	1.36 ± 0.09ab	1.32 ± 0.12b
OMb (%)	97.82 ± 0.09b	97.81 ± 0.08b	97.93 ± 0.19a
$\mathbf{h}_{ab}$	0.87 ± 0.07a	0.87 ± 0.09a	0.84 ± 0.08a

* different letters within the same column indicate significative differences ($p < 0.05$).

Table 2.

Correlation coefficient r	***British***	***Holstein***	***Indicus***
WBS vs **L**	-0.51	ns	-0.48
WBS vs **a**	ns	-0.43	ns
WBS vs **b**	-0.58	ns	ns
WBS vs **L***	-0.49	ns	-0.44
WBS vs **a***	ns	ns	ns
WBS vs **b***	-0.52	ns	ns

***r:** correlation coefficient (tenderness vs color parameters values) ($p < 0.05$)

4. CONCLUSSIONS

It can be concluded that British and Holstein breeds presented similar quality attributes such as tenderness and color, being significative different of Indicus. Correlation equations might provide costless method trying to predict meat tenderness from objective color measurements. Based on the results shown here, it is very important to consider the asymmetry and dispersion of the population distribution. More accurate results would be obtained when a larger number of animals could be analyzed.

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On the color analysis of the presentation of Japanese food: The relationship between color and taste

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ABSTRACT

A color of the food has a significant effect on the psychology of people. And so we paid attention to the information of the colors in the presentation of Japanese food related to the effect. We examined then the result of the color analysis and the conditions how we feel Japanese food delicious. We processed first some photos of the arranged dishes to the mosaic images aiming to exclude the form effect of stimuli. We measured the color configuration of those stimuli in the pixel unit. Main color composition of Japanese food consists of white, gray and brown. In addition, there was also a high percentage of yellow and green. Yellow is the color of natural ingredients such as fish and meat, green is the color of vegetables. Subjects looked often at the middle of the dish. It became also clear that the eyes of their subjects had a trend to gather in the accent color of the dish. Subjects preferred a clear boundary between the presentation of dishes and foods in the presentation of the Japanese food. However, Japanese food in the presentation that was scattered in many color, was not preferred. Many participants looked the presentation of Japanese food that consists of white, gray and brown base color with one accent color very delicious.

1. INTRODUCTION

The percentage of visual sensitivity is approximately 90% of the total sensory receptors and so the color and presentation of food is critical to directing the taste. That is the main reason why we research the color in the presentation of Japanese food. There was a research of color analysis about the rule of dishing of the Wanmori (the Wanmori-dish is used in the Japanese tea ceremony and presented in a lacquered wooden bowl) in a tea ceremony or about the color distribution (Ohtani 2001). We made stimuli for our experiment with the mosaic processing of the photograph of a Japanese food. Then we compared and considered the color composition of the Japanese dish by measuring sample photograph per pixel. Furthermore, we analyzed the subject's eyes to the stimuli and considered the tendency for the taste about the Japanese food.

2. METHOD

2.1 Preparation for stimuli

We chose the whole plate photograph for each sample dish so that we could arrange the fundamental conditions for the measurement. So we extracted 13 samples from the independent volume of "Today's Cooking" published from Japan Broadcast Publishing Co., Ltd. (see Table 1) (Japan Broadcast).

2.2 Processing of stimuli

We recorded the selected photographs in JPEG form by using the color scanner (Epson GT-9700F). Each recorded picture was converted to the mosaic picture by using drawing software (Adobe Illustrator). And then we used as stimulus 30 division mosaic which refers to the long side of a rectangle of a picture based on the measurement value of Color Comfort Meter (CCOM21, Advanced Systems Co. Ltd., Japan-made). We prepared the pictures shown as stimuli by using Microsoft Office Power Point (see Table 2). Although each stimulus was shown by a pair of dishes, we presented it in three standards.

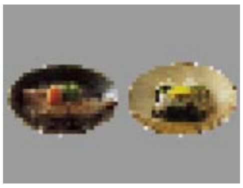
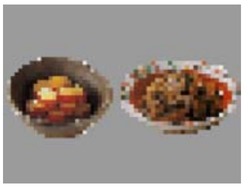
2.3 Measurement and analysis of eye movement

Eye movement of the subject was tracked by using EMR-NL8B eye measurement system (nac Image Technology Inc., Japan-made) and was analyzed by an analytic software (see Figure 1). The oldest of the subjects is 25 years old and the youngest 18 years old. We presented 18 image pictures as stimulus to the subjects. The composition of stimuli consisted of 9 sets of image picture in Table 2 and 9 sets which were replaced right and left. Each picture as a stimulus was presented 7 seconds long. We presented a calibrated image picture of gray (RGB: 155, 155, 155) three seconds to the subjects for the purpose of the clearing of an afterimage (see Figure 2). We gave then the following three comments to each subject. Our comments were that a subject should look at the picture of cooking, the picture had mosaic processing and a subject should turns eyes only to the dish which looked like delicious through color information.

Table 1. The Japanese food used for the stimuli.

No.		Name of dishes
1		Lightly fried pleuronectidae
2		Dried horse mackerel and cucumber dressed with grated daikon
3		Hot-pot meal of pacific cod and vegetables
4		Sukiyaki style of beef
5		Boiled turnip with deep-fried tofu
6		Boiled fine wheat noodles served in a hot soup with grilled eggplant
7		Quickly prepared pickles of Japanese ginger and cucumber
8		Sweet potato boiled in soy and sugar
9		Fried and boiled eggplant
10		Boiled beef in soy sauce with mirin (sweet sake) and ginger
11		Chilled tofu (with Japanese horseradish and the Welsh onion)
12		Warm salad of Shimeji mushroom and potato
13		Garlic salad of white-meat fish

Table 2. The stimuli shown in the experiment.

Same kind of materials	Similar color of plates	Close value of Color Comfort Meter
No.1 & No.3	No.6 & No.3	No.8 & No.10
		
Fish dishes	Brown plates	(66)
No.5 & No.2 Vegetable dishes	No.7 & No.9 White plates	No.11 & No.7 (72)
No.10 & No.4 Meat dishes	No.1 & No.12 Black plates	No.6 & No.13 (68)

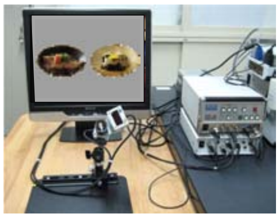


Figure 1. Eye measurement system.

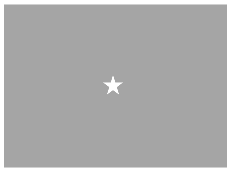


Figure 2. Screen for proofreading eyes.

3. RESULTS AND DISCUSSION

3.1 Color elements of Japanese food

We worked some photos of the arranged dishes to the mosaic images, because we aimed to exclude the form effect of stimuli. We measured the color configuration of those stimuli in the pixel unit. The color elements of stimuli are shown in Figure 3. Main color composition of Japanese food consists of white, gray and brown. In addition, there were also high percentage dishes of yellow and green. Yellow is the color of natural ingredients such as fish and meat, green is the color of vegetables.

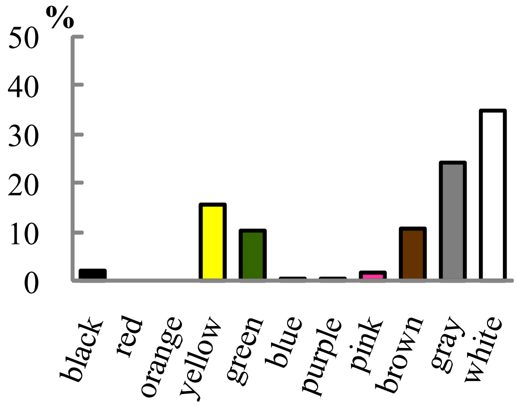


Figure 3. Color elements of Japanese food.

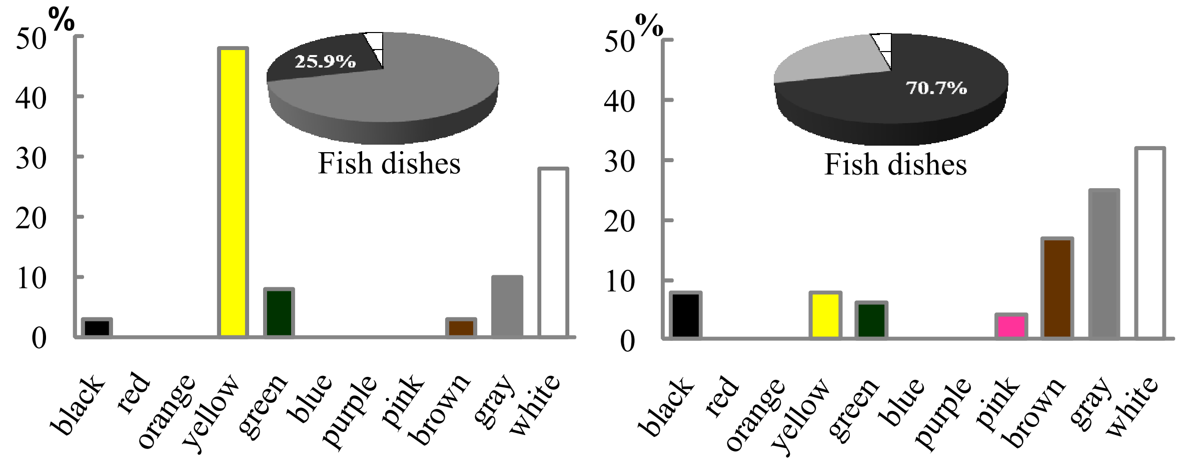
3.2 Color elements of the Japanese food which looks delicious

We discussed about the color analysis and the conditions we feel food delicious. People feel that the Japanese food in which the accent color is arranged effectively on the base colors such as white, ashes and brown is delicious (Figure 4). If the color elements of the dishes are close, the subject feels the dish in which the borderline of the color is clearer than the color scattered dish “more delicious”.

3.3 Eye analysis in the recognition process of dishes

Subjects have a trend to look at the middle of the dish. Even when the participants compare the left dish with the right, the eyes of them gather to the center of the dish. It became also clear that the eyes of the subjects have a trend to gather to the accent color of the dish (Figure 5).

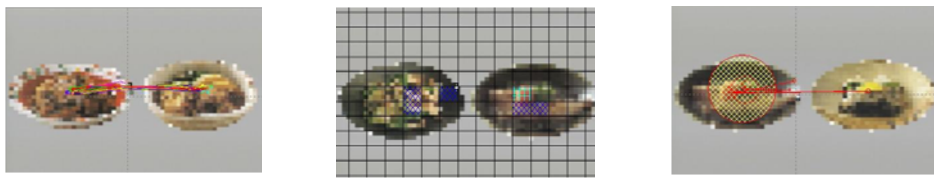
Subjects preferred a clear boundary between the presentation of dishes and foods in the presentation of the Japanese food. However, Japanese food in the presentation that was scattered in many color, was not preferred. Many participants looked the presentation of Japanese food that consists of white, gray and brown base color with one accent color very delicious.



Hot-pot meal of pacific cod and vegetables (No.3).

Lightly fried pleuronectidae (No.1).

Figure 4. Color elements of the Japanese food which looks delicious.



Tracking analysis of eye movement.

Time analysis of a stationary point by area.

Analysis of a stationary point of eye movement.

Figure 5. Eye analysis of the recognition process of dishes.

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The color of toys and its relationship to child development. Aspects transferred to the appearance of sweets

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ABSTRACT

This team of research teachers is in charge of teaching Morphology in the Industrial Design Course of Studies of the National University of Córdoba. The relationship between shape expression and man's behavior with the Color Institute of which we are members, constitute one of the axes of our research studies. Trough the concept of reading, the knowledge of perception psychology laws allows us to orientate the search for new shapes paying attention to the justifying levels and their effects on man's behavior. Children are specially sensitive and receptive to the surrounding stimuli. Visual stimuli generate different body reactions, and colors, besides stimulating them visually, affect their state of mind and produce emotional feelings in them. This paper aims at verifying if the research developed in relation to toys shape and color and child development could be transferred to the study of color in the world of sweets. From a conceptualization of the child's evolutionary stages, the definition of game behavior and the limitation of the variables to be considered, an analysis of existing cases in the toy world was developed to later approach the design decision level.

DEVELOPMENT

In this new work, the same methodology was transferred to a particular group of objects, that of sweets, in which design plays an increasing role. The stage chosen for the original research was that of early childhood since that is the stage in which the child's answers to the different stimuli are less conditioned by their culture. Between one and three years of age, the child is interested in exploring and getting to know the environment in which he lives to discover new sources of sensorial experiences.

The child progressively differentiates the surrounding objects by defining them so as to make them have an identity of their own, even though their aspect, place and time may change. In a second stage, he already establishes global categories among them from a generalization of the objects outstanding features.

The game, an innate kind of behavior which is inserted and remains throughout a lifetime, is understood as any type of activity done for fun. It involves expression and understanding applied to any human being, regardless of their age, sex or culture. It is an essential and fundamental instance for the child's intellectual, emotional and social development. Through the game, the child enjoys himself, expresses his feelings and conflicts, shares with others and learns.

Toys are either handcrafted or industrially made and are specially designed and produced by adults to stimulate and accompany games. They are objects a child can dominate and make use of, material expressions of a game, and communication vectors, from the social and cultural point of view; through their aesthetics and game proposal, they transmit the precepts and values of the society to which they belong.

Toys open the game; not only are they the tools the child handles as he pleases, but mostly they act as a sort of fascination and spell upon those who use them and determine the player's behavior. The leisure movements and attitudes do not go from the player to the toy but just the other way round: the toy stimulates and leads the player's behavior.

This attraction or spell-like possibility in a way determines sweets visual expression. Although this toy possibility is important to justify shape and shape variables during the harmonious development of babies and children's potentialities, in the case of sweets, the justifying decision level is not based on the relation with learning or capacity stimulation, but mostly and almost exclusively, on consume promotion. Sweets are a provocation in the non-regulated, non-habitual food world and are considered an essential aspect for individual and social development.

Sweets are defined as industrial food, mainly oriented to children; many times, they are not classified as food in the popular sense. Sweets, or "empty calories", have practically no nutritive value and basically contain simple sugar and artificial coloring elements which result in those striking colors attracting potential consumers and which are associated with the concept of pleasure. There is, then, in this definition a reference to the sensorial, social and emotional aspects of these products which can be obtained through the consuming activity.

Unlike the investigation on toy color, in this second stage we are not so much interested in the evolutionary precision but in the market to which these products are oriented. It is made up by children and adolescents and the companies establish the approach to their products according to the demands of each group.

The products designed for children respond to an impulsive way of buying since they instantly evaluate and decide on the type of product, being its visual image as well as the extra values coming from gifts, tattoos or stickers a strong influence. These products are bigger in size for adolescents and they are associated with promotional campaigns in which the values of youth and fashion are highlighted.

Obviously, color has a significant influence on children's state of mind. Thus the importance of knowing about color properties, vibrations and influences to adequately combine them in their object environment.

Visual evolution indicates that since their birth babies are inclined to strong luminosity contrasts, especially the black and white relation. After the first month, he/she starts distinguishing other colors as long as they present intense contrasts. When they are six months old, babies start differentiating different chromas, and their attention is specially turned to saturated, shining and brilliant tones.

The field work developed in the first stage consisted in a morphological register and analysis of the toys industrially manufactured and oriented to the group described above. This analysis was carried out as a paradigmatic chain in which each of the links is an object representing other similarly-featured objects regarding perceptual aspects.

The decision to build a "paradigmatic chain" sprang from the need to compare the formal attributes that differentiate objects of the same kind. Through gained experience in the topic it is possible to establish significant relations between man and their objects and associate one with other known objects with which it shares essential characteristics, and to recognize and name things.

This kind of associations among signs, is known as paradigmatic association and makes it possible to establish differences among objects sharing type features. In this way, we thus denominate the set of properties and characteristics that determine an object identity and include semantic and syntactic aspects. The former refer to the communication of potential actions to be carried out through the object or sectors thereof, and the latter to spatial arrangement, order and scale relations.

In paradigmatic chains, the objects sharing denotation, one of the sign functions defined by identity features and their primary function, are selected. The differences between each of the "links" of the chain are shown in the particular connotations and in the description of that primary function, and they allow the comparison of particular formal expressions of different designers or brands.

The elaborated paradigmatic chain was then made up by "toys". All the selected products were exercise toys for children between newly-born and three year olds. Differences were then made between sensorial, manipulative and motor toys, although, in many cases, multiple types of stimuli were detected in the same product.

To fulfill this research stage, cards were designed to systematize shape variables and they were grouped in making-up aspects and superficial manifestations.

Firstly, an iconic image of the toy, the designer's data and brand were presented together with a synthetic schema of the components. More details were given of the user described by the manufacturer and the materials, and as to the communicational aspects, the object was related to the planned uses.

The making-up elements refer to the shape geometry and its material concretion. The geometric elements and their relations constitute the abstract structure and determine the shape. The materiality, that is, the concrete structure, refers to the way in which the form is systematically constituted by units and is shown in the corresponding generative systems and in the concretion means used as well (saturation, systematic constitution or construction).

For analytical purposes, the components, which are units differentiated by discontinued relations, were recognized and typologically characterized in plane and spatial lines, surfaces on the plane, space and volumes.

As regards the superficial manifestations, color, brightness, texture and transparency characteristics were dealt with. These variables were differentiated according to their role in the objects. These roles are as follows: dominant, secondary and stress. The first one refers to the greater extension presented in the object and characterizes it in a general way; the secondary role occupies a smaller surface and is softer than the dominant one. Stress strongly contrasts with the previous roles and acts as an attention focus with a smaller superficial dimension. This differentiation does not intend to consider all possible cases; instead, it presents a first approximation to the relation between superficial manifestations and the objects.

Color was identified and named through the Natural Color System. This tridimensional ordering system created in 1985 at the Scandinavian Color Institute follows a logic order giving each color a univocal notation. Based on visual perception, it makes it possible to designate any color through a unique code which facilitates their ordering and notation. The NCS color card collection is made up by 1750 samples uniformly distributed in the chromatic space.

Texture, known as the more or less uniform arrangement of signs on a surface, is analyzed from different points of view. Regarding its components or the directly involved sensorial canal, we differentiate bidimensional and tridimensional texture, the former being graphic and the latter tactile. In turn, we consider the directionality, density and motive scale variables which refer to texture composition.

The different types of spatial light distribution resulting from its incidence on surfaces with different physical characteristics, produce brilliant, semi-mate and mate finishings which are recorded on the analysis cards. On the other hand, surfaces can also be described as transparent, translucent or opaque depending on whether light can go through them or not.

This first research stage was ended with the morphological analysis and recording of the selected toys and a series of reflections were made from partial observations.

After having characterized the children under study, a lack of correspondence between color use and the type of necessary stimulation for the period chosen was observed. There is too much information on the products, which could hinder the perception of such products and which is almost exclusively centered on their composing aspects and luminous contrasts. The importance of the composing elements is more relevant than color variations at the progressive differentiation of objects appearing as figures on the background and which are identified beyond changes in their position or situation.

As movement stimulation is the most adequate type of stimulation, exercise toys provide an answer to physical and movement capacities through action and repetition in order to dominate body manipulation and control. Here, color plays a secondary role since the associations that would normally lead to the recognition of iconography or codifications are not likely to be made in that state.

We identify the differentiation of components, of parts that can be taken as units, and that can be grouped, separated and reunited, as color essential role in this group of toys.

The justification of color use in most of the studied objects mainly responds to a "consecrated" use of colors identifying childhood. The difference between the needs of the toy user and the cultural conditioning of those who choose it results from the previous statement. Those associations or evocations produced by these objects are only present in the intelligence of an adult who is, in the eyes of the manufacturer, the consumer and the financial addressee of the manufactured product.

In the second stage, that of methodology transposition to the analysis of sweet appearance, cards were filled in with the characteristics developed for different types of objects.

On the one hand, different types of sweets were analyzed in order to widen the study field; those having a determined color of their own due to their raw material were not included, namely that of milk jam (dulce de leche) or chocolate and the wrapping paper was not considered. Then, candies were selected as a type of object to understand the differences and similarities between them.

The use of mental associations in the determination of product meaning justifies the decisions made regarding color. The value of synesthesias is recognized in the transmission of ideas and the allocation of meaning to sweets from their relation to conventions, clichés or analogies. In this way, tastes are recognized through the evocation of the natural element referred to: red / strawberry or green / mint, and even determined value variations appear due to taste intensity: soft or strong mint with light or dark greens. Anyway, there is always a codification under this relationship, allocating, in some cases, arbitrary colors which require previous experience for their understanding, such as the blue color which codifies pineapple taste in Sugus sweets.

Another decision-making resource comes from different source object iconicity. False teeth, worms, brains, teddy bears lend their components and colors to sweets which are related to the leisure feature that these products may present.

This feature present in toys as well as in some sweets and that makes them "funny" responds to different objectives. In the first case, form expression is determined by the stimulus / learning relationship while in the second case the stimulus / consume relation is a priority.

Sweet attraction, seduction and relationship with pleasure make children wish to know Charlie's chocolate factory and poor Hansel and Gretel fall in the hands of the wicked witch of the forest, personifying today's irrational consume habits. Sweets mean prize, satisfaction, transgression, fun and socialization.

According to Eduardo Archetti, to eat sweets implies a behavior code and a communication model, a solid body of images and tastes which take us to a system of uses closely linked to social occasions and contexts. In this world of primary needs sweets are superfluous since their consumption is not structured and there are no fixed rules on what, when or how to eat them. The lack of formality, fixed timetables and strict etiquette rules belong to the realm of sweets.

Food appearance in general is directly related to our appetite since taste, smell and sight have an influence on the desire to eat. There are certain food colors coming from nature that generate trust and are understood as "natural".

If color is absolutely artificial in the case of the analyzed sweets, then stereotypes determine the decisions as to the use of these variables. We understand that, however more efficient communication might be, this type of justification may appear reductive, thus impoverishing the experience by putting forward solidified meaning models.

The growth of food industries and the competition between this kind of products generate food matters which are the design object to be investigated and which must have a coherent appearance. The artificial food product has the manufactured object status since it is the result of the undergone transformations rather than of the composing raw material nature.

Taking the designer as a cultural operator, we are interested in going deeper into the research done in this new field to responsibly take part in a culture construction in which the industrially produced objects may condition increasingly and more rapidly changing social practices.

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Effect of taste and tone listening on achromatic colour perception

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ABSTRACT

The goal of this study was to investigate whether taste and tone hearing effect to the perception of colour in not chromaesthesia but normal subjects. To reveal this goal, 8 non-synaesthetic individuals were required to adjust the colour of a target on the monitor until it was achromatic while tasting three kind of taste, or being exposed to three kinds of tones. The subjective achromatic colours of adjustment with taste/tone were compared to those without taste/tone. However any taste or frequency of tone showed no significant differences between taste/tone and non-taste/tone condition, the standard deviations of adjustment hearing 1 kHz tone were significantly smaller than that of the other conditions. As the attention was caused by a tone sound, then the accuracy of colour adjustment might rise. Taste may relax our sensation rather than strain.

1. ABNORMAL ADDITIONAL PERCEPTION TRIGGERD BY STIMULATION OF THE OTHER SENSORY MODALITY

Synaesthesia is a phenomenon in which the stimulation of one modality of sensation evokes a response in another modality, leading to a merging of sensory functions (Dixon et al. 2000). Many recent studies have revealed the neurophysiologic mechanisms of synaesthesia (e.g. Weiss and Fink 2009, Hanggi et al. 2008, Simner et al. 2009). It is difficult to know if this phenomenon is caused by learning experiences in childhood or if it is congenital. Recently some studies point to the existence of synaesthetic-like responses without abnormal neuronal connections (Meier and Rothen 2009, Kadosh Cohen et al. 2009a), and one inquiry estimates that as many as 4% of people experience some form of enhanced cross talk between the senses (Bargary et al. 2009).

If synaesthesia is congenital, we are all born as synaesthetes; however, most of us subsequently lose the experience with brain development (Kadosh Cohen et al. 2009b). Even if learning experiences in childhood cause synaesthesia, the linkages to specific sensations are assumed to be acquired (Beeli et al. 2007). Thus, we possess the alternatives of having or of not having synaesthesia just before or after our birth. The idea that all of us can develop synaesthesia implies that our colour vision remains under the effects of the other sensations, such as taste or hearing. In this study, we investigate the ways in which our perception of neutral achromatic colour is affected by taste or hearing in order to better grasp our abilities to create.

2. METHODS

2.1 Subjects

One of the authors (HS) and seven subjects, all of whom were naive to the purpose of the experiments, served as observers. All subjects (aged 20–29) were considered colour normal, as assessed by both Ishihara pseudoisochromatic plates.

2.2 Stimuli and apparatus

The test stimulus was 2° disk patch that was presented at the centre of a CRT screen (Nanao FlexScan T561; 1024 × 768 pixel; 120 Hz), driven by a personal computer. Test stimuli were presented on a uniform gray background (CIE x, y = 0.3039, 0.3168, Y = 42.885 cdm^{-2}), and the colour of the test stimulus was changed by the subjects' keyboard manipulations, along a two-dimensional opposed (Yellow-Blue and Red-Green) axis with subjective luminance equality. Sucrose, citric acid, and catechin produced sweet, sour, and bitter tastes respectively. Auditory stimuli were white noise, pink noise, and a 1 kHz tone, which was generated by a synthesizer, recorded, and saved on a personal computer.

2.3 Procedures

For each trial, each observer adjusted the test stimulus to be subjectively achromatic, by pressing four arrow keys, each of which increased and decreased Yellowness, Blueness, Redness, and Greenness. In the tasting condition, each observer adjusted the test stimulus upon experiencing one of three tastes—a sweet, sour, or bitter—for each trial, after the first set of 20 trials without any taste. The observers rinsed their mouths with water before each trial to rid the previous taste. In the auditory condition, they first adjusted the stimulus to be achromatic by using earplugs that lessened any sounds; they then repeatedly listened to one of the three tones with earphones. In both conditions, each test was made up of 20 adjustment trials. At the beginning of each experiment, the observers practiced adjustments for an apparent achromatic stimulus in some trials. They used chin rests to fix their headstand rested at least 10 minutes between each taste/auditory condition.

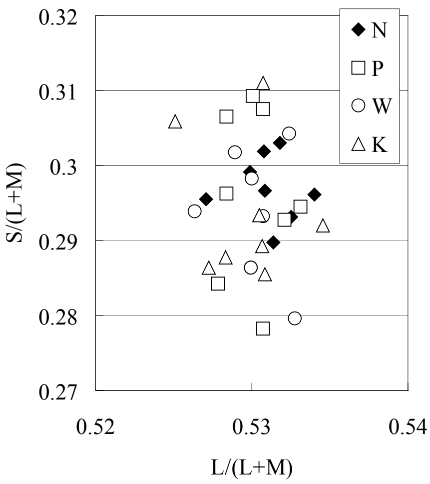

Figure 1. Distribution of the average of adjustment under each auditory condition.

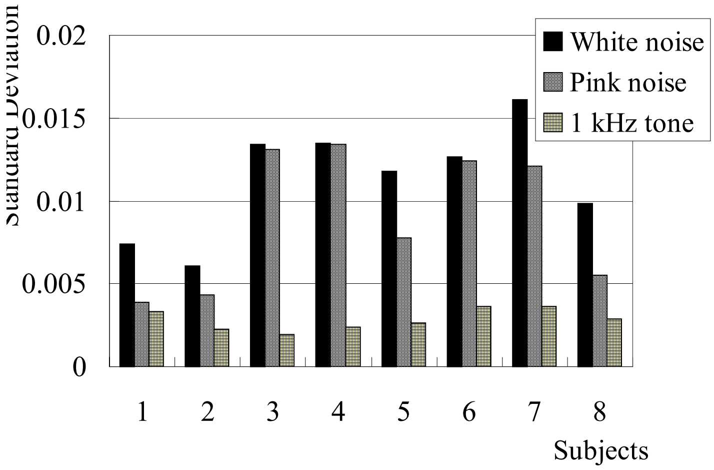

Figure 2. The standard deviation of each tone condition.

2.4 Results

The differences between each taste/auditory condition were not elicited, and the eccentricities of the distribution of each condition were not observed in both the taste and auditory conditions. Figure 1 shows the distribution of the average of adjustment on L/(L + M), S/(L + M) chromaticity diagram (MacLeod and Boynton 1979). Each symbol shows three kinds of sounds for each subject under each auditory condition.

On the other hand, Figure 2 indicates the standard deviation of adjustment in the auditory condition. The standard deviation of 1 kHz tone was significantly smaller of the three for all subjects ($p < .01$, $df = 7$). The standard deviation of adjustment with hearing white noise and pink noise showed no difference.

3. DISCUSSION

No differences in colour perception are evident with sweet, sour, and bitter tastes. Tone hearing did not change the apparent achromatic colour for each subject. Failure to elicit synaesthetic-like responses shows that the perceptual system of each modality is completely separate from the others and that sensory interaction between sensory modalities does not exist. Of course, this finding does not exclude either the possibility of congenital or learned synaesthesia. The results indicate that non-synaesthetic people do not have indications of synaesthesia.

On the other hand, the 1 kHz tone produced a significant decrease in the standard deviation to achromatic colour adjustment. As the adjusted achromatic colour did not manifest any differences in other auditory conditions, this effect was not a synaesthetic phenomenon. However, the results in the present paper may suggest that a 1 kHz tone causes an elevation in attention. The greater concentration caused by the 1 kHz tone made the standard deviation small. Thus, only the 1 kHz tone without any other frequency was more efficient in enhancing concentration on the adjustment of achromatic colour. A possible explanation for this result may be that the auditory effect of tone on achromatic perception is not an additive but a relative one. One may naturally interpret this paper’s findings not as indicating a frequency construction of tone stimuli but rather of the Gestaltic features of tone hearing in achromatic perception.

The auditory discrimination mechanisms of single frequency tones from other noises concentrate on adjustments to achromatic colour. The processing of auditory stimuli located in temporal lobes has selective attention to verbal and nonverbal sounds (Meneguello et al. 2006), and verbal processing is sometimes affected by colour perception, such as in the Stroop effect. As there are many differences between the Stroop effect and the phenomenon reported here, some kinds of tone, just as verbal sounds, may inversely concentrate our attention on achromatic perception.

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Food color memory and names: A linguistic vantage

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ABSTRACT

We name colors of foods with great ease. We categorize them constantly. This process is conventionalized through our cultures and our biological dictates. People identify food colors through words that are again highly constrained. Embodiment of experience and perception deals with these constraints to make color term use a cognitively economical mechanism; keeping numbers of concepts in mind through categorial conceptualization in long term memory (Gibbs 2005). The parallel process that puts together our linguistic and visual information, allows the individual to map a correspondence between the two frames. The result of this mapping is a "cognitive color" in long term color memory. This paper presents an experiment in triggering long term memory and the response results. The objective was to verify whether individuals' cognitive color of well known foods, both raw and cooked, that they had just identified with NCS color samples, would be predominantly a primary basic color term, a secondary basic color term, or complete descriptive utterances. The name used to communicate a desired signification is accessed through the judgement of similarity and difference with a point of reference. In this case, the food color vantage represents the cognitive color remembered.

1. INTRODUCTION

We eat, choose, shop for, hunt / gather, cook and prepare food to eat. First we have to select the food, which means that it has to be recognizable, edible, ripe, and fresh, or properly conserved and seasoned. Then we have to put the food through a process that makes it ready to eat; from the farm to the table. These steps are quite conventionalized through our cultures and our biological dictates. People identify food colors through words that are again highly constrained. Linguistic constraints are of four types: *cognitive capacities*, *the nature of reality*, *convention*, *context* (Croft and Cruse 2004: 101-103). Cognitive constraints are about the cognitive mechanisms used to understand experience. They refer to our tendency to apply certain perceptual operations, such as the Gestalt principals, to rapidly and accurately make decisions. The nature of reality refers to how things, actions, etc., are conceptualized, for example how we perceive something as being present or absent, e.g., if the peas are green they are the way they are supposed to be. Convention is the social mechanism that allows a community to agree on how to codify relations and language in given situations. The context constrains possible interacting factors and influences other constraints directly. Our embodiment of experience and perception deals with these constraints to make color term use a cognitively economical mechanism, which allows us to keep vast numbers of concepts in mind through categorial conceptualization in our long term memory (Gibbs 2005). The parallel process activated to categorize color puts together our linguistic and visual information; it allows the individual to map a correspondence between the two frames.

Basic color terms (BCT) (*black, white, red, green, yellow, purple, brown, pink*, even *blue*) are all used in reference to foods and cooking processes in recipes. This use of color terms in the cooking process appears to have increased in time (Ronchi and Sandford 2010: 37-38). With this in mind the objective of this experiment was to see how individuals would call the color of well known foods, both raw and cooked. Do individuals name a "cognitive color" with a BCT, as Derefeldt et al. (2004: 7) suggest, with a secondary color term, or with a complete descriptive utterance, when asked to name the color of a food that they have just identified with the NCS color samples? Will the "technical perceptual task" influence the "semantic classification task"? This paper explains what occurred when subjects were asked to find the color shift of raw food to cooked version. Even though the food colors had just been identified in a complex memory task, the color vantage or cognitive color tended to be basic.

2. METHODS AND RESULTS

To see what color words would be used by subjects, after having identified raw and cooked food color prototypes, the author proceeded in the following way: the subjects had their vision tested with *The City University Colour Vison Test (Keeler, London)* and no defects were found. Each subject then sat at a desk in a lab with the Second Edition NCS samples placed in front of him / her. An incandescent lamp fitted in the ceiling (the observation geometry being 0° / 45°) served as illumination and a middle grey cardboard (luminance of 20 cd / sq.m) acted as an adapting field. After finding the NCS sample that was most similar to their memory color of first raw and then cooked spinach, peas, leeks, cauliflower, chicken and beef, they were asked to say what they would call the color of each item, e.g., "what would you call the color of raw spinach?" and "what would you call the color of cooked spinach?" Each response was registered one at a time.

2.1 Reaction

Each subject reacted to the color search in a different manner, making comments on how to indicate a change in food state. Although the inter-individual differences, as a whole, were wide, the standard deviation between raw and cooked food was actually contained. Results indicated that the average *difference between the raw and cooked foods* was lower and varied less in blackness (M = 5, SD = 6.54) than in colorfulness (M = 5.97, SD = 13.95). The food item comparison resulted with a greater raw versus cooked difference in colorfulness for spinach (blackness M = 8, SD = 14.18; and colorfulness M = 9.5, SD = 16.06) and peas (blackness M = 0, SD = 7.82; and colorfulness M = 6.5, SD = 14.35). The raw versus cooked difference for leeks (blackness M = 1, SD = 2.11; and colorfulness M = 0.7, SD = 2.83), and cauliflower (blackness M = 1, SD = 2.11; and colorfulness M = 0.90, SD = 2.32) were minimal, as could be expected. The difference in raw and cooked versions of chicken were quite varied (blackness M = 3, SD = 14.94; and colorfulness M = 1.6, SD = 25.72), as can be seen by the standard deviation. The raw versus cooked difference for beef was greatest in colorfulness (blackness M = 17, SD = 13.17; and colorfulness M = 31, SD = 28.94).[1]

[1] The standard deviation of these raw and cooked food color means may be considered normal distribution, *i.e.,* in a normal distribution, about 68% of the scores are within one standard deviation of the mean and about 95% of the scores are within two standard deviations of the mean.

Although there was a large range of specific NCS color sample choices, each person made little variation between the raw and cooked version in the *color term named*; 20% of the cases used the same BCT for both food stages. Whereas, 30% of the cases used the same NCS color code for the food in both stages. The memory color that individuals use as a linguistic vantage, or point of reference, is defined as a "cognitive color" (Derefeldt et al. 2004, Davidoff 1991). Derefeldt et al., in writing about their experiments observed a similar type of reaction, although their subjects "saw" the original stimulus shortly before having to remember it and identify it.

In the visual experiments, the "original" color stimulus and the selected "actual" color stimulus are significantly and systematically *different* (memory color shift). The memory color shift is usually directed towards a *basic color* or a *color prototype* (in other words: a long-term memory color of a familiar object) which was *similar* to the "original color". The reason is that the observer tends to categorize the original color and to remember only that category, *i.e*., to remember a cognitive color (Derefeldt et al. 2004: 16, the author's italics).

This experiment confirms Derefeldt's research. The subjects said that they felt as if they needed to make a difference in the two stages of the food process, yet even though uneasy, opted for the only cognitively economical category names. They used the semantic category "cognitive color" that resulted in their set of long-term memory color prototypes, rather than a complete utterance in explanation.

2.2 Results

Out of 120 items identified, the cognitive color was represented by a BCT in some form in 76% of the cases. This can be broken down into 36% of the items called with a single primary BCT (e.g., *green*), another 20% called with a primary BCT and a modifier *dark*, *light* or *bright* (e.g., *dark green*). This means that a total of 56% cases used a primary or secondary BCT plus a lexeme modifier. Another 20% of the items were identified with a BCT plus the suffix -*ish* (e.g., *greenish*), or a BCT compound (e.g., *white grey* or *greenish white*). The remaining cases were 12% subordinate color terms (e.g., *pea green, beige*), and 12% utterances like, *cooked spinach green*, *turtle dove grey brown*, or *a darker green not like spinach*.

A need to differentiate between the two states, raw and cooked, seemed to trigger a needed morphemic addition to the BCT. A BCT (monolexeme) was used more for the raw state, four out of six foods (not for peas or cauliflower). In the case of peas, the raw state was quickly identified by *pea green* (which appears to be a prototypical green), and in the case of cauliflower it was called *white* in a majority of instances, both raw and cooked. Talmy (2000: 315-316) refers to a figure-ground alignment mechanism that uses what is more recent in our memory as the figure (the specific color object relation, or working memory) and what was earlier on the scene as the ground (the basic color, long term memory). The figure-ground mechanism allows us to recalculate through a vantage operation (MacLaury 2002) the color name requested. The name used to communicate a desired signification is accessed through the judgement of *similarity* and *difference* with a point of reference, in this case the food color vantage represents the cognitive color remembered.

In this experiment the foods were called most in the following ways: raw spinach *green*, and cooked spinach *dark green*; raw peas *pea green* and cooked peas *green*; both raw and cooked leeks and cauliflower were identified as *white* in most cases; raw chicken *pink* and cooked chicken *beige*, or *almost white*; raw beef *red* and cooked beef *brown*. This is in keeping with Hutchings food color indications: cauliflower *white*, leeks *white*, peas *green* (1994: 486); and the relation between doneness and *brownness* (1994: 135). Furthermore, *pea* *green* has been found as a color term since 1752.[2] This may explain why the term is salient (60% raw peas), though *sage green,* used since 1596, was named only once for cooked peas. *Spinach green* has been used as a color term since the beginning of the 1900's, but was named for only 10% of both the raw and cooked state. The terms *white* (60% cooked chicken) and *red* (70% raw beef) for the respective meat types did appear to be salient in some form.

3. CONCLUSIONS

Evidence shows that we humans memorize color through the categorization of our visual experiences. We establish a color prototype, or exemplar, in keeping with our direct primary experiences. We keep a constant color in mind that is used as our reference point, independent of illumination, and it is related to the visual context and experience of the color surround combination. This color does not reflect the specific color, but the cognitive color that tends toward the BCT. Basic categories are used to economize cognitive effort. Cognitive functions of attention, perception, cognition and memory converge and must be studied as a whole.

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[2] The years relative to the when the food color names were introduced are from Hutchings (1994: 23).

Psychological effects of the tray-color on diners: Comparison between young persons and elderly persons

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ABSTRACT

The psychological effects of 6 kinds of colors of FRP (Fiber Reinforced Plastics) - trays, which were used frequently in the food services, were investigated toward the elderly persons living in the nursing homes, those in their own homes and the young persons, the university students. The images of the tray-colors were investigated by using SD method, which consisted of 11 antonym adjective pairs. By the factor analyses of the data obtained by SD method, two components, "activity" and "relaxation", were extracted. In the case of the elderly persons living in the nursing homes, all colors investigated were in the positive zone for both components. But in the case of the young persons and the elderly persons living in their own homes, the pastel colors* were in the positive zone for both components, but the orange color was in negative zone for "relaxation", and the blue color was in negative zone for "activity". Although the pastel colors were shown to promote the diner's appetite and to give the feelings of comfortableness, cheerfulness and happiness, the questionnaire showed that the pastel colored - trays were more recommendable for the breakfast and the lunch.

1. INTRODUCTION

We generally enjoy our meals time through five senses. The informations obtained through the sense of sight are said to be the most important factors for enhancing the diner's appetite (Birren 1963, Hutchings 2003: 30, 121), especially via the atmosphere produced by the color not only of the dish itself and its arrangement, but also of the dining room including the table setting. Colors work directly on our sense to produce various emotions (Birren 1963). Our previous reports showed that a tablecloth-color gave diners various and different emotions by changing the strength of the brightness of the dining room (Tomita et al. 2005, Tomita et al. 2006), and that the sensitivity of diners for sweetness was influenced by the tablecloth-color (Tomita et al. 2004).

By the way, Japan is progressing an aged society and the elderly persons who live in the nursing homes are increasing. Then, the improvement of the environment of the dining in the nursing homes are requested to promote their appetite to keep their nutrional state better for their higher ADL (activities of daily living) and QOL (quality of life). Then, the psychological effects of the colors of FRP (Fiber Reinforced Plastics)-trays, which are frequently used not only in the nursing homes but in the food-court etc., were investigated toward not only the elderly persons living in the nursing homes but the elderly persons living in their own homes and the university students as young persons.

2. MATERIALS AND METHODS

Questionnaire studies, which consisted of the general questions concerning to the physicaland/or mental situation that day, color image of the trays, and so on, were performed toward the elderly persons living in the nursing homes (nursing-elderly; age: 83.6 ± 8.3, n= 22 / color), the elderly persons living in their own homes (home-elderly; age: 68.4 ± 6.6, n = 20 / color) and the young persons, the university students (age: 20.6 ± 1.5, n = 34 /color). The images of 6 kinds of tray-colors were investigated by using SD method, which consisted of 11 antonym adjective pairs. In the case of the elderly persons, a few supplementary questions about their eye condition such as cataract and/or vision were asked. All subjects took part in the experiment more than 1.5 hours after eating. In the case of the elderly persons in the nursing homes, the interview surveys were performed.

The colors of trays (430mm (D)×310mm (W)×20mm (H)) made from FRP (Fiber Reinforced Plastics), were as shown in Table 1.

Table 1. L, a*, b* values of each tray-color measured by the spectrophotometer (CM-2600d made from KONICA MINOLTA in Japan).*

	Yellow *		Pink *		Green *		Blue		Brown		Orange	
	SCI	SCE	SCI	SCE	SCI	SCE	SCI	SCE	SCI	SCE	SCI	SCE
L*	87.27	84.93	82.23	79.59	78.51	75.87	58.97	54.55	38.45	30.52	73.94	70.87
a*	-5.09	-5.29	6.26	6.55	25.22	27.36	2.01	2.17	4.73	6.19	30.12	31.85
b*	28.21	30.15	10.01	10.98	-15.77	-16.68	-18.96	-20.41	10.64	16.75	28.92	32.19

The questionnaire studies were performed in the dining room under 400-600 lx. The room temperature and the humidity were around 25°C and 50%, respectively.

Subject answered the questionnaire at the table covered with the beige colored-tablecloth, on which a randomly selected tray was set with dish plates and bowls.

Data analyses were performed using PASW Statistics 18 program. A factor analyses were performed in which the following 5 point were observed.: 1. The eigenvalue must be 1.0 or more; 2. The cummulative proportion rate must be 50% or more; 3. The reliable coefficient, Cronbach's α, must be 0.65 or more; 4. The number of components was verified by Scree plot; and 5. Adjectives with factor loadings of 0.4 or more on more than one component were omitted.

Table 2. Two components were extracted from 11 antonym adjective pairs by factor analysis. Each component was named "activity" and "relaxation", respectively.

Antonym adjective pairs			Component	
			1	2
Cheerful	-	Gloomy	0.912	0.053
Happy	-	Lonely	0.892	0.081
Lively	-	Not lively	0.805	0.105
Healthy	-	Unhealthy	0.701	0.273
Conversational	-	Silent	0.679	0.203
Warm	-	Cool	0.573	0.035
Healing	-	Impatient	0.368	0.706
Comfortable	-	Uncomfortable	0.416	0.671
Calmly	-	Irritate	-0.342	0.65
Eigenvalue			4.605	1.638
Cumulative proportion (%)			44.228	60.991
Cronbach's α-coefficient			0.895	0.685

3. RESULTS

3.1 Image profiles of tray-colors

Image profiles of 6 kinds of tray-colors by the elderly persons and the young persons were shown in Figure 1. The color images toward 6 kinds of colors by the elderly persons especially living in the nursing homes (Fig. 1-A) showed almost the same profiles. But the image profiles of blue and brown by the young persons (Fig. 1-C) showed significantly different profiles from those by the elderly persons (Fig. 1-B).

3.2 Psychological effects of tray-color

By using the factor analyses of color images obtained by SD method, two components, "activity" and "relaxation", were extracted as shown in Table 2.

The scores of each color for two components by each subject group were shown in Figure 2, which showed that the pastel colors were in the positive zone for two components in the case of all subject groups, but the orange was in positive zone for "activity" but in negative zone for "relaxation", the blue was in negative zone for "activity", and the brown was in positive zone for "relaxation" in the case of the elderly persons living in their own homes and the young persons. In addition, the pastel colored-trays were answered to be more recommendable for the breakfast and the lunch and the brown colored-tray was for dinner in the case of the elderly persons living in the nursing homes and the young subjects. Although the image profiles of 6 kinds of tray-colors showed almost the same profiles in the elderly persons living in the nursing homes, it might be useful for them to change the tray-color depending on the mealtime in order to make their daily life rhythm.

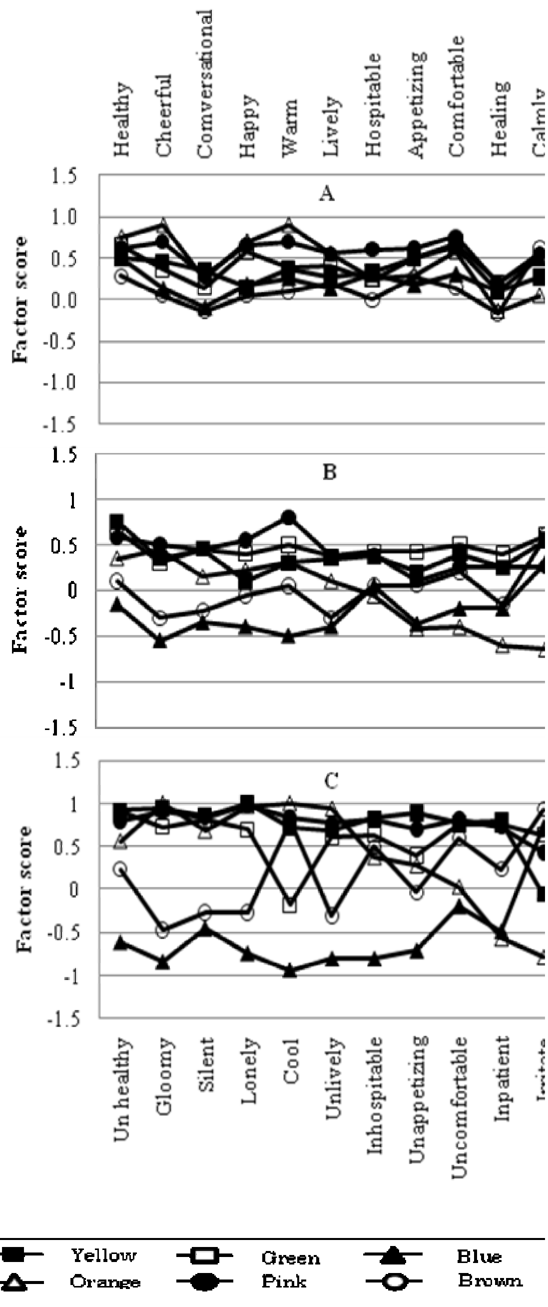

Figure 1. Image profiles of each tray color by the SD method, using 11 antonym adjective pairs.

A: Elderly persons to have living in nursing home, B: Elderly persons to have living in own home, C: Young persons.

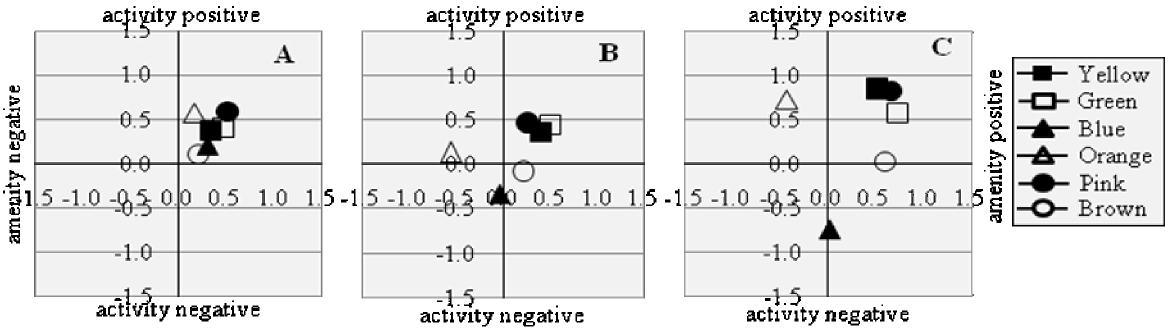

Figure 2. Score on component-1, "activity", and component-2, "relaxation". A: Elderly persons to have living in nursing home, B: Elderly persons to have living in own home, C: Young persons.

4. CONCLUSIONS

It was recommendable to change the tray-color depending on the mealtime by using the color images to give the different emotions for diners. The effective usage of tray-color at the mealtimes showed the possibility to increase QOL for the elderly persons especially living in the nursing homes.

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Food, color and health: Therapeutic and preventive approaches

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ABSTRACT

The use of color as a healing item or balancer is not a recent discovery. The techniques that came with the use of colors also applied to the Golden era of Greece, ancient Egypt and the ancient civilizations of India and China. These civilizations believed that everything happening in the cosmos affected the individual, as well as the whole universe. We start from the basis that man is not only its physical body but mind, emotion, alma, among others. Our life is set in a constant interaction with our body with energies we create and which we cross. We also think that these bodies have different vibrational frequencies that correspond to different colors. If this interaction is a dynamic and balanced process, it creates in us well-being and health, if there is resistance, interaction ceases, energy stops and diseases appear occurs. It is not hard to imagine that long known civilizations, decided to take shortcuts in the ways of healing. Knowing that we can transmit our fitness as a confluence and resulting forces, we can also modify that state of mind with the intervention of other forces of nature but different vibrational frequency. The proper use of color (i.e. its radiation) appears in the several processes balancing them, relieving illness, not as a substitute for drugs, but with the original power of light who works at all levels to be the most powerful cosmic force.

1. POWER ACCORDING TO THE VIBRATIONAL PROPERTIES OF COLORS

One of the most efficient ways of restoring the balance of the color in an organism is through food. The color-therapy is a simple method to cure diseases and disorders of the mental, emotional and physical bodies based on the principle of energy. Each food has a value or degree according to the color of our bodies, to provide the vibration that is missing from the energy of light expressed by colors.

We can figure out that for energetic medicine and according to the chakras, that there is a relationship among feelings, its radiation in colors and diseases, so we can put them together according to the aura that reflects them.

1) Rage and anger are indicated in the aura by dark red color, it causes stroke (brain condition with deprivacy of senses and movement).
2) Excessive ambition, gives the aura a bright orange color and causes rheumatism.
3) Pride turns aura into brownish orange and causes arthritis.
4) Greed and Envy darkens the green aura and shows black spots. Causes excess of uric acid.
5) The lack of enthusiasm and interest is expressed in the aura by a dark grey, brings depression and skin diseases.
6) The absence of ideals is represented by a dull violet tone that appears in the form of melancholy and sadness causing respiratory problems.

Chromotherapy is the science that deals with healing and eating, through color.

Yellow, color of the sun, provides security and stimulates creativity.

Red, strong color, red fruits, is recommended against apathy, depression, lack of sexual desire and fatigue.

Orange upraises the mood and also helps depressive condition.

Blue violet relaxes, vegetables of that color rebalance nervous system and are indicated for very nervous people who get tired easily.

Green foods mitigate excitement, useful during depressions.

White is the sum of all colors (garlic, onions). White vegetables are the medicine against all diseases.

2. FOODS BASED ON TO THE ENERGETIC PROPERTIES OF COLORS, ACCORDING TO TAO

There are three basic factors created within Tao: Ether T, Color A, Sound O, base of light colors. There are 999 basic colors but the eye can only recognize 6 with its sub colors. Color is the distinctive base of light.

The Taoists believe the Universe is a vast ocean interacting, driven by interaction of Yin-Yang, human beings are one of the most complex of such interaction. The movement of Yin-Yang is expressed through five phases or movements of energy known as the five elements and their corresponding colors: water (*black*), wood (*green*), fire (*red*), earth (*yellow*), metal (*white*).

Red food is related to the heart. Revitalizes, tones up, promotes blood circulation, stimulates sexuality.

Yellow food, orange, brown, relates to spleen and stomach. Stabilizes, balances, harmonizes, calms down.

Green food has affinity with the liver, tones the blood in the liver, desintoxicates, purifies.

Black food has affinity with kidneys and bladder. Nourishes deeper energy in the body and blood, tones up the essence, contracts and refreshes.

White food has affinity with the lungs and large intestine, purifies.

3. COLOR DIET BASED ON PIGMENTATION OR COLORIMETRY

Color's diet is a curious diet that has been very succesful, especially in the United States, where places such as the Centre for Disease Prevention and Control prepare their menus according to the colors and which makes it more fun, tasty and nice looking.

They are the key to a healthy diet, for consuming daily fruits, fresh vegetables of different colors, and it ensures low calories high amount of micronutrients (vitamins, minerals, fiber and phytochemicals) food intake. It significantly reduces the risk of developing cardiovascular diseases, cancer and diabetes, among others. For this reason, more and more nutritionists worldwide recommend to incorporate foods of different colors in the daily diet.

Colors diet is base on the pigments responsible that give color to each food, have a specific and beneficial effect on health, so eat at least 5 colors a day to protect your body.

For example, pink and purple foods contain strong antioxidants and polyphenols as resveratrol, which helps delay ageing and neutralizes the oxidative process caused by free radicals.

Red and orange foods are rich in beta carotene and those vegetables help the health of the skin, protect free radicals produced by the sun, and help to eliminate toxins.

Red foods are rich in lycopene, and reduce the risk of cancer as well as circulatory problems.

Green foods help to prevent cholesterol, reduce the risk of cardiovascular disease and prevent constipation. They contain glucosinolate and due to the high content of lutein are beneficial to our eyes.

White foods, including cabbage, onion, garlic, leeks, pears, etc., contain sulfide dialilo (an enemy of carcinogens). These foods help reduce bad colesterol, lower blood pressure and strengthen the immune system.

Red group: Possesses lycopene (antioxidant) and other anticancer that helps prevent the formation of nitrosamines. They have a high content of Vitamin C and carotenes. Found in tomatoes, strawberries, sugar beet, watermelon, etc.

Orange group: Contains beta-carotene, vitamin C and several antioxidants. Ex.: carrots, peppers, orange, papaya, pumpkin.

Yellow group: Contains curcumin, an anticancer, plus betacarotenos substance. Ex.: corn, peppers, egg yolk.

Green group: Is a source of vitamin C, K, iron, calcium, chlorophyll, all green leaves are anticancer and green fruit.

White group: Contains folic acid, vitamin K, fat-soluble vitamins, proteins of good, quality hydrates of carbon, unsaturated fatty acids, phenolic compounds, sulphides alilicas (inhibit enzymes that form harmful substances). Ex.: onion, potatoes, mushrooms, milk, garlic, banana, white meat, egg white.

Brown group: Contains more protein, vitamin B complex, iron, fibres and monounsaturated fatsand carbohydrates. Ex.: dried fruits, wheat germ, rice, legumes, oats, beef.

Blue group: Contains anthocyanin which favours circulation and anti carcinogenic agents. It is rich in iron and B vitamins. Ex.: grapes, blackberries, cherries, plums.

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Kinetics effect of hydrothermal conditions on translucence of milled rice

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ABSTRACT

The effect of hydrothermal process of rough rice on the translucence of milled rice grains was investigated. The relationships between translucence, gelatinization degree (GD) and head rice yield (HRY) were also determined. A factorial design: temperature (85, 95 ºC), cooking time (90-180 min at 85 ºC; 45-75 min at 95 ºC) and tempering time (0-24 hours) between hydration and cooking stages was performed. Milled rice translucence was determined with a colorimeter recording the change of the *x*-chromatic variable (Δx) in contrast to black and white bottom. Translucence index (TI) relates the difference between Δx of rice sample and opaque control sample with the difference among Δx of translucent and opaque rice control samples (TI = 0 for non-treated rice and TI = 1 for parboiled rice). Hydrothermal conditions significantly affected TI which values resulted between 0.05 and 0.98. TI was correlated with HRY ($r = 0.76$). A nonlinear relationship among TI and GD evaluated by DSC calorimetry was found. The significance of these results lies in the possibility to quantitatively assess the translucence of rice and also the fact of having mathematical expressions that connect TI with other quality parameters characteristic of parboiled rice.

1. INTRODUCTION

Rice parboiling involves hydration, cooking, drying and milling in order to obtain milled parboiled rice. Traditional method using pressure steam has been widely used mainly due to the economic benefits from improved milling yields and less loss of solids during cooking (Bhattacharya 2004). Gelatinization produces translucent grain with greater plasticity and resistance to the breakage. In alternative hydrothermal methods the pressurized steam is replaced by water vapor at 15-20 ºC above the gelatinization temperature and tempering stage was set among hydration and cooking steps. They lead to complete or partial gelatinization providing as well as the traditional method a better HRY than non-parboiled rice. Characteristics of parboiled rice are: firmness, lowest stickiness of cooked rice, higher thiamine content, longer cooking time and its own organoleptic properties (Tuley 1992, Champagne 2004). The influence of vapor pressure parboiling on milled rice properties has been widely studied (Champagne et al. 1998, Mohapatra and Bal 2006). However, the information related to the effect of hydrothermal conditions on cooked rice properties of is very poor (Miah et al. 2002). The objective was to study the hydrothermal treatment of rough rice evaluating the effect of process conditions on the translucence of milled rice. Hydrothemal conditions were set based on process temperature, cooking time and tempering time. Correlations between TI and other quality indexes such as HRY and GD were also evaluated.

2. MATERIALS AND METHODS

2.1 Parboiling method

Local variety of long rice (Don Juan) provided by INTA Concepción del Uruguay was used. An experimental cooking chamber with water circulation was used. Rice samples are placed in a basket within the cooking camera which can dive (during hydration step) or rise (during cooking step) above the water level by a piston sliding across the top. Conditions of hydrothermal process were shown in Table 1. Rice was finally oven drying at 25 ° C until 12% moisture level was reached.

2.3. Translucence index

A Hunterlab Labscan Spectro Colorimeter (LS-5000, Hunter Laboratory, Inc., USA) with D65 illuminant (CIE 1964, 10° Standard Observer) was used. A layer of black or white modeling paste (area 28 cm^2) was used to support a monolayer of kernels. Based on significant change of CIE chromaticity of translucent sample if white or black contrast was used (Hutchings and Gordon 1981). CIE chromaticity co-ordinate (x) was determined and the difference $\Delta x_S = x_S(\text{white}) - x_S(\text{black})$ was obtained. TI was calculated as:

$$\boldsymbol{TI\%} = \left(\frac{\Delta x_S - 2.72\ 10^{-2}}{5.65\ 10^{-2} - 2.72\ 10^{-2}} \right) \cdot 100 \qquad (1)$$

where Δx_S is the sample change, 2.72 · 10_2 and 5.65 · 10_2 are the Δx_S-values of unprocessed rice (TI = 0%), and traditional parboiled rice (TI = 100%) respectively. All measurements were replicated.

2.4. Head rice yield and gelatinization degree

Rice was milled in a Suzuki, MT-95 laboratory mill and HRY was calculated as percentage of whole milled grains respect to brown rice. Gelatinization degree was calculated relating the gelatinization enthalpy of the sample, ΔH, with $\Delta H_{control}$ corresponding to non-processed rice. Enthalpies were obtained in PL-DSC calorimeter (Polymer Laboratories Ltd., UK), calibrated using pure indium standard ($\Delta H_{\text{melting}}$=28.41 J/g, 156.66 ºC). Tests were performed in triplicate.

2.5. Response surface method (RSM)

A RSM was applied to analyze the effect of process conditions on quality variables. In such method the responses studied (Y_K, $K = 1,\ldots,p$) are matched to the factors (x_i, $i = 1,\ldots,n$) by the polynomial model associated with the experimental design (Khuri and Cornell 1987). The Statgraphics software package (Statistical graphics Corporation, USA) was used for statistical analysis of the experimental results.

3. RESULTS AND DISCUSSION

Processing conditions and experimental results of translucence are shown in Table 1. The comparison with the control sample (TI = 0) evidences the convenient effect of hydrothermal treatment, particularly for tempered samples, resulting increments of 86% for TI index. From a visual observation it was found that all samples with TI < 70% presented an undesirable ''white belly''. This defect has neither been observed in tempered samples which aspect was translucent. TI was correlated with HRY (r = 0.76) and also with GD (r = 0.98).

Table 1. Average values of translucence index (TI), head rice yield (HRY) and gelatinization degree (GD) obtained for different hydrothermal process conditions: temperature (x_1), cooking time (x_2) and tempering time (x_3).

Test nº	x_1 (ºC)	x_2 (min)	x_3 (hs)	*TI* (%)	*HRY (%)*	*GD (%)*
1	85	90	0	42.6	77.9	23.4
2	85	120	0	53.0	81.6	26.3
3	85	150	0	49.0	80.8	25.2
4	85	180	0	72.8	83.6	32.9
5	95	45	0	5.0	81.5	14.4
6	95	55	0	56.0	79.7	27.2
7	95	65	0	47.9	78.1	24.9
8	95	75	0	54.0	77.5	26.6
9	85	90	24	71.5	84.2	32.4
10	85	120	24	80.6	84.8	36.1
11	85	150	24	89.6	85.4	40.6
12	85	180	24	98.3	86.0	46.7
13	95	45	24	86.9	86.1	39.1
14	95	55	24	87.0	85.9	39.2
15	95	65	24	87.2	85.7	39.3
16	95	75	24	87.6	85.60	39.5

The nonlinear relationships between HRY and TI (r^2 = 0.89) or TI and GD (r^2 = 0.93) were:

$$\boldsymbol{HRY} = \mathbf{92.9 - 31.1 \exp[- 0.018\ TI]} \qquad \mathbf{(2)}$$

$$\boldsymbol{TI} = \mathbf{-0.0562}\ \boldsymbol{GD}^{\mathbf{2}} + \mathbf{6.33}\ \boldsymbol{GD} - \mathbf{74.7} \qquad \mathbf{(3)}$$

A similar relationship has been reported between HRY and gelatinization degree determined by DSC (Marshall et al. 1993).

The effect of hydrothermal conditions on TI, performed by RSM method, was satisfactorily modeled (r^2 = 0.97) by means of the following expression in terms of process variables:

$$\boldsymbol{TI} = \mathbf{-58.87 + 1.27}\boldsymbol{x}_{\mathbf{1}} - \mathbf{0.27}\boldsymbol{x}_{\mathbf{2}} + \mathbf{1.35}\boldsymbol{x}_{\mathbf{3}} + \mathbf{0.002}\boldsymbol{x}_{\mathbf{2}}^{\mathbf{2}} \qquad \mathbf{(4)}$$

Process variables were both significant (p-value < 0.05) and quadratic effect of cooking time was evidenced. Figure 1 shows the estimated response surfaces of TI as function of tempering and cooking time. It can be appreciated that TI values increased with time and tempering.

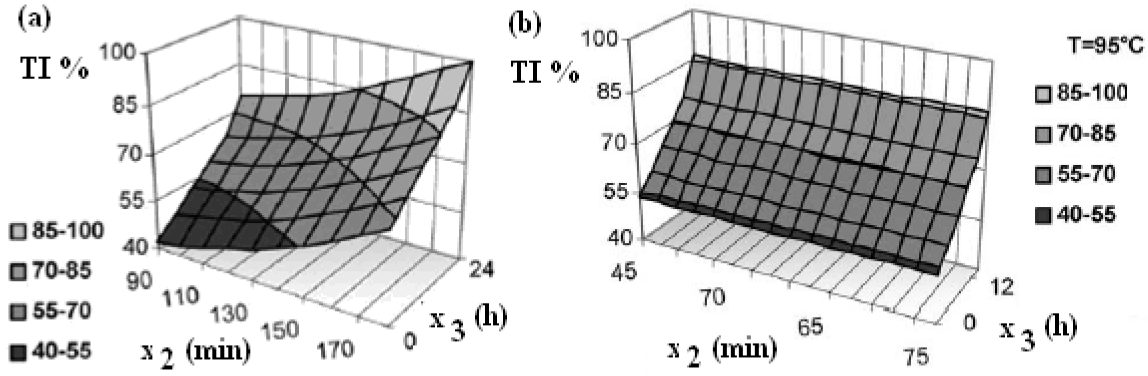

Figure 1. Effect of cooking and tempering time on TI for fixed temperature: (a) 85 ºC, (b) 95 ºC.

From optimization analysis it was found that the conditions to optimise the process include 24 h of tempering at 25 ºC after hydration step. The cooking step can be performed using 85 ºC (174.4 min) or 93.7 ºC (45 min). Both conditions provide a more firm and translucent grain with satisfactory values of translucence index.

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Non-destructive assessment of water and pigments in leaves from the remission function using the Kubelka-Munk theory

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ABSTRACT

Correlations between light reflectance of leaves and their pigments content are relevant in developing non-destructive methods that allow remote sensing of vegetation. In the present work, the applicability of the Kubelka-Munk theory and the Pile of Plates model in plant leaves was confirmed and it was further used to elaborate a methodology for the determination of their pigments and water concentration. Several leaves from different species: *Hedera helix*, *Liquidambar styraciflua*, *Populus alba*, *Rosa sp*., *Gardenia jasminoides*, *Schefflera arboricola*, *Aloysia triphylla* and *Ficus benjamina* were selected. Chlorophyll-a and chlorophyll-b were quantitatively determined in the leaves by solvent extraction and subsequent spectrophotometric determination. On the other hand, reflectance and transmittance spectra were recorded for the studied species in the UV-visible range and in the near infra-red region. The remission function, a quantity proportional to the chromophore concentration in solid samples, was calculated from reflectance measurements using the Kubelka-Munk theory. Optical parameters of leaves such as the light absorption (k) and the light scattering (s) coefficients were also estimated from transmittance and reflectance data using the Pile of Plates model. The correlations developed in this study allow the direct determination of chlorophylls and water in intact leaves by measuring reflectance and transmittance spectra.

1. INTRODUCTION

The determination of pigments concentration in leaves is usually performed by solvent extraction and posterior spectrophotometric measurements of the resultant solutions (Sims and Gamon 2002) while humidity quantification is performed by drying leaves in oven (Cordon and Lagorio 2006). These classical methodologies have the disadvantage of being both time-consuming and sample-destructive. During the last years, efforts in developing non-destructive techniques to assess pigments content on intact leaves have been made. Reflectance and transmittance spectroscopies are very attractive tools to reach this goal (Hartfield et al. 2008). In this work we present new correlations between optical parameters and the content of water and photosynthetic pigments, based on the Kubelka-Munk theory and on the Pile of Plates model (Cordon and Lagorio 2007).

2. EXPERIMENTAL

2.1 Materials and sample preparation

Leaves from different species: *Hedera helix*, *Liquidambar styraciflua*, *Populus alba*, *Rosa sp*., *Gardenia jasminoides*, *Schefflera arboricola*, *Aloysia triphylla* and *Ficus benjamina* were studied. To determine pigments concentrations, about 0.4 g of each species were ground in a mortar and extracted with acetone. The obtained suspension was vacuum-filtered. The absorbance of the resultant filtrate was measured in a 1cm-optical path cell at 663, 537 and 647 nm using a spectrophotometer Shimadzu 3101. Chlorophyll-a, Chlorophyll-b, carotenoids and anthocyanins concentration (in μmol mL^{-1}) were calculated from equations 1 to 4 (Sims and Gamon 2002).

$$\text{Chlor a} = 0.01373 \cdot A_{663} - 0.000897 \cdot A_{537} - 0.003046 \cdot A_{647} \quad (1)$$

$$\text{Chlor b} = 0.02405 \cdot A_{647} - 0.004305 \cdot A_{537} - 0.005507 \cdot A_{663} \quad (2)$$

$$\text{Carotenoids} = \frac{(A_{470} - (17.1 \cdot (\text{Chlor a} + \text{Chlor b}) - 9.479 \cdot (\text{Anth}))}{119.26} \quad (3)$$

$$\text{Anth} = 0.08173 \cdot A_{537} - 0.00697 \cdot A_{647} - 0.002228 \cdot A_{663} \quad (4)$$

where A_x is the absorbance for the pigments-solution at wavelength x.

Water content was estimated from the difference in weight from fresh leaves and leaves dried at 70 °C for 72 hs in an oven and cooled in a dessicator.

2.2 Reflectance and transmittance measurements

Diffuse reflectance was recorded as a function of wavelength from 459 to 2500 nm for individual leaves and for groups of four stacked leaves (optically thick sample showing zero transmittance). Diffuse transmittance was measured for individual leaves. A spectrophotometer (UV3101PC, Shimadzu) equipped with an integrating sphere (ISR-3100, Shimadzu) was used for the reflectance and transmittance measurements. Barium sulphate was employed as a white reference standard to adjust 100% reflectance level.

The scattering coefficient, s, representing the fraction of light scattered and the absorption coefficient, k, representing the fraction of light absorbed by the leaves, were calculated from the diffuse reflectance and diffuse transmittance values obtained for individual leaves using equations (5)-(9) (Kubelka-Munk theory and Pile of Plates model).

$$R_\infty = 1/a \quad (5)$$

$$k = [(a-1)/(a+1)]\log b \quad (6)$$

$$s = \left[2a/\left(a^2 - 1\right)\right]\log b \quad (7)$$

$$a = \left(1 + r^2 - t^2 + \Delta\right)/2r \quad (8)$$

$$b = \left(1 - r^2 + t^2 + \Delta\right)/2t \quad (9)$$

Where, $\mathbf{R}_\infty$ is the infinite diffuse reflectance (the diffuse reflectance obtained for a group of stacked leaves), **t** is the diffuse transmittance of a leaf, **a** and **b** are optical constants and **r** is the diffuse reflectance value for a single leaf. The quantity Δ is defined by equation (10):

$$\Delta^2 = (1+r+t).(1+r-t).(1-r+t).(1-r-t) \qquad (10)$$

The remission function, F(R) was obtained according to equation (11).

$$F(R) = \frac{(1-R_\infty(\lambda))^2}{2R_\infty(\lambda)} \qquad (11)$$

3. RESULTS AND DISCUSSION

The values obtained for *F(R)* on a group of leaves matched with the quotient *k/s* obtained for individual leaves (results not shown) revealing the applicability of Kubelka-Munk theory and the Pile of Plates model on the plant leaves.

A good linear correlation was found between the water content and the remission function at 1456 nm (Figure 1).

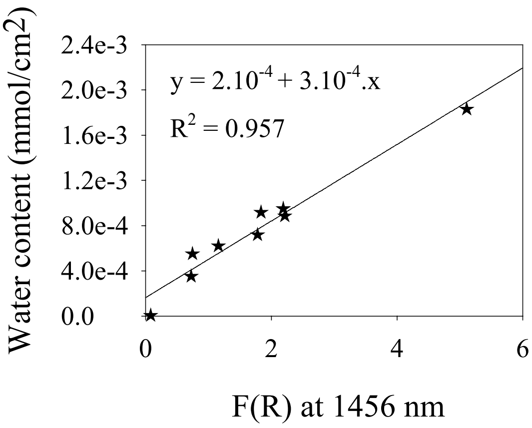

Figure 1. Water content of leaves in mmol/cm² as a function of the remission function (F(R)).

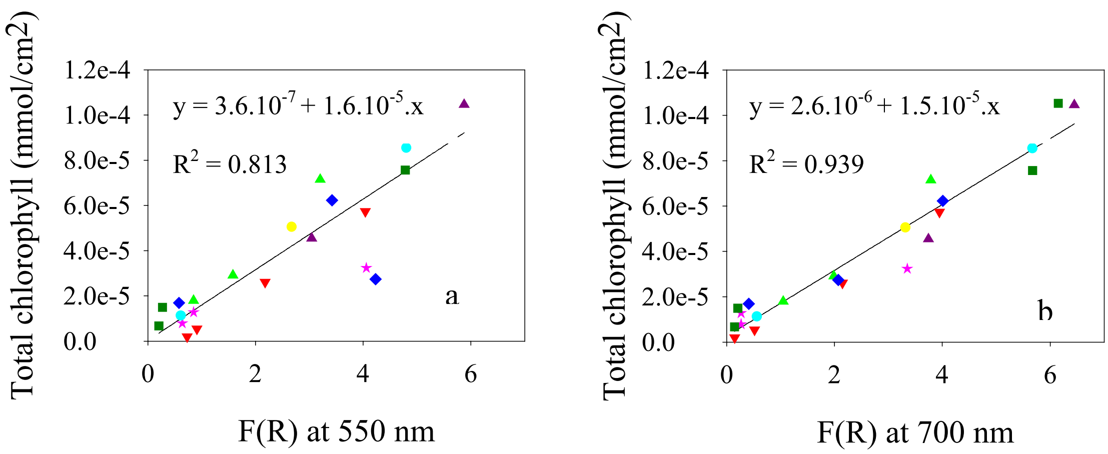

Figure 2. Total chlorophyll content of leaves in mmol/cm² as a function of F(R) at 550 nm (a) and 700 nm (b). Hedera helix ▲, Liquidambar styraciflua ▼, Populus alba ★, Rosa sp. ◆, Gardenia jasminoides ●, Schefflera arboricola ■, Aloysia triphylla ●, Ficus benjamina ▲.

Correlations between the total-chlorophyll content and the remission function, at both 550 and 700 nm are shown in Figure 2.

It is observed that the correlation at 700 nm is better than that found at 550 nm. In Figure3, the absorption coefficient, k, is plotted as a function of the total-chlorophyll content.

The results show that the best correlation found to estimate non-destructively chlorophyll content may be inferred from the experimental values of *k* at 700 nm. No correlations were found for carotenoids and anthocyanins in this study.

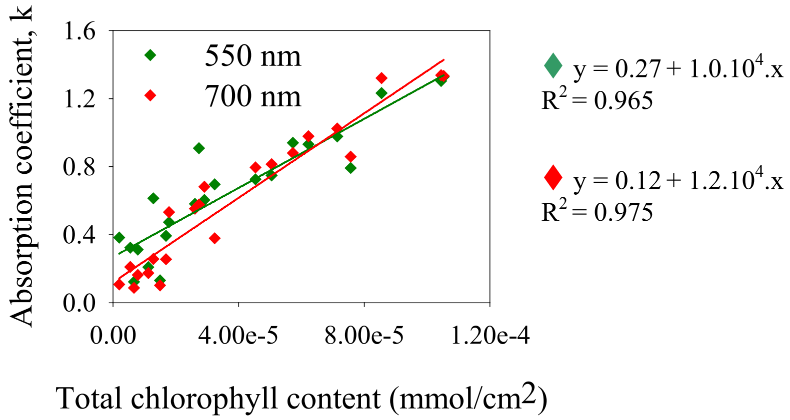

Figure 3. Absorption coefficient as a function of the total-chlorophyll content at 550 nm and 700 nm for the species mentioned in Figure 2.

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Measuring banana appearance aspects using spectrophotometer and digital camera

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ABSTRACT

Visual colour appearance of bananas dominates the consumer's decision when buying the fruit on the market. A reliable instrumental method is introduced to describe the banana ripeness using colour appearance terms and freckle percentage. The method would benefit decision making in the supply processes (such as harvest, transportation, packhouse, and on the market shelf), speed up the communication between each supply stage and reduce waste.

1. BACKGROUND

Visual colour appearance of banana fruits dominates consumer's decision on buying the fruits on the market (Hutchings 1999). Leading industries are using banana colour charts to manage the fruit quality through the whole supply chain globally. The method is subjective and the scale is coarse. Others apply spectrophotometers for the colour measurement on a small area of the peeled skin (Ward and Nussinovitch 1996). Previous studies show that digital image methods can be applied for fruit colour measurement (Balaban 2008, Park et al. 2005). A more reliable instrumental method is needed to describe ripeness of banana using colour appearance terms and freckle percentage. This would benefit decision making in the supply processes, speed up the communication between supply stages and reduce waste.

2. EXPERIMENTAL CONDITIONS

Two boxes, one of green and one of ripe, Fyffe bananas were purchased, each containing more than 9 banana hands. Each hand included 5 or 6 fingers which were individually marked. Each hand was investigated every day for a period of 9 days, by which time a large proportion of skins had turned brown/black. These samples were kept in a laboratory at a temperature of 14±1°C - see Figure 1. The daily procedure for the experiment was: 1) image capturing of hands; 2) detaching and numbering fingers; 3) image capturing of fingers; 4) peeling the skin; 5) spectrophotometer measurement of the peeled skin.

A conventional bench-top sphere-based spectrophotometer (Macbeth® CE7000A) was used to measure the skin colour as indicated in Figure 1 right. Three points were selected, each 25.4 mm circular shape. The results were averaged for each banana.

Figure 1. Left: banana samples are grouped and numbered in green (un-ripe) and yellow (ripe) colours in the laboratory; Right: measuring positions on banana skin.

Banana images were captured in a grey interior standard viewing cabinet (VeriVide®, Enderby, UK). The light source was a diffused D65 simulator. The luminance level of a barium sulphate white tile placed in the middle of the floor was 441.36 cd/m² with chromaticity co-ordinates x = 0.3196 and y = 0.3348. Before conducting each experiment, all devices were given 30 minutes warm-up time.

3. RESULTS

When comparing results the technique of MCDM (Mean colour difference calculated from individual colour values and the mean values of the group) was applied. This is used to calculate the mean colour difference from a set of colour differences between pairs of samples. The smaller the colour difference number, the more repeatable or more reproducible the result. Typically, about 3 units can be visually perceived for banana fruit samples.

3.1 Uncertainty of the spectral measurement

The following analysis was applied to evaluate the uncertainty of the spectrophotometer measurement. For each hand on each day, each banana skin was measured at the 3 positions shown in Figure 1. The colour difference was calculated between each point and the mean of 3 points. The average colour differences for all fingers for the particular day were used to indicate variation for that banana hand as listed in Table 1. It can be seen that the green banana had a colour variation ranging from 1 to 1.9 units. This is smaller than for the yellow bananas, which ranged from 1.7 to 3.0 units. The average colour difference MCDM was 1.4 units for green and 2.1 units for yellow fruit.

Table 1. The uncertainty of the spectrophotometer measurement on each day for each banana type in terms of colour differences.

Green	No. of fingers	L*	a*	b*	C*	h	ΔE^*_{ab}
H1	5	53.80	-12.27	34.57	36.69	109.56	1.0
H2	6	59.07	-10.93	35.90	37.54	106.95	1.1
H3	5	58.47	-11.34	35.36	37.14	107.80	1.3
H4	5	56.95	-10.92	35.20	36.86	107.23	1.5
H5	6	60.19	-10.14	34.99	36.44	106.15	1.3
H6	5	57.46	-11.05	34.76	36.48	107.67	1.3
H7	6	56.24	-11.53	34.66	36.53	108.41	1.7
H8	6	58.42	-10.86	36.23	37.83	106.69	1.9
H9	5	55.25	-11.65	35.68	37.53	108.10	1.4
Yellow	No. of fingers	L*	a*	b*	C*	h	ΔE^*_{ab}
H1	6	70.94	7.63	48.60	49.22	80.99	2.0
H2	5	69.39	9.43	46.66	47.61	78.56	1.7
H3	6	70.49	9.49	45.61	46.60	78.24	2.0
H4	6	58.19	13.32	39.91	42.18	71.08	2.9
H5	5	62.91	12.41	43.27	45.04	73.91	1.8
H6	6	63.46	12.18	43.15	44.94	74.00	1.7
H7	6	56.67	14.50	37.67	40.41	68.86	3.0
H8	6	53.39	16.29	37.66	41.15	66.14	2.1
H9	6	44.79	14.52	26.83	30.52	61.38	1.7

Figure 2 is a plot of banana colours for the 9 days on CIE a*b* and L*Cab colour charts. These two charts clearly show that the green bananas had much smaller colour variation remaining green throughout the experiment. The yellow bananas, however, increased in redness, while lightness increased and chroma decreased. That is, colour changed from bright colourful yellow to dark pale brown.

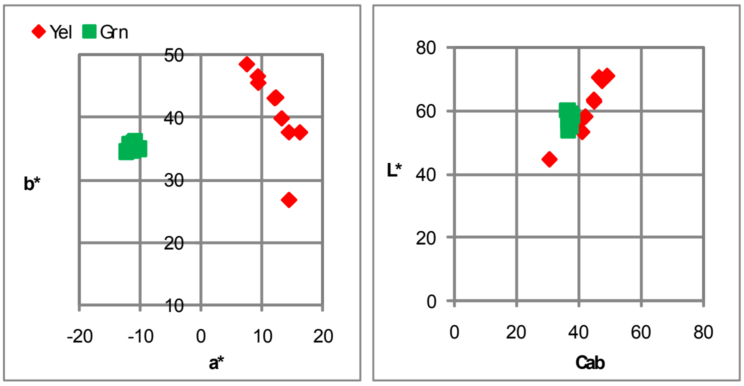

*Figure 2. Green and yellow banana colours for 10 days plotted on a CIE a*b* (left) and L*Cab (right) diagrams.*

3.2 Uncertainty of the digital image method

A similar analysis process was used for the digital imaging methods. Uncertainty of the digital image system was quantified on whole hand images and each individual finger.

For whole hand images, colour differences at 3 areas were calculated for all fingers in each hand against the mean values of the hand, and between the face and back positions (see Table 2). From Table 2, it can be seen that the variation for green bananas is smaller than that for yellow fruit. Variations between face and back are 1.9 ΔE for green and 2.7 ΔE for yellow.

Table 2. Banana hand variations (ΔE^*_{ab}).

ΔE^*_{ab}		H1	H2	H3	H4	H5	H6	H7	H8	H9	Mean
Green	back	1.2	0.5	2.0	0.5	4.1	0.8	0.2	0.9	3.0	1.5
	face	1.8	0.7	0.3	3.4	1.8	1.1	1.3	1.9	1.7	1.6
Yellow	back	4.1	0.5	0.7	0.4	4.9	0.6	3.8	5.9	4.0	2.8
	face	2.6	1.7	1.2	1.2	3.1	0.7	0.4	5.7	3.8	2.3
Green	face vs. back	2.2	0.8	2.0	3.4	2.1	1.2	1.1	2.0	2.7	1.9
Yellow	face vs. back	3.8	2.1	1.3	0.9	1.7	1.7	4.2	1.6	7.5	2.7

In summary, the colour results using the digital image method had ΔE*ab values ranged between 0.2 to 4.1 for green bananas and between 0.4 to 5.9 for yellow, with mean values less than 1.6 for green and less than 2.8 for yellow fruit. These results indicate that 1) images between hands or between fingers are repeatable; 2) images from hands and figures give repeatable results; and 3) images from face and back are not so repeatable.

3.3 Comparing the digital imaging and spectrophotometer methods

The spectrophotometer measurements on the peeled skins were compared with colour results from digital image method (see Figure 3). It can be seen that hue values gave good agreement but some discrepancies were found for the lightness and chroma values. This was caused by differences in the sampling positions when using different methods, especially as bananas ripened.

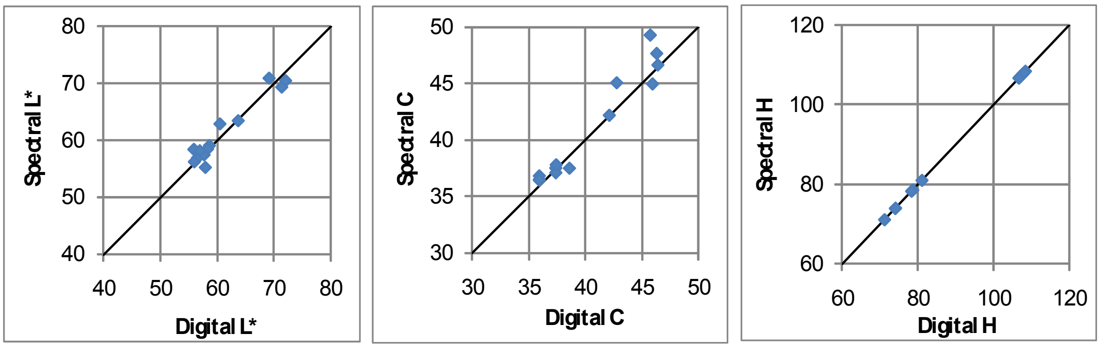

Figure 3. Comparing digital image colour and spectrophotometer results for lightness (left), chroma (middle) and hue (right).

3.4 Banana colour changes with time

The hue values were plotted with days to reveal the ripening process (Figure 4). In Figure 4 left diagram, green bananas changed little in hue as they remained consistently unripe. Figure 4 (middle) shows clear systematic pattern for yellow samples, i.e. the riper the banana, the redder the hue. Figure 4 (right) indicates similar trends: the freckle percentage for green banana not changing, while as the yellow fruit ripened the percentages of freckling increased.

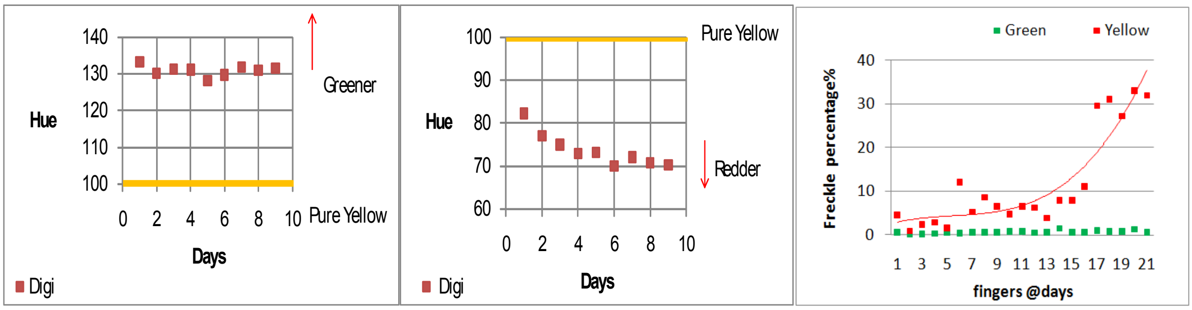

Figure 4. Hue changes with time for green bananas (left), yellow (middle), and freckle percentage changes for green and yellow bananas (right).

4. CONCLUSIONS AND DISCUSSIONS

A digital image method has been developed for automatic scaling of banana images of colour and freckle percentage to define the ripeness of the fruit. This method is repeatable, reproducible and non-destructive. The technique can be further developed for quality control purposes along the whole fruit supply chain. The industry will benefit from this objective technique by reducing decision time and waste.

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Effects of stimulus chromaticity on transparency perception: A study on perceptual "clarity" of spatially overlapping figures

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ABSTRACT

In this study, we examined effects of stimulus chromaticity on perceptual "clarity" of spatially overlapping figures which give rise to transparency perception. The results of the clarity-matching experiment showed that, for the LM-axis condition, the green or red rectangle appeared clearer than the red or green one, depending on the observers; for the S-axis condition, the blue rectangle, for most of the observers, appeared clearer than the yellow one. The difference in the perceptual clarity within each of the LM- and S-axis conditions, together with the individual difference, suggests that perceptual clarity of chromatic stimuli may be mediated by uni-polar, non-opponent chromatic mechanisms rather than by bi-polar, opponent mechanisms.

1. INTRODUCTION

In our daily life, transparent material, such as wrapping paper, is often used to make foods (e.g., fruits and vegetables) appear attractive. In this study, we report the result of a basic research concerning human transparency perception. Previous studies on transparency perception have shown that, for achromatic stimuli (e.g. light- and dark-gray rectangles) presented on a white background, perceptual transparency became increased when the luminance of the overlapping area of two figures was around the average level of the luminances of the figures (Oyama and Nakahara 1960). On the other hand, we have found that, when the luminance of the overlapping area was set at much lower than the luminances of the figures, perceptual transparency became much more enhanced, and further, the figure appeared to be very "clear", but not "cloudy" or "foul" (Kawai 2002). In this study, we examined the effect of stimulus chromaticity on the perceptual "clarity" of the stimulus.

2. METHODS

2.1 Stimuli and Apparatus

The stimuli were generated by a VSG 2/5 graphic card (Cambridge Research Systems) housed in a PC/AT compatible computer, and presented on a color CRT monitor (EIZO Flex Scan T566) at a refresh rate of 60 Hz. Figure 1 shows the stimulus configuration schematically. The test stimulus, presented in the upper half of the CRT monitor, was composed of two chromatic (A, C) and an achromatic (B) areas. The region subtended by area A + C (or B + C) describes a rectangle of size 4.0˚ (W) × 1.7˚ (H) and area C of size 2.8˚ (W)

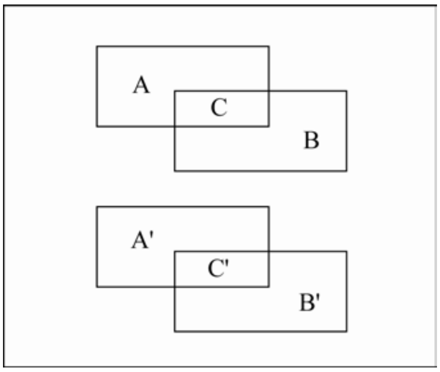

Figure 1. Schematic representation of the stimuli. *Test stimulus, presented in the upper half of the CRT monitor, was composed of two chromatic (A and C) and an achromatic (B) areas. The comparison stimulus, presented in the lower half, was composed of three achromatic areas (A', B', C'). See text for details.*

× 0.6° (H) at a viewing distance of 110 cm. The chromaticity of area A and C was set at one of the four colors which were located pair-wise on the LM- and S-axes of the DKL color space (Derrington et al. 1984). CIE chromaticity coordinates of the four colors were x = 0.366, y = 0.293 for "red" (increase in L cone activation), x = 0.233 y = 0.355 for "green" (increase in M cone activation), x = 0.269, y = 0.232 for "blue" (increase in S cone activation), and x = 0.386, y = 0.516 for "yellow" (decrease in S cone activation). The chromaticity coordinates of area B was x = 0.306, y = 0.321. The luminance of areas A, B and C was set at 30, 50, 10 cd/m^2, respectively.

The distances of the stimulus chromaticity coordinate from the origin of the DKL color space (corresponding to the adapting white background; x = 0.306, y = 0.321, 74 cd/m^2) were the same for the four colors. These stimulus configurations give rise to bistable transparent perception in which a chromatic rectangle (A + C) appears superimposed on an achromatic rectangle (B + C) or vice versa.

The comparison stimulus, presented in the lower half of the monitor, was composed of three achromatic areas (A', B', C'). The chromaticity coordinates of the three areas was x = 0.306, y = 0.321. The luminance of area A' and B' was 30, and 50 cd/m^2, respectively. The luminance of area C' was adjusted by the observer in the experiment (see below).

2.2 Procedure

For each color of the four test stimuli, a "clarity-matching" experiment was conducted. An experimental block started after the observer adapted to the white background for 3 min. and trained to obtain a stable percept that a chromatic rectangle (A + C) of the test stimulus appeared in front of the achromatic rectangle (B + C).

In each trial, the test (A + C + B) and the comparison (A' + C' + B') stimuli were presented. The observer was instructed to adjust the luminance of the overlapping area C' of the comparison stimulus by pressing appropriate buttons of a response box at hand, so that the achromatic rectangle (A' + C') appeared 'transparent' and 'equally clear' with the chromatic rectangle (A + C) of the test stimulus. The stimulus display was presented until the observer completed the adjustment, and it was replaced with a uniform white field (74 cd/m^2) which was presented for 10 sec. in order to eliminate the chromatic adaptation effect. Five trials were repeated in an experimental block for each color of the test stimulus. One experimental session was composed of two blocks in which either of the red-green or the yellow-blue pair of the test stimulus color was tested. Two sessions, one for the red-green and one for the yellow-blue, were excuted in a single experimental day. For each observer, 2 or 3 blocks were carried out for each color of the test stimulus.

Before the main experiments, the observers carried out more than 5 practice blocks in order to establish the criterion for perceptual clarity.

Four undergraduate and one graduate students, naive to the purpose of the experiment, and one of the authors served as observers.

3. RESULTS AND DISCCUSSION

Figure 2 shows the matched luminance of the overlapping area C' of the comparison stimulus averaged over 10 or 15 adjustments (depending on the observers); panel (a) is for the LM-axis condition (red (open bars) and green (solid bars)) of the test stimulus, and (b) for the S-axis condition (blue (dotted bars) and yellow (striped bars)). Error bars indicate 1 SD.

For the LM-axis condition, the matched luminance is lower for the green than for the red test stimulus for the 4 observers (S2, S3, S5, S6), and it is lower for the red than for the green for one observer (S4). No difference is obtained for the other one (S1). For the S-axis condition, the matched luminance is lower for the blue than for the yellow test stimulus for all the observers except one (S6) for whom it is lower for the yellow than for the blue.

To confirm these observations, one-way ANOVA and multiple comparison (Tukey's HSD) were carried out for each observer's data. The analysis revealed that, for the LM-axis condition, the matched luminance for the two observers was significantly lower for the green than for the red test stimulus (S5, diff. = 1.28, HSD = 0.931, $p < 0.01$; S6, diff. = 2.46, HSD = 1.294, $p < 0.01$); for the two observers showing a similar tendency, the difference was marginally significant (S2, diff. = 1.25, HSD = 1.206, $p < 0.1$; S3, diff. = 0.86, HSD = 0.782, $p < 0.1$),. For the other two observers, the difference was totally non-significant (S1), or the matched luminance was significantly lower for the red than for the green test stimulus (S4, diff. = 2.13, HSD = 0.997, $p < 0.01$). For the S-axis condition, the matched luminance for the 4 observers was significantly lower for the blue than for the yellow test stimulus (S3, diff. = 1.25, HSD = 1.122, $p < 0.01$; S4, diff. = 2.17, HSD = 0.997, $p < 0.01$; S5, diff. = 1.10, HSD = 0.931, $p < 0.01$; S1, diff. = 1.83, HSD = 1.462, $p < 0.05$), for one observer showing a similar tendency, the difference did not reach a significant level (S2), and for the other one, the matched luminance was significantly lower for the yellow than for the blue test stimulus (S6, diff. = 1.48, HSD = 1.294, $p < 0.01$).

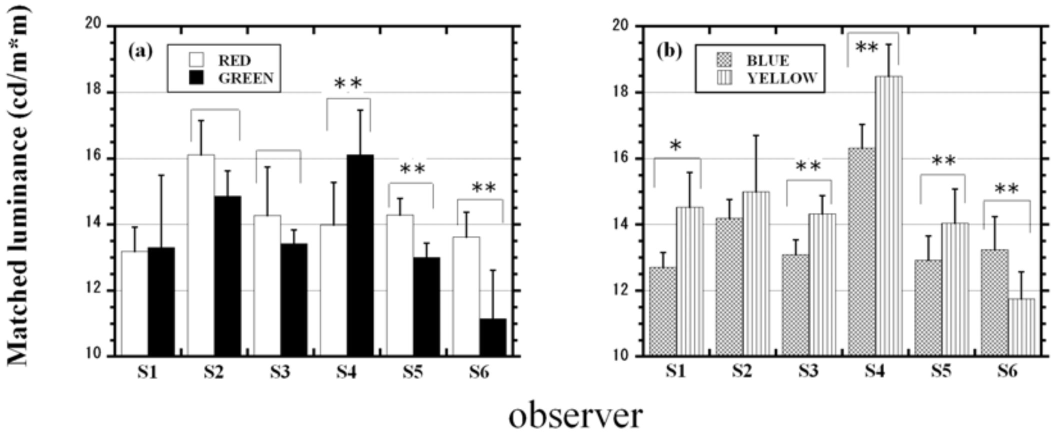

Figure 2. Matched luminance of overlappint area C' of the comparison stimulus.
*The matched luminance of the comparison stimulus averaged over 10 or 15 adjustments (depending on the observers); panel (a) is for the LM-axis condition (red (open bars) and green (solid bars)) of the test stimulus; panel (b) for the S-axis condition (blue (dotted bars) and yellow (striped bars)). Error bars indicate 1 SD. Blakets with ** indicate the significance level of $p < 0.01$; those with * indicate $p < 0.05$; those without asterisk indicate marginal significance ($p < 0.1$).*

It is noted that our previous study with achromatic stimuli found that the perceptual clarity of the overlapping figures was more enhanced when the luminance of the overlapping area was the lower than the other areas (Kawai 2002). Taking into account this finding, the present results imply that, for the LM-axis condition, the green test stimulus generally appears 'clearer' than the red test stimulus, and for the S-axis condition, the blue test stimulus generally appears 'clearer' than the yellow test stimulus, although some of the observers show opposite tendency or no such difference.

The difference in the perceptual clarity within each of the LM- and S-axis conditions, together with the individual difference, suggests that perceptual clarity of chromatic stimuli may be mediated by uni-polar, non-opponent chromatic mechanisms rather than by bi-polar, opponent mechanisms. This notion of non-opponent chromatic mechanisms is consistent with the multi-stage color model proposed by De Valois and De Valois (1993), and the conclusion of De Valois et al. (1997) derived from the hue scaling experiments.

Introspections by the observers seem to support the possible contribution by the (presumably higher-order) non-opponent mechanisms to the perceptual clarity. The observers reported that, for the green and the blue test stimulus (B + C) which gave rise to higher degree of perceptual clarity, the overlapping area (C) appeared black and to have relatively weaker tint of color. On the other hand, for the red and the yellow test stimulus which gave rise to lower degree of perceptual clarity, the overlapping area appeared relatively 'whitish' and to have slightly stronger tint of color, although the tint of color was somewhat different from that of the non-overlapping area.

In the present stimulus conditions, the saturation of the overlapping area was rather low due to the low luminance level (i.e. 10 cd/m^2). It might be the case that the low-level saturation gave rise to perceptual clarity. However, perceptual clarity became enhanced when the low saturation was accompanied by perceptual 'blackness', whereas it became reduced when the low saturation was accompanied by perceptual 'whitishness'. The relation between perceptual clarity and the 'blackness' and 'whitishness' is yet to be elucidated, but it seems at least likely that perceptual clarity may be contributed by the higher-order mechanisms which are also involved in the information processing of perceptual saturation.

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Visual texture in foods

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ABSTRACT

Visual texture provides a good indication as to the condition of foodstuffs as regards their maturation, firmness, softness, and a good approximate date of harvest or picking, and expiry. In order to measure it, different objective methods are applied that not only determine the resistance of the product to a force applied during transport, but that also help to select: time and temperature of washing and cooking; correct form of packing, and machinery used in their final preparation. In the past, the texture of foods, unlike their color, was only measured by experts, either by eye or even by fingernail. Various different objective measuring techniques have been put forward which consider texture as a variation in one or several linear dimensions of the textured surface, e.g. the Fourier transform that means that surfaces in both the spatial and the temporal domain can be analyzed. It then allows an autocorrelation function to be applied to detect the deterministic components of the surface. This paper intends to find a more effective method than those currently in use by combining the wavelet technique and an SOM (Self-Organization Map) type model of artificial neural networks (ANN).

1. INTRODUCTION

The method presented in this paper permits the automatic classification of images by combining the wavelet technique to extract the texture characteristics and a SOM (Self-Organization Map) type model of artificial neural networks (ANN) to classify these characteristics in an unsupervised form. The advantage of discrete wavelet transformations (DWT) is that they are very effective in separating different aspects of information from the image. An ANN stage can then classify these aspects independently and reintegrate them by using a superior ANN in a similar fashion to how the human visual system works.

The method provides much flexibility, ranging from the choice of wavelet functions to the size of the network architecture, and can be adapted to a very great number of scenarios. As it is computationally very efficient, it can be applied in many real situations in which this type of automatic classification is necessary.

2. DESCRIPTION OF THE MODEL

The basic architecture of the model (Figure 1) includes five process stages. The general idea involves extracting the distinctive characteristics of the texture and then classifying them automatically to generate a *map of characteristics* that will allow the textures to be grouped into different types. So stage 1 separates the chromatic information from the image, stage 2 separates certain spatial characteristics, stage 3 automatically classifies these spatial characteristics, stage 4 integrates the spatial characteristics found and stage 5 reintegrates the chromatic information in a final classification.

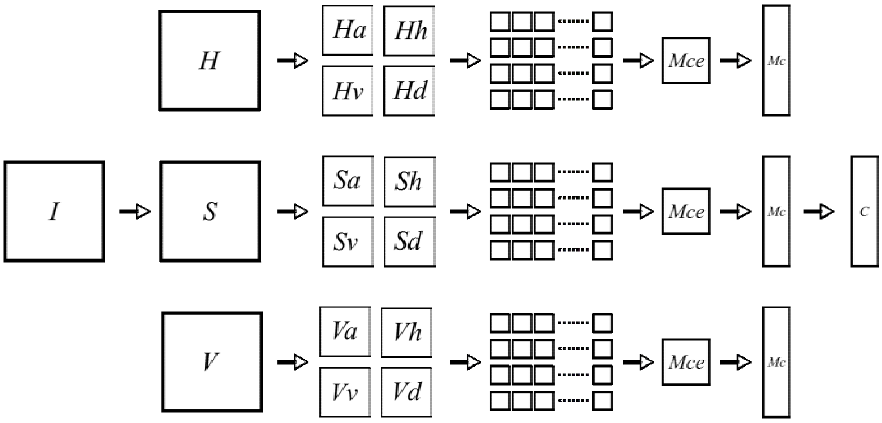

Figure 1. Diagram of the network model.

2.1 Chromatic differentiation

The first stage consists in converting the image from the RGB color space to HSV. The vast majority of digital image formats encode the information in the RGB color space, but the information on the red, green and blue values does not reflect the most important characteristics of a texture. However, by having values for Hue, Saturation and Value it is possible to extract distinctive characteristics from an image much more easily. The conversion from one color space to another can be done simply by means of a linear transformation.

2.2 Spatial differentiation

Once the information has been separated from the image into its respective H, S and V channels, a transformed wavelet is applied to each one of them. This type of transform applied to each channel, as if it were a matrix, produces four matrices half the size of the original matrix. Each one of the resulting matrices contains a reduced version, and another three contain information on the horizontal, vertical and diagonal characteristics of the original matrix. In this stage it is possible to apply different kinds of filters to produce a convolution on the original matrix and so generate reduced matrices (Mallat 1989, Daubechies 1992).

This type of transformation is applied to each channel of the transformed image, generating twelve matrices half the size of the original image, which also present differentiated spatial and colour information. For example: for Hue there is Ha, Hh, Hv and Hd, for Saturation Sa, Sh, Sv and Sd, and for Value Va, Vh, Vv and Vd.

2.3 Automatic classification of differential characteristics

This stage generates a map of the differential characteristics of each color-spatial channel (C_{ce}) by using SOM-type networks (Kohonen 1989, 1997). By means of unsupervised training, this type of network can classify variable entry patterns in a reduced number of categories thanks to connections that generate a single winning neuron within a layer, which activates and reinforces its connections, thus facilitating activation every time it receives a similar pattern. In our model we used an array of layers of this type of units for each C_{ce}. The number of layers may vary according to the variety of types of texture to be classified.

The units of these layers are of the linear type from 0 to 1. Each unit shares the weight of the excitatory connections of its receptive field with the units of the same layer and has lateral inhibitory connections to the units in the same position within the other layers. So for a processing cycle each layer may have several units activated with values between 0 and 1 that represent the degree of similitude between the perceived and the classified sub-pattern, but only one for each position within each layer. To achieve this behavior, a receptive field is used that is a fraction of the size of the entry layer and which is displaced over the differential characteristics of the same layer. For instance, if a C_{ce} has a dimension of 128 × 128, a receptive field of 8 × 8 can be used that can be displaced over a space of 16 × 16. The resulting layer will thus have a dimension of 8 × 8. As all the units of a layer share the weights of the connections to their respective receptive fields each layer learns to differentiate one particular characteristic.

The final response of this stage consists of a normalized linear sum of the responses from these layers, effectively producing a map of the differential characteristics of the C_{ce}.

2.4 Integration of the spatial characteristics

In this stage the information from the twelve layers of the color-spatial maps (M_{ce}) is integrated into three maps of chromatic characteristics (M_c). In so doing, SOM-type ANNs are used and, as in the previous stage, they are responsible for grouping the different spatial characteristics present in the M_{ce}.

In this case, three layers are used for the three HSV channels of color information. Each layer represents the chromatic characteristics present in each channel regardless of its spatial position. The dimension of each one of these layers depends on the number of differential characteristics that are expected to be present in each channel. The units of these layers are also of a linear type from 0 and 1, and they have excitatory connections corresponding to receptive fields that can be displaced over the entry pattern, and inhibitory connections with the units of its same layer. During the training stage each unit displaces four receptive fields over the M_{ce} corresponding to the AHVD channels initially differentiated by the wavelet transformation. The positions of these receptive fields coincide within each channel, integrating the information contained in them and thanks to the lateral inhibition only one unit per layer is activated, reinforcing recognition of one distinctive characteristic in particular. At the end of the training stage, the lateral inhibition connections are no longer used, allowing each unit to be activated in relation to the presence of the differential characteristic learnt, effectively creating a map of color characteristics by channel.

2.5 Integration of the chromatic characteristics and final response

This stage produces the final response by integrating the color characteristics mapped in the three corresponding HSV channels. A layer of simple SOM-type ANN is used to do this. The number of units of this single layer depends on the number of categories to be differentiated. Each unit has excitatory connections with all the units of the three M_c layers and lateral inhibitory connections with the other units of the layer. The response is the activation of a single unit corresponding to the category of the texture fed at entry of the model.

3. USE OF THE MODEL AND CONCLUSION

There are many variants that can be introduced in order to improve the efficacy of the model. Firstly, it is possible that alternative color spaces to HSV produce a better outcome depending on the type of images to be classified. Likewise, the results can also vary depending on the type of wavelet function used, but in general the functions of the haar or daubechies families produce good results. Another alternative to the use of wavelets to differentiate spatial characteristics consists in the successive application of several transformations, which can be especially useful if the images are of high resolution and a differentiation is to be made by very small visual characteristics.

A more difficult variable to measure is the number of intermediate layers in generating the maps of characteristics. It is necessary to bear in mind that this number depends on the number of differential characteristics expected to be present, in such a way that a very small number may imply the loss of some of these characteristics or may prevent these units from reaching equilibrium in training. Therefore, perhaps the most practical solution is to determine a generous value experimentally that will then diminish in accordance with the characteristics of the images. As regards training, and due to the fact that the stages that use SOM units learn progressively, the effective learning of the subsequent layers will not begin until they have reached a state of equilibrium. Therefore, to make the learning computationally efficient, it is advisable to train these layers in succession as their responses begin to stabilize.

Despite the care we have mentioned, we consider that this model improves the automatic classification of images within a very wide range of possible scenarios.

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On the prototypical transformation of food appearance from the farm to the table

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ABSTRACT

Food transition "from the farm to the table" is complex. It seems impossible to select one characteristic or aspect in isolation, because of the multidisciplinary inter-dependencies. This is the case when assessing the visual-structural-chemio-physical consequences of the cooking processes (Hutchings 1994), and the multi-sensory implications, which include visual appearance, color and cesia (Caivano 1991) and a synesthetic conjunction (Caivano 2008). The present paper describes two experiments concerning two facets of color processing (one direct and one indirect) by comparing raw and cooked vegetables and meats. (All cooked foods were boiled and without seasoning). We invoke a change in prototypical color when passing from the farm to the table, as deduced from the match of memory color with NCS samples (Experiment I) and the related changes in visual weights, by determining the area of the raw food that is capable of balancing a (fixed) area of a cooked food (Experiment II). The data show that the calculated raw-cooked prototypical color difference ΔE^*_{ab} (smaller than that obtained from instrumental assessment), increases with increasing visual weight, due to the cooking process.

1. INTRODUCTION

The transition from the farm to the table occurs, periodically, across our whole life span. There is a large variety of food, so mental "data reduction" imposes reference to prototypes. However, if abstraction is made from the raw eaten fruits and vegetables, the cooking process requires us to use at least two kinds of prototypes, since we are expected to recognize any selected food. Traditionally foods are subdivided into two main categories, vegetables and meat. These are flanked by the inescapable modulations of fresh versus stale, ripe versus unripe, and so on. The prototype is "independent of lighting", in line with the fact that it may be regarded as a variant of the concept of perceptual constancy, where the illuminant is discounted. The prototype is an expression of long term color memory (Derefeldt et al. 2004). In the case of food, it is a consequence of a life long experience. Since food is per se an experimentally complex test object, the question arises, which of its numerous components is most representative? The transition from the farm to the table calls into play a wide multi-dimensionality, resulting in the conjunction of a number of features and characteristics, typical of farm products, but increasing in number because of the cooking process. Let us refer to Hutching's (1994) polar diagram.

Moreover, synesthesia, the phenomenon by which associations among different sensorial continua are produced (Caivano 2008), covers a wider umbrella of factors at the table than at the farm. Briefly, the visual response takes place in cross-modality interactions, in a metaphorical transfer of sensory objective to other senses. In the case of food, the interaction involves the six receptors of taste (responsible for flavor), as well as touch and smell (Kuehni 1997, Hutchings 1994). In this way, we enter second order vision, because first order vision becomes insufficient. Global responses are needed to deal with the process of complex input. We are particularly interested in food color, because it does not follow the rules for other stimulus features. Their specificities are lost at the site of their conjunction, because of counteracting and compensating interactions among the responses to various features. Color automatically escapes this rule.

2. METHODS AND FINDINGS

It is well known that the visual system is capable of processing surface color in two different ways: a) directly e.g., by estimating its appearance under fixed environmental and illumination conditions, and b) by the use of a global response. Accordingly, our first experiment concerns point a), where the visual appearance of long term memory colors (related to food prototypes) is assessed by the visual scaling offered by the NCS samples. In the second experiment the assessment of color appearance is compared to the global response in visual balance (or match of the visual weights of raw food and cooked food). The ten observers taking part in Experiment I differ from the five observers of Experiment II in matter of their familiarity with the use of the NCS. This is a factor of great importance (Derefeldt et al. 2004). The members of the first group attended one pre-training session; those of the second group, in addition to decades practice, were adapted to the task by using an ad hoc procedure.

2.1 Experiment I. Long term memory colors of raw and cooked foods

The subject sat at a desk in the lab with the Second Edition NCS samples place in front of him/her. An incandescent lamp fitted in the ceiling (the observation geometry being 0° / 45°) served as illumination, and a middle grey cardboard (luminance of 20 cd/sq.m) acted as an adapting field. The task consisted in finding the NCS sample that was most similar to their memory color of raw and cooked vegetables and of two kinds of meat.

First let us consider the hue of the prototypical color. The observers are conscious of the difference in cooked and raw food colors, as revealed by the fact that they succeeded in assigning different NCS colors to either case. However, the observers unable to take advantage of the NCS scaling (30%) preferred to use the same underlying categorial name for both. This again confirms what is reported in the literature about observers who are not familiar with the use of NCS (Derefeldt et al. 2004). Passing to nuance, let us consider the relation between Db and Dc, the cooked-raw differences in blackness (crosses) and colorfulness (open circles), as is shown respectively in Figure 1. We find that plots of this kind depend on the type of food considered. Two limit cases (spinach and cauliflower) are shown in Figure 1. The configuration of the plots for other foods tested by us (peas, leeks, chicken, roast beef) lie in intermediate positions.

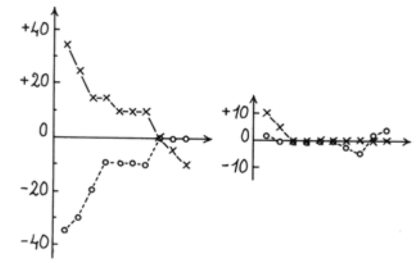

Figure 1. Each pair of data (crosses for Db, open circles for Dc) refers to a different observer. In the case of spinach (left plot) as Db decreases, Dc increases, that is, the raw-cooked differences in blackness are inversely related to the differences in colorfulness. In the case of cauliflower (right plot) the raw-cooked difference is minimum.

2.2 Experiment II. The raw-cooked color difference and the relative visual balance

Let us consider now how the visual weight of food changes, when passing from the farm to the table. The display used in the experiment is shown in Figure 2. The observer's task (Ronchi 2002) consists in finding the area of a grey reference capable of balancing a test object (10° × 10°). For this, the constant stimuli method is used, the independent variable being wR, the width of reference sharing the height with the test. In this way, once a reference is given, a psychometric function is obtained, the balance condition corresponding to the 52.5% of the ordinates. In the case where the luminance of the reference increases, the psychometric function shifts to the right, by showing that a small area of high chroma balances a high area of low chroma. By repeating the session at different times of day (with the proper temporal sampling interval), a bi-peaked circadiancy emerges, by enlarging the range of response variability beyond that indicated by the interquartile distance of the psychometric function.

During the main experiment we used the cooked food as the (10° × 10°) test object and the raw food as the 10° × wR reference. Thus intra-display luminance contrast was kept constant in the session, where a given food was tested. Five observers, who are skilled and experienced in matters of balance assessment, took part in Experiment II. Some of their results are shown in Figure 3 and 4, where they are compared with the color difference between the long term memory prototypical colors, at the farm and at the table, respectively assessed (as in section 2.1), by requesting a match with the Second Edition NCS samples.

Figure 3 shows that the long term memory decreases the raw-cooked prototypical color difference ($\Delta E^{*}ab$), with respect to that calculated for the direct NCS matches of the raw and for the cooked samples of the same food. In turn, Figure 4 shows that as the visual weight inceases (and hence also wR at the balance) due to the cooking process, also the color difference increases, both for the long-term memorized prototypes and of the direct NCS matches at the farm and at the table.

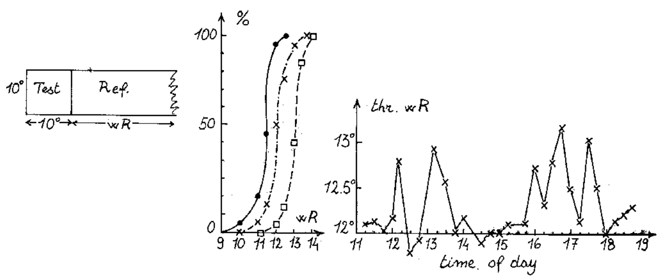

Figure 2. The display, the psychometric functions for three luminances of the reference (increasing from left to right), and an effect of intradian variability of the balance condition.

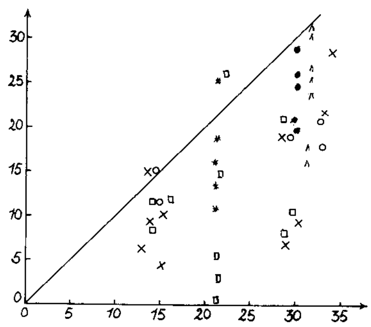

Figure 3. The calculated $\Delta E^{*}ab$ between cooked and raw food. Ordinates, at the long term memory (prototypical) level. Abscissae, at the direct level of instrumental assessment. Data points refer to different observers for different foods.

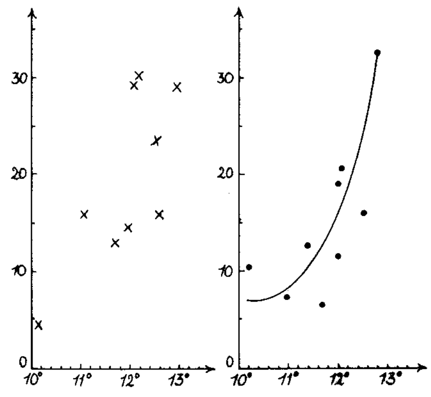

Figure 4. Abscissae: the width (wR) of the reference sample at balance (the larger wR, the greater the visual weight of the test). Ordinates: ΔE^*_{ab}, left plot, between raw and cooked prototypical colors (data from one observer); right plot, for direct instrumental assessments.

3. CONCLUSIONS

The assessment of long term memory (prototypical) colors, both at the farm and at the table, allows a quantitative perceptual classification. The individual differences, as expected, may depend both on individual sensitivity related factors, and on the ability to apply fine NCS hue scaling. Due to long term memory, the calculated prototypical color difference is smaller compared to that for the direct NCS match. Nonetheless, it increases with increasing visual food weight, due to the cooking process, as shown by global responses, such as visual balance.

Note, in particular, the the data points shown in Figure 3 are so clustered, that it is as if the related foods might be subdivided into three main groups: *left*, chard, aigrette, fennel, spinach; *middle*, leeks and zucchini; *right*, potatoes, peas, broccoli, french beans.

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Beverages and containers: An experiment for color appearance teaching

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ABSTRACT

It is the aim of this paper to approach the contribution to color teaching in depth through an applied experiment and to benefit the study of food color appearance. Its project was submitted in the 2007 National Conference on Color in Mar del Plata and in the 2008 Argentine Congress on Color in Santa Fé. This is an experiment proposal to introduce *color appearance* as a subject to be taught to second-year Project Language students studying Industrial Design at the *Universidad Nacional de Mar del Plata*. It begins with an introduction to the topic of food color appearance and it sets forth the need to conduct an examination prior to introducing the subject to students, to then develop the contribution to color and cesia teaching.

1. FOOD COLOR APPEARANCE

In the food world, a beverage can have a certain color and appear as having another and one of the reasons for this change in appearance is the color of the container itself. Therefore, to what extent can the visual perception of a beverage be altered without modifying it in chemical terms?

Here the “overlap” as to container and beverage relationship (without regard to the container graphic effect) is relevant since the change in the color appearance of a drink may benefit the communication of the product characteristics and this may lead to greater consumer acceptance. This change, however, may also convey the idea that the characteristics inherent in the product have been modified and thus cause consumer indifference and rejection. And this may be the result of a design decision which, for example, promotes this phenomenon in the first case or ignores it in the second instance.

The subject of *color appearance*, just as that of *cesia*, is seldom analyzed fully when teaching project language, but it is of great importance in the launching of a new food product.

2. PRIOR EXAMINATION

The proposed aim was to introduce second-year Project Language students of Industrial Design at the *Universidad Nacional de Mar del Plata* to the subject of *visual appearance* through color by experimenting with the phenomenon of perception which involves the observer, the content (beverage), the container (receptacle) which serves as filter and the light source. To such end, a prior examination of the possibilities of teaching the subject was conducted. Different types of sodas and flavored water were surveyed, in terms of their contents and their containers (Figure 1). At that first opportunity (Giglio 2007), in addition to traditional colors such as orange, other colors such as blue or purple were used which, until recently, were reserved to other types of products. Nowadays, flavored water has expanded its color spectrum, as can be seen in its sport line (Figure 2), which promoted the development of this practice.

The examination was carried out by surveying the different colors of existing drinks and PET or glass containers. One example of this examination is the selection of an orange drink and its appearance in transparent colorless, yellow, green and light-blue containers, where the change in appearance of the drink saturation can be seen (Figures 3 and 4).

Figure 1. Different colored PET containers

Figure 2. Different colored drinks.

Figures 3 and 4. Change in appearance of the saturation of an orange drink due to changes in the color of containers.

The possibilities of different colored beverages and containers were then analyzed following a structured survey, as shown in Figure 5. The original colors are in the containers circled in white; containers which seem to have colorless liquid are circled in yellow; those which seem to have liquid of a similar color are circled in red; and green circles show another example of those containers which seem to have different shades.

Figure 6 shows mainly the change in appearance of the beverage color due to the influence of the color of the container bottom.

Figure 5. Change in appearance of beverage color. Examination using different colored drinks and containers.

Figure 6. Change in appearance of beverage color saturation. Examination using different colored drinks and colored-bottom containers.

3. CONTRIBUTION TO COLOR TEACHING

In general, the study of color appearance is carried out through practices based on the coordination of pigment colors resulting from the action of “juxtaposition” and the *simultaneous contrast* study. Moreover, subtractive mixing practices are basically carried out by mixing pigments or through the filter “overlap” to a beam. In turn, *color appearance* is also experienced as a result of the light pigment color effect and its possibility of reproducing colors as appropriate. These practices seem to apply only to the area of lighting.

This educational experiment aims at contributing to color *appearance* teaching, profiting from the possibilities offered by the *beverage-container* relationship in order to complete subtractive mixing in a comprehensive way (light-pigment) due to the color “overlap”, related to the topic of cesia, which allows for the change in appearance in terms of shade, value and saturation to finally be able to expand its application possibilities, for example, to the food industry.

The development of the practice consists of a *descriptive phase* which involves the survey and study of cases, an *experimental phase* which involves the determination of variables and invariables (Figures 7, 8 and 9) and an *analytical phase* which allows for cross referencing. This is explained in the first part of the Theory and Practical Work on Color.

For this experiment, it is necessary to have, on the one hand, colored water with pigments –several colorings which try to reproduce the colors of sodas and flavored water. The main colorings may be red, green, blue, yellow, cyan, magenta and black. Containers are organized in relation to their shape, degree of transparency and color.

Table 1 contains detailed instructions on how to conduct the practice.

Table 1. Instructions to conduct the experiment.

Instructions	Drinks	Containers
Select the containers to be used pursuant to the following criteria. **Survey them.**		Different colored containers. Different colors Same cesia (transparency)
		Containers of the same color but different cesia Same color Different cesia
Select or produce the liquids to be used pursuant to the following criteria. **Survey them.**	Different transparent liquids of different colors Different colors Same cesia (transparency)	
Experiment on and observe the changes in appearance in each case. **Analyze the results of the experiment as regards color appearance.**	Each color of transparent liquids Same color Same cesia (transparency)	Different colored containers Different colors Same cesia (transparency)
	Each color of transparent liquids Same color Same cesia (transparency)	Containers of the same color but with different diffusivity on permeability Same color Different cesia
	Each color of the transparent liquids Same color Same cesia (transparency)	Different colored containers with different diffusivity on permeability Different colors Different cesia

Figure 7. Students working on the experiment in the workshop.

Figures 8 and 9. Photographic survey.

4. FINAL REMARKS

The possibility of experimenting beyond the instructions given allowed students to propose new experiment alternatives in regard to the color appearance of beverages.

One of the questions posed after this practice is: *How is its meaning changed?* The in-depth analysis of the subject in semantic and pragmatic terms is consequently proposed for higher education instances through surveys, observations, experiments with consumers, among other practices, where students may comprehend the effects of senses, the relationship between what is visually perceived and the other senses (taste: liquid taste; touch: liquid texture, etc.) their acceptance or rejection.

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Cross-sectional colour evaluation in borage stems

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ABSTRACT

Borage (*Borago Officinalis*) is a very popular vegetable in the Ebro valley (Spain) owing to its gastronomic and nutritional qualities, but its market is not as widespread as should be expected. This vegetable is commercially available lightly processed, cut and packaged in expanded polystyrene trays covered with stretch PVC films. In the cutting's stage, the products will develop colour alterations. The browning reaction is due to the polyphenol oxidase (PPO) enzymatic action. PPO is one of the most important enzymes in minimally processed vegetables. Its reactions can change flavour, texture and nutritional value besides colour, one of the sensory characteristics most valued by consumers. In this work, we have studied the cut from two different knifes, ceramic and special steel knife for vegetables. We have used digital analysis of the image to determinate the percentage of browning area with respect to the total area of the cut from each batch to compare the knife. As results from this study we could say that the ceramic knife is better knife for vegetables, because it produces less percentage of browning and this cut produces less damage in the cut area than the special steel knife for vegetables.

1. INTRODUCTION

Colour and relative humidity are the two most important attributes that food technologists evaluate in vegetables (Francis and Clydesdale 1975). For consumers, the colour and general appearance are the most important attributes when they are selecting a product, since the first evaluation is visual. Colour is, therefore, of great commercial importance.

Thus, the conservation of a product colour is of primary concern as it is not only associated with its quality but also with its correct technological processing. It should also be pointed out that colour is used as an indicator of defects in the product.

One of these defects is enzymatic browning which is mainly caused by polyphenol oxidase (PPO) that is found in most fruits and vegetables (Martínez and Whitaker 1995, Whitaker 1995).

Borage (*Borago Officinalis*) is a vegetable that is mainly commercialised fresh but may also be presented cut up and packed. The process of cutting produces cell rupture allowing the poliphenols to came into contact with enzymes (mainly PPO), which leads to the browning. This browning modifies the colour of the borage thus affecting its quality and, therefore it shelf life.

In this work, we present the application of technologies of scanning and digital image processing in obtaining information regarding colour changes in cut borage and the influence of the type of knife used in making the cuts.

2. MATERIAL AND METHODS

The borage used in this study was harvested in optimum condition in greenhouses in Zaragoza (in the Ebro Valley, Spain). It was transported and stored in refrigeration until it was analysed.

To perform the study of colour evolution, a series of stalks were selected as homogeneous as possible. These were cut in 1 cm-tick pieces. The knives used were a GRANTON® stainless steel knife for vegetables and a Kyocera® ceramic knife. Twenty pieces were cut with each of the knives and the browning evolution of each cut was observed for 8 hours. All the tests were performed in triplicate.

For image acquisition, an HP G 4010 Scan jet scanner (1200 ppi resolution, reproduction in millions of colours) was used and the images were saved in .tiff format. Digital image processing was performed using Matrox Inspector 8.0® software.

In order to obtain the CIELAB coordinates, a colour calibration was performed of the images obtained whit the HP Scanner/Matrox combination, using the 300 NCS colour samples which make up the UNE 48-103-94 Spanish colour norm. The means of the R, G, B coordinates were obtained for each colour sample and a square multiple regression was applied between the L*, a*, b* (CIELAB) coordinates of the UNE norm and the corresponding R, G, B values and their products R^2, G^2, B^2, RB, RG, GB, of the measured colour samples so as to obtain the corresponding transformation functions (Martínez 2001).

In order to study the evolution of browning of each of the borage stalk cuts, three 3 x 3 pixel ROIs (Region Of Interest) were used in the most affected areas. The mean pixel of each ROI and the corresponding R, G, B coordinates were obtained followed by the means and the standard deviations. Applying the transformation functions obtained to these values, the corresponding L*, a*, b*, C^*_{ab} and h_{ab} coordinates were calculated.

To quantify the browning area, the obtained images were previously processed in Photoshop 6.0®, eliminating the characteristic hair of the borage from each image as this provokes errors in the analysis. In addition, the background colour of the image was changed to black (R=0, G=0, B=0) so that there would be not interferences. Once the image had been modified, the remaining digital image processing was performed using Matrox Inspector 8.0® software. Firstly the image was calibrated to express the results in mm. and the cut area was delimited as a ROI for which the total area was calculated. From this image, eliminating the green band, another image was obtained, corresponding to the non-green (browning) zone, whose area was calculated.

3. RESULTS

The evolution of colour over time (in the selected ROIs) may be seen in the variation of the h_{ab} coordinate (Fig. 1). It can be observed that the cut made with the ceramic knife maintains the yellow-green colour typical of borage better than the stainless steel knife that produces a colour evolution towards more orange hues.

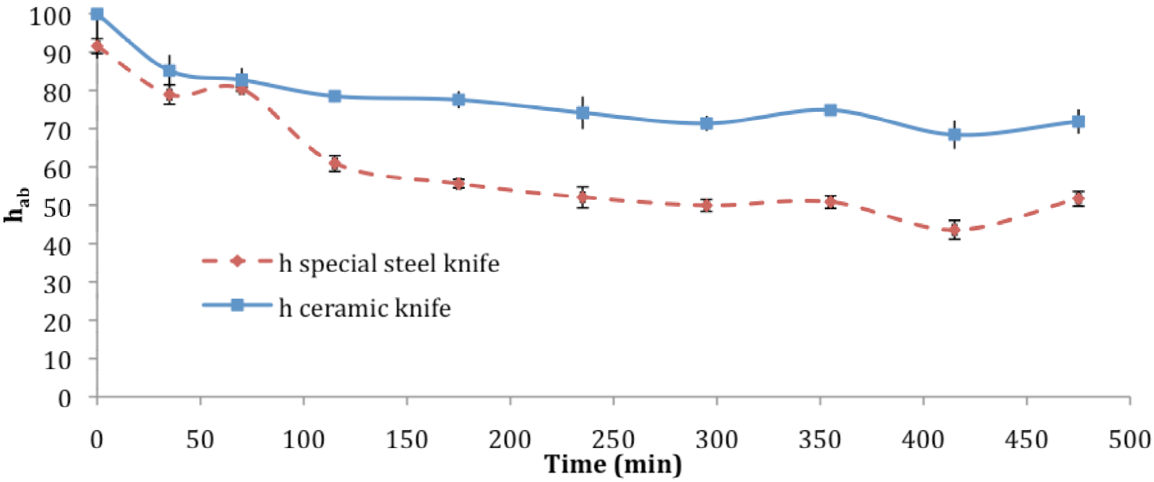

Figure 1. Evolution of the h_{ab} coordinate in selected areas of cuts of ceramic and steel knife.

In Figures 2 and 3 we show some examples of the evolution, over the time of the test, of a stalk cut with each knife. At first, the image presents small pink areas, which correspond to the browning areas. In time, the pink area increases. It should be pointed out that the borage stalks lost water over the time of test that caused a surface area decrease.

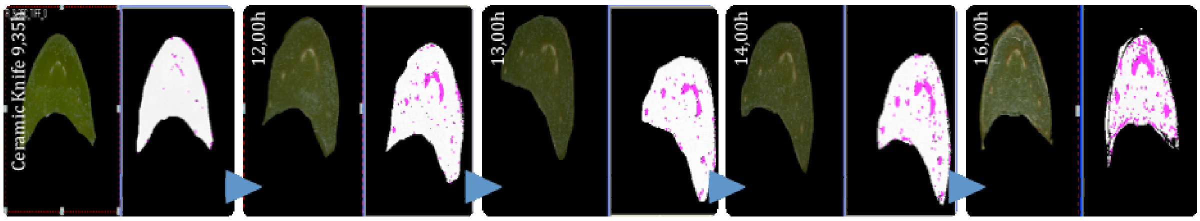

Figure 2. Borage stems image cuts with ceramic knife.

As can be seen in the images, the browning area of the borage cut with the ceramic knife (Fig. 2) is smaller at the end of the test than that corresponding to the special stainless steel knife for vegetables (Fig. 3).

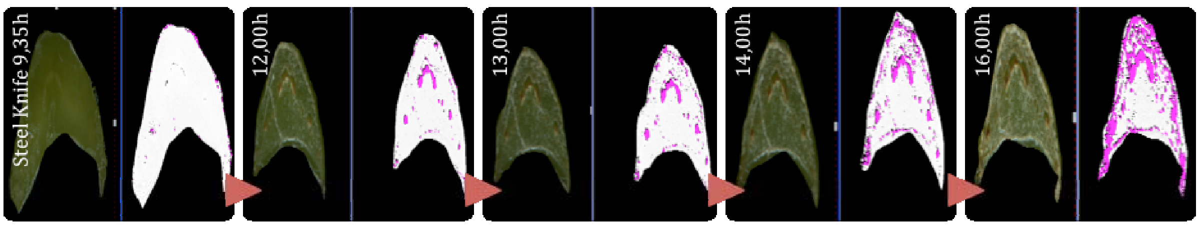

Figure 3. Borage stems image cuts with steel knife.

In Figure 4 we can see the evolution of the percentage of the browning area with regard to the total area of the cut, as well as the standard deviation for each moment of the test, which is lower for the ceramic knife. One explanation for this may be that the ceramic knife cut is finer and causes less damage on the cut area than the stainless-steel knife.

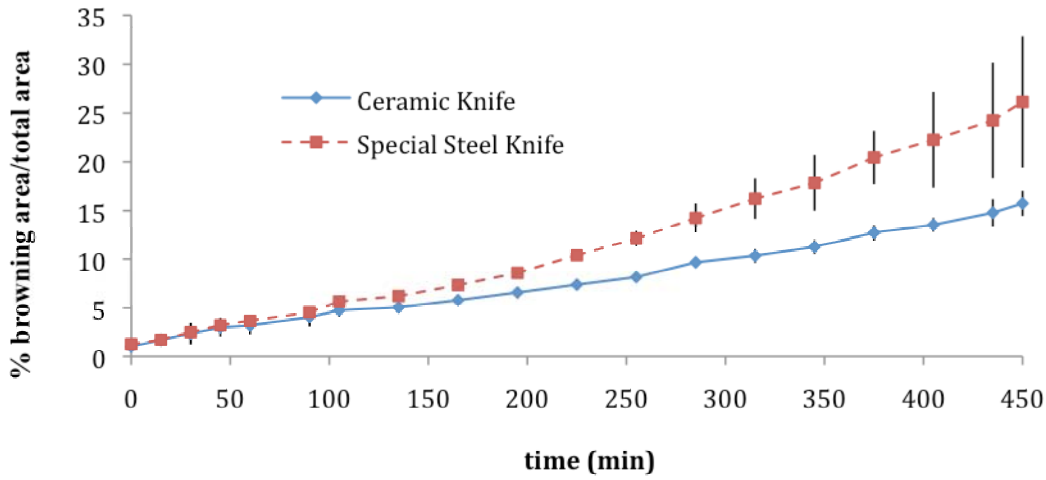

Figure 4. Evolution of % browning area of cuts of ceramic and steel knife.

4. CONCLUSION

The use of a scanner and a digital image processing program permits the study of the browning evolution of borage and may be extended to similar vegetable products.

The study of the browning of the cut shows that both the colour change (measured as the h_{ab} coordinate variation) and the affected area depend on the type of knife chosen for cutting the borage.

From this we may conclude that, for vegetables, the ceramic knife presents advantages when cutting the stalks since it causes less browning.

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Sensing chlorophyll and anthocyanin concentrations in leaves with spatial resolution from digital image

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ABSTRACT

The aim of this work is to develop a computational vision-methodology to infer the pigments concentration in plant leaves with spatial resolution from a digital image. For this purpose, reflectance spectra of uniformly colored leaves were then recorded. On these leaves, chlorophyll-a, chlorophyll-b, carotenoids and anthocyanins were determined by extraction and posterior spectrophotometric measurement. From the reflectance spectra, the RGB coordinates were calculated. Then, correlations between the color coordinates and the pigment concentrations were obtained. On the other hand, images from heterogeneously colored leaves were captured using a commercial scanner. The scanned images were digitally processed to obtain R, G and B bands. Using the correlations between the colour coordinates (R, G and B) and pigments concentration, deducted for homogeneous leaves, the concentration of pigments per pixel in heterogeneous leaves were estimated.

1. INTRODUCTION

Prediction of nutrients shortage in plants from the observation of visual symptoms is a current practice in Agronomy. In fact, chlorosis of older leaves is a sign for nitrogen deficiency while redness in mature leaves, caused by the increase in anthocyanins content, can be a symptom for phosphorus deficiency.

As the color of plant leaves is an indicator of their pigments quality and content, it makes sense to think in the possible application of color images of leaves to the non-destructive assessment of plant health. Digital images and color analysis of leaves have been studied in literature, in connection with the evaluation of the effect of environmental stress on plants. These works included stress produced by water shortage and nitrogen deficiency (Ahmad and Reid 1996), low temperature (Bacci et al. 1998) and senescence (Schaberg et al. 2008).

The present study shows a method to infer the concentration of pigments in a leaf from images obtained with a commercial scanner. The methodology presented here displays a great potential due to the low cost of implementation, as it only requires a commercial scanner and software for the digital processing of the images. Additionally, this method has practical advantages as an alternative procedure to the analysis of pigments by traditional chemical methods. Chemical methods are destructive and time-consuming whereas imaging methods may be performed quickly, on intact plant material, allowing additionally the spatial resolution of pigments concentrations in leaves.

2. MATERIALS AND METHODS

Uniformly colored leaves of different species were selected. Reflectance spectra of these leaves were then obtained from 300 to 700 nm, using a spectrophotometer equipped with an integrating sphere. Barium sulphate was used as 100% reflectance. Seven reflectance spectra were averaged for each species and the resultant spectrum was used for further derivation of colour coordinates (R, G and B). The selected species were: *Hedera helix, Liquidambar styraciflua, Populus alba, Rosa sp., Gardenia jasminoides, Schefflera arboricola, Aloysia triphylla* and *Ficus benjamina*. On these leaves, chlorophyll-a, chlorophyll-b, carotenoids and anthocyanins were determined by extraction and posterior spectrophotometric measurement (Sims and Gamon 2002).

From the reflectance spectrum defined as S (λ) of uniformly colored leaves, it was possible to calculate the tristimulus values XYZ using equations 1, 2 and 3. In these equations, $\bar{x}$, $\bar{y}$ and $\bar{z}$ are the functions defined by the CIE standard observer and I (λ) is the spectral distribution of a known reference illuminant (in this case D65). The color space used in this case was sRGB. The normalization factor N was calculated by the equation 4.

$$X = \frac{1}{N}\int_{\lambda} \bar{x}(\lambda)\, S(\lambda)\, I(\lambda)\, d\lambda \qquad (1)$$

$$Y = \frac{1}{N}\int_{\lambda} \bar{y}(\lambda)\, S(\lambda)\, I(\lambda)\, d\lambda \qquad (2)$$

$$Z = \frac{1}{N}\int_{\lambda} \bar{z}(\lambda)\, S(\lambda)\, I(\lambda)\, d\lambda \qquad (3)$$

$$N = \int_{\lambda} \bar{y}(\lambda)\, I(\lambda)\, d\lambda \qquad (4)$$

Given an XYZ color whose components are in the nominal range (0, 1), the transformation from XYZ to the RGB values was performed according to the following equations:

$$\begin{bmatrix} r \\ g \\ b \end{bmatrix} = [M]^{-1} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \quad (5);\ \text{where}\quad [M]^{-1} = \begin{bmatrix} 3.2404542 & -1.5371385 & -0.4985314 \\ -0.9692660 & 1.8760108 & 0.0415560 \\ 0.0556434 & -0.2040259 & 1.0572252 \end{bmatrix} \quad (6)$$

And

$$R = \begin{cases} 12.92\, r & r \le 0.0031308 \\ 1.055\, r^{1.0/2.4} - 0.055 & r > 0.0031308 \end{cases} \qquad (7)$$

$$G = \begin{cases} 12.92\, g & g \le 0.0031308 \\ 1.055\, g^{1.0/2.4} - 0.055 & g > 0.0031308 \end{cases} \qquad (8)$$

$$B = \begin{cases} 12.92\, b & b \le 0.0031308 \\ 1.055\, b^{1.0/2.4} - 0.055 & b > 0.0031308 \end{cases} \qquad (9)$$

Finally to express the values for R, G and B in the range (0, 255) each component must be multiplied by 255 (Smith and Pokorny 2003).

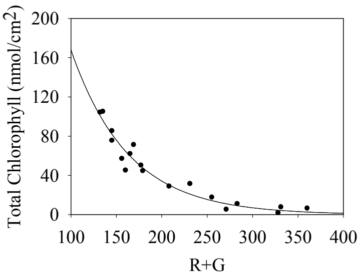
Then, correlations between the color coordinates and the pigment concentration in nmol/cm^2 were obtained.

On the other hand, images from *Ipomoea indica* and *Sorbus foliolosa* were captured using a commercial scanner (HP-DeskJet F380, Hewlett-Packard). The scanned images in TIFF format with a resolution of 300 ppi and a depth of 24 bits were digitally processed using the ERDAS IMAGINE 8.4 program.

Using the correlations between the color coordinates (R, G and B) and the pigments' concentration, deducted for homogeneous leaves, the concentration of pigments per pixel in heterogeneous leaves were estimated.

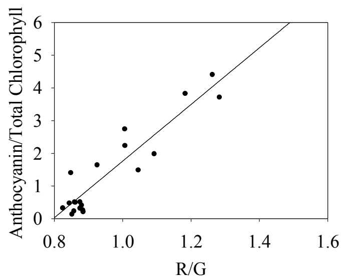
3. RESULTS AND DISCUSSIONS

Values for the R component decreased non-linearly as chlorophyll concentration declined. Values for G component decreased linearly with chlorophyll content. Values for the B component, on the other hand resulted insensitive to chlorophyll concentration (data not shown). An excellent correlation was finally found for the sum of R and G with the chlorophyll content and between the ratio R/G and the proportion Anthocyanins/Total Chlorophyll, see figures 1 and 2, respectively. No correlation was found for carotenoids.



Total chlorophyll = 822.488 Exp [-0.016 * (**R**+**G**)]

Figure 1. Correlation between the total chlorophyll content (nmol/cm^2 of leaf) and the sum of component R and G of the scanned images.



Anthocyanin/Total Chlorophyll = -6.899 + 8.662 * (**R/G**)

Figure 2. Correlation between the relationship Anthocianyn/Total Chlorophyll content (nmol/cm^2 of leaf) and the ratio of the component R and G of the scanned images.

By applying the correlations shown in Figures 1 and 2 on leaf images obtained with a scanner, it was possible to obtain images of chlorophyll and anthocyanin´s content. Figure 3 shows the scanned image of a leaf of *Ipomoea indica* (a) and the image of total chlorophyll content from the same leaf (b).

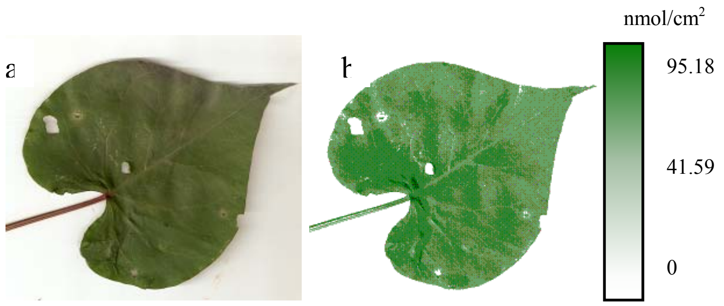


Figure 3. Scanned image of a leaf of Ipomoea indica (a) and image of total chlorophyll content in nmol/cm^2 (b).

Figure 4 shows the scanned image of a leaf of *Sorbus foliolosa* (a); image for the relationship between anthocyanin content and total chlorophyll (b) image for the total chlorophyll content of leaf (c).

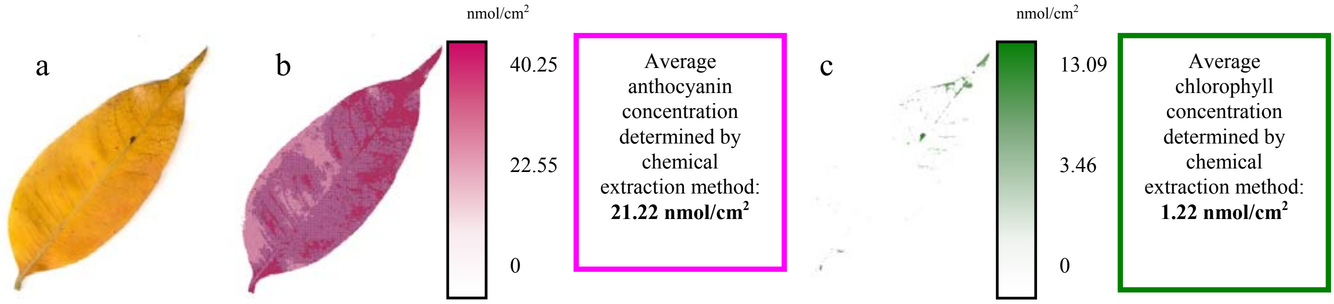


Figure 4. Scanned image of a leaf of Sorbus foliolosa (a); image for the relationship between anthocyanin content and total chlorophyll (b); and image of total chlorophyll content in nmol/cm^2 of leaf (c).

4. CONCLUSIONS

In this work it was possible to successfully develop a method for monitoring non-destructively pigments content in leaves. This procedure allows knowing the content of chlorophylls and anthocyanins in leaves using color images obtained with a commercial scanner. The application of this methodology to the diagnosis of plant health inferred from leaf pigments concentration is highly effective and easily implemented due to the low cost of operation.

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Rabbit meat hamburgers: Color differences due to industrial or organic rearing system

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ABSTRACT

The aim of this work was to study the influence of rearing system ('I' industrial / 'O' organic), and the conservation (no vaccum/vaccum-frozen/chilled) on the color of rabbit burgers, fresh or preserved for 8 days, both raw and cooked. From the 'mix' of 'O' or 'I' meat, burgers of 50g (6 burgers/treat.) were produced and covered with plastic wrap or vacuum-packed and were analyzed the next day (4 °C ± 1) or were kept for 8 days refrigerated or frozen (-17 ºC ± 1). The color was analyzed (Minolta CR300) on raw meat (40' of 'blooming' in vacuum-packed burgers) and cooked meat (71 ºC ± 1 ºC in the center); sensory evaluation was conducted by a trained panel. Statistical analysis of data was performed using ProcMixed, SAS and the averages were compared by Tukey test. Treatment ('I' vs 'O') and shelf-life (1-8d) were significant for all variables analyzed and it was high the frequency of 'TreatxTime' interactions. There were no differences due to preservation or the packaging except for a* and b* of raw burgers.The 'I'/'O'origin determined differences in all parameters except for b* and C^*_{ab} of cooked hamburgers. From a sensory standpoint, 'O' burgers showed a higher overall color and surface brightness but less color uniformity.We conclude that the origin of meat and shelf-life significantly influence the colorimetric parameters of rabbit hamburgers while the packaging and preservation are not significant.

1. INTRODUCTION

Today's consumers are more concerned with the characteristics of food quality, resulting in an increasingly selective demand and a growing need to differentiate them. There are several alternatives that introduce differentiation factors in the rabbit meat obtained, such as feeding because of it direct impact on the meat quality characteristics and production systems (Pla 2008).

For more than a decade the European population has turned to a more friendly environment and animal welfare production, such as organic production, that consumers perceive as safer. The conditions of production in Argentina are easy to convert into an organic production system. Due to the increasing worldwide demand of organic products, we have the SENASA Resolution (National Security Service and Food) No. 1286/93 available, which is laying down the requirements for animal production, the Law 25.127/99 of 'organic production' as a framework for the organic sector development, and recently, the Development and Promotion of Organic Production Project in Argentina, which objectives are to increase the participation of Argentine organic products in the world trade and the domestic market.

The short shelf life of packaged refrigerated hamburgers is one of the main problems in its commercialization. The freshness of meat is affected by lipid oxidation, which is considered the major nonmicrobiological factor involved in quality deterioration of meat. An approach to overcoming the problem of limited shelf life is to use vacuum packaging, in order to preserve a fresh appearance and delay microbial growth and lipid and pigment oxidation. Another method of meat preservation is freezing, however the frost-defrost process determines an alteration in the raw color (Cabanes Roiron et al. 1994).

The objective of this research was to assess the effects of packaging, temperature of conservation and ageing on the colorimetric parameters of hamburgers from 'organic' or 'industrial' origin rabbit meat.

2. MATERIALS AND METHODS

A total of 20 rabbit carcasses from the organic production and 20 carcasses from industrial production system were used (Slaughter weight: 2.3-2.5 kg) and there were manually pulping 24 hours after slaughter (cold store 4 ± 1 ºC). The meat was homogenized using a Foss Tecator 2096 Homogenizer, without adding any preservative compound, salt or other additives. Carcasses from each production system were processed separately and burgers of 50g each were prepared using a stainless steel mold to ensure the uniformity of format.

Chilled (4 °C ± 1) or freezed (-17 °C ± 1) burgers, with or without vacuum packaging (Multivax; Cryovac pouches of 60 microns) were analyzed at 1 and 8 days after preparation (6 hamburgers/origin/temperature/packet/day). The color was analyzed (Minolta CR300, Illuminant D65, geometry 0°, aperture 8mm, dull; L*:lightness; coordinate a*:-a/+a green-red, coordinate b*:-b/+b blue-yellow and estimated the Chroma (C^*_{ab}:$\sqrt{(a^{*2}+b^{*2})}$) on raw meat (after 40' of 'blooming' in the case of vacuum-packed burgers) and cooked meat. The burgers were cooked in a double contact grill to reach 71 ºC ± 1 ºC in the center of the sample (cold point), monitored by thermocouples. Cooked burgers were analyzed by an analytical panel of 8 trained assessors according to international standards and experience in meat sensory analysis (ISO 1987, 1993, 1994). The following descriptors were assessed: overall colour, brightness and colour homogeneity, using an unstructured linear scale of 10 cm without anchorage. The ends of the scales corresponded to the intensity of the attribute; Global Color 1: light pink to 10: red; Brightness: 1 without brightness to 10 brilliant; Uniformity of color: 1 non-homogeneous to 10 homogeneous.

Statistical analysis of data was performed using the Proc Mixed of SAS (2004) for repeated measurements. Differences between treatments were analyzed by Tukey test ($p < 0.05$).

3. RESULTS AND DISCUSSION

Table 1. describes the values of the colorimetric parameters of the hamburgers obtained according to the origin of the meat, the packaging system, the storage temperature and the days of storage. Up to 8 days, refrigeration or freezing temperatures of conservation did not influence any of the colorimetric parameters analyzed. Cabanes Roiron et al. (1994) found that the freezing of 12 days caused a decrease in brightness, color parameter b * and saturation in the Biceps femoris muscle, which was presented duller and 'bluer', whereas no differences were found in other portions which could explain the lack of influence on hamburgers, made with all the meat from the carcass.

The packaging system (with / without vacuum) determined differences in the color parameters a* and b* of raw hamburgers ($p < 0.01$) and showed interaction with the origin of meat: for the Industrial system, hamburgers were redder and less yellow when they were vacuum- packed while in the meat from the organic system the differences between the packaging systems were much smaller and the vacuum-packed showed a trend to lower values of a* and b* regarding non vacuum-packed.

In general, regardless of other factors, the burgers from the organic farming system were characterized by a lower L*, higher a* and lower b* color parameters respect the ‘I’ group hamburgers. This trend, to a lesser extent, remained after cooking. From the sensory point of view "organic" burgers had a higher overall color and surface brightness.

The most influential factor on the colorimetric parameters of refrigerated hamburger proved to be the shelf life (1 vs 8 days) although the interaction was significant for ‘origin of meat x days’. The most influential factor on the colorimetric parameters of refrigerated hamburger proved to be the shelf life (1 vs 8 days) although the interaction was significant for ‘origin of meat x days’. For the burgers from group ‘I’, the storage time caused a decrease of brightness and color parameter b* but an increased of a* parameter on raw meat while after cooking, the same differences were much more limited. Visual analysis showed burgers with less color and brightness after conservation. Hamburgers from group ‘O’ showed a decrease in all parameters evaluated on raw meat and a similar trend as ‘I’ hamburger on colorimetric parameters on cooked meat. However, visually, they were less bright, but showed a higher overall color after 8 days of storage.

Table 1. Effect of meat origin, packaging, temperature and time of ageing on instrumental and sensory color parameters.

	Industrial breeding						**Organic breeding**						St. dev	**Probability**		
	Freezing		Refrigeration				Freezing		Refrigeration							
	NoV	V	NoV		Vacuum		NoV	V	NoV		Vacuum			ind. vs organic	No V. vs vacuum	1 vs 8 days
	8 days	8 days	1 days	8 days	1 days	8 days	8 days	8 days	1 days	8 days	1 days	8 days				
Raw Hamburgers																
L*	61.4	62.7	69.1	63.4	69.1	61.1	51.7	52.8	57.0	53.3	57.0	53.3	1.88	<.0001	NS	<.001
A*	8.41	10.9	4.53	5.96	4.53	11.4	11.4	11.8	14.0	12.3	14.0	12.3	1.21	<.0001	.007	0.003
B*	13.2	10.9	16.5	12.0	16.5	10.9	7.65	6.23	9.84	9.09	9.84	7.02	1.07	<.0001	.003	<.001
C*	15.7	15.4	17.1	13.4	17.1	15.8	13.7	13.4	17.1	15.3	17.1	14.2	1.49	.0774	NS	<.001
Cooked Hamburgers																
L*	71.3	67.9	69.1	70.5	69.1	68.8	70.7	70.6	63.5	69.2	63.5	71.1	3.07	.0501	NS	.001
A*	5.54	6.33	4.53	4.79	4.53	7.01	8.97	6.28	6.52	5.76	6.52	7.74	0.92	<.0001	NS	.014
B*	17.7	14.9	16.5	16.0	16.5	14.0	14.3	13.4	19.7	15.4	19.7	14.4	2.57	NS	NS	.001
C*	18.5	16.2	17.1	16.7	17.1	15.6	16.9	14.8	20.8	16.5	20.8	16.4	2.58	NS	NS	.005
Sensorial analysis																
Global color	0.66	1.58	1.60	1.26	1.60	1.02	6.82	8.22	5.86	9.28	5.86	7.97	1.26	<.0001	NS	.009
Bright.	4.88	6.30	7.00	6.62	7.00	4.98	7.48	6.70	8.30	7.68	8.30	6.47	1.76	.0099	NS	.047
Uniform of color	6.56	5.96	6.13	6.36	6.13	8.16	4.09	3.70	7.20	2.30	7.16	4.52	2.28	NS	NS	NS

Global Color 1: light pink to 10: red; Brightness: 1 without brightness to 10 brilliant; Uniformity of color: 1 non-homogeneous to 10 homogeneous.
Probability ‘refrigeration *vs* freezing’ at 8 days: NS.
Significant interactions: Raw Burgers (‘meat origin x days’: < 0.01 for L*, a* and b*); Cooked burgers (‘meat origin x days’: < 0.01 for L* and a*); Sensorial analysis (‘meat origin x days’: < 0.01 for uniformity of color and brightness).

The data found in the literature, about muscles and / or carcasses, are variables and not always consistent for the colorimetric parameters (Combes et al. 2003, Dalle Zotte 2007, Pla 2008). Under the organic production system, the nine months freezing compared to 24 hours chilling, significantly decreased, a* (-0.01 vs 2.79) and b* (-2.13 vs -0.35) values, and increased L* value (62.3 vs 58.2) resulting in worse loin meat colour (Dalle Zotte 2007). Vacuum packaging caused less water retention capacity, which led to discoloration and changes in organoleptic quality of fresh rabbit meat (Gariepy et al. 2007).

4. CONCLUSIONS

The preserved rabbit burgers colorimetric parameters with or without vacuum, chilled or frozen, were influenced by the origin of the meat and the storage time, with strong interaction between both factors. 'Organic' burgers were less bright, 'redder' (> a *), more brilliant and colorful (sensory) than 'industrial' burgers. The storage time determined the reduction in all colorimetric parameters in the 'Organic' group although, visually, they had less brightness but larger overall color after 8 days of conservation.

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Colour of honeys from the south-western Pampas region: Relationships between Pfund colour scale and CIELAB tristimulus method

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ABSTRACT

The international market usually classifies honey according to the Pfund colour scale. The Pfund grader gives a measure (mm) of the point along a calibrated amber glass prism where the liquid honey matches the prism. The CIELAB tristimulus method provides more information of honey colour. In order to find a relationship between both methods, 50 honey samples were selected as representative from the South-Western Pampas region (Argentina). The colour was assessed by a Pfund grader and by a HunterLab colorimeter. Samples were slightly heated (40 ºC) and centrifuged to eliminate bubbles. Statistical analysis shows a direct relationship between Pfund colour and C^*_{ab} and both variables inversely related to L^* and h_{ab}. Multiple Linear Regression indicates that colour according to the Pfund scale can be estimated accurately on the basis of CIELAB parameters (R^2 = 0.91). In order to find a simpler equation, we have defined the Total Colour (E) as the CIELAB colour difference (ΔE^*_{ab}) between the honey and the white reference. Taking this parameter into account the correlation reached higher values (R^2 = 0.96) when a non linear quadratic polynomial regression is used.

1. INTRODUCTION

Colour is the most important physical trait used to typify honey. The international market usually classifies honey according to the Pfund colour scale, being light honey more valued than dark honey. The Pfund grader is an optical comparator device manufactured by Köeler Inc., adopted for colour grading in the United States at the beginning of the XX century (Aubert and Gonnet 1983). It gives a measure of the point along a calibrated amber glass prism where the liquid honey sample placed in a glass cuvette shaped trough matches the prism. Pfund scale ranges from 0 to 140 mm, beginning with very light-coloured and increasing up to the darkest honeys. The scale shows seven ranges with different colour designations named water white, extra white, white, extra light amber, light amber, amber and dark. This classification is officially admitted in the United States Standards for Grades of Extracted Honey (effective date May 23, 1985).

Even when other comparators have been adopted, results are expressed in Pfund ranges. Two of them are described as official methods of the AOAC international, the USDA colour comparator and the Lovibond 2000 (AOAC 2000).

The Pfund grader as well as the other colour comparators does not allow registering greenish, reddish or greyish hues distinguished by consumers. These nuances could be related to botanical origins, *e.g.* greenish from lime (*Tilia* sp.), greyish-yellow from borage (*Borago* *officinalis*), and greenish brown from tree of heaven (*Ailanthus altissima*) and maple (*Acer* sp.) (Crane 1990).

Other methods successfully tested provide more information of honey colour, such as the CIELAB tristimulus method (Aubert and Gonnet 1983, Terrab et al. 2002, Bogdanov et al. 2004, González-Miret et al. 2007). The first attempt to use a spectrophotometric method to asses honey colour was that of Aubert and Gonnet (1983). They conclude that the studied spectrophotometric method should be a standard research system for a more accurate floral classification of honeys; however the Pfund index might remain, due to its easiness in practical use, as the commercial reference.

Bogdanov et al. (2004) state in a review dealing with physico-chemical honey analysis that in order to apply CIELAB methods to routine honey analysis, they have to be validated by a comparison with the classical colour grading methods. The aim of this work is to find a relationship between data recorded with the Pfund and CIELAB methods.

2. MATERIALS AND METHODS

A set of 50 samples were selected as representative of the colour range of honeys from the south-western Pampas region (Argentina).

Pollen analysis was performed according to Louveaux et al. (1978). The pollen types were identified to species whenever possible, otherwise to genus, tribe or family taxa.

The colour of honey samples was assessed by a Pfund grader and by a HunterLab colorimeter, using an optical glass cuvette (10 × 50 × 50 mm). Samples were slightly heated at 40 ºC and centrifuged in order to eliminate bubbles. D65 Standard Illuminant and CIE 1964 Standard Observer (10º visual field) were used in the calculus. Different mathematical algorithms were tested in order to find the possibility of predicting the Pfund colour of honeys based on tristimulus colorimetry variables. Simple and multiple correlation models were applied including scalar (L* a* b*) or angular (L* C^*_{ab} h_{ab}) CIELAB variables. Electric conductivity was measured according to Louveaux et al. (1973).

3. RESULTS AND DISCUSION

Average values of honey samples colour and conductivity are shown in Table 1. All samples showed high L* values, possibly due to the local melliferous flora.

Table 1. Distribution of the variables measured in honey samples.

	L*	**a***	**b***	**C^*_{ab}**	**h_{ab}**	**Pfund** (mm)	**Conductivity** (mS/cm)
Average	83.83	0.32	43.74	43.88	91.67	45.75	0.26
SD	5.00	3.51	20.02	20.02	5.00	25.71	0.09
Minimum	73.59	-3.75	14.09	14.32	82.95	3.93	0.14
Maximum	91.17	9.94	81.58	82.18	101.07	85.23	0.42

Fifty six pollen types were identified in the honey samples. The families Brassicaceae, Myrtaceae, Asteraceae and Fabaceae were the most represented (Figure 1). The combination of three pollen types: *Diplotaxis tenuifolia*, *Eucalyptus* sp. and *Centaurea solstitialis* points out the geographical origin of the samples (Valle et al. 2007). The presence of *Diplotaxis tenuifolia, Centaurea* sp. and *Prosopis* sp. pollen is slightly related to greenish hue (R = 0,39;

$p < 0.05$) while another group (*Eucalyptus* sp., *Baccaris* sp., *Schinus* sp., *Condalia microphyla* and *Larrea* sp.) shows an inverse relationship to reddish hue with low correlation coefficient ($R = -0.33$; $p < 0.05$).

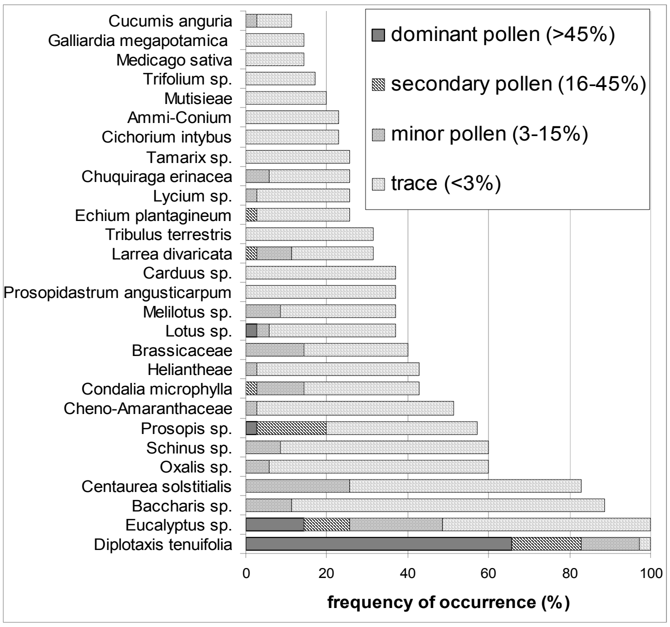

Figure 1. Pollen spectrum.

Multivariate analysis show direct relationship between Pfund scores, conductivity and CIELAB variables (Table 2). Light honeys showed high lightness, low chroma, slight greenish hue and low conductivity, whereas the darker ones behave in the opposite way (Figure 2).

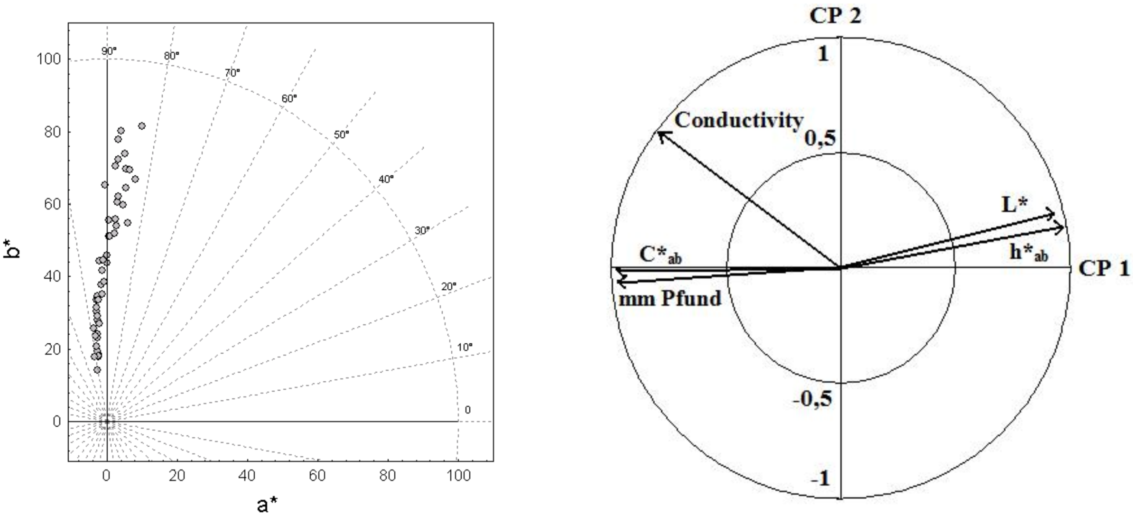

Figure 2. On the left, a and b* coordinates; on the right multivariate analysis.*

It has been found that colour according to the Pfund scale can be estimated accurately as a function of CIELAB parameters by means of Multiple Linear Regression analysis, based on the following regression equation ($R^2 = 0.91$; $F_{3,46} = 152.55$, $p < 0.0001$):

$$\text{mm Pfund} = -\,0.631\ L^* + 0.840\ C^*_{ab} - 1.026\ h_{ab} + 155.89$$

Table 2. Correlation matrix.

	L*	C^*_{ab}	h^*_{ab}	mm Pfund
C^*_{ab}	-0.86**			
h^*_{ab}	0.96**	-0.94**		
mm Pfund	-0.87**	0.95**	-0.93**	
Conductivity	-0.64**	0.75**	-0.69**	0.72**

Observers usually interpret the Pfund colour index as the “total colour” of honeys by comparison with a standard coloured glass prism. In order to find an equation which relates Pfund and the colour of honeys we have defined the Total Colour (E) as the CIELAB colour difference (ΔE^*_{ab}) between the honey and the white reference. Taking this parameter into account it has been obtained a slight improvement of the linear correlation coefficients. Moreover, the correlation reached higher values (R^2 = 0.96) when a non linear quadratic polynomial regression is used.

$$\text{mm Pfund} = -32.82 + 2.48\ E - 0.013\ E^2$$

These results allow calculating the Pfund score by means of instrumental colorimetric measurements, without involving visual comparisons. Being CIELAB the method currently used in colour measurement and the Pfund scale widely used in honey trade, relating both methods mathematically by means of a single equation can be of great interest for the industry.

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Colour-copigmentation study in wine blending

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ABSTRACT

A study of the copigmentation evolution in wines from different varieties has been undertaken. Colorimetric measurement of Tempranillo (T) and Graciano (G) monovarietal wines, wine from vinification with both grapes (W), and wine from blending Tempranillo and Graciano wines (M), have been made by spectrophotometric determination. Significant differences ($p < 0.05$) were found between wines. Graciano led to quite darker and more colourfulness wines. Both, grape blending (M) and wine blending (W), had a similar behaviour to Tempranillo. However there are differences between them (both blendings) for h_{ab} and b* parameters. The colour difference value ΔE^*_{ab} was in the range between 1.16 and 6.12 units. Wine blending is similar to Tempranillo, however grape blending has different colour of the other wines.

Colour difference between copigmented and non-copigmented wines was 13.58 CIELAB units in the initial stages, and 9.27 in the final stages. The evaluation of this parameter allows knowing if changes of colour, owed to the copigmentation, are visually relevant. Wines from grape blending had higher copigmentation values than Graciano and Tempranillo wines.

Wine blending were the most stable; however wines from grape blending had a similar behaviour to Graciano wines. So, vinification with grape blending had going to less stable wines than vinification with wine blending.

1. INTRODUCTION

Anthocyanins are the pigments responsible for the colour of red wines, which are transferred from skins to the must during the maceration stage. The bright red colour of young wines is mainly due to free anthocyanins, self-association, and copigmentation of anthocyanins with other phenols present in wine such as flavanols, flavonols and hydroxycinnamic acids (Haslam 1980). Copigmentation consists of hydrophobic interactions (π–π stacking) between the planar polarisable nuclei of the coloured forms of the anthocyanins and other molecules (i.e., copigments). Copigmentation complexes adopt a sandwich configuration that protects the flavylium chromophore from the nucleophilic attack of water, thus reducing the formation of colourless hemiketal and chalcone forms. The final result is that anthocyanin solutions show a more intense colour than theoretically could be expected according to the pH value of the media (Goto and Kondo 1991). In addition, anthocyanin chromophores may also associate among themselves (self-association), as well as with aromatic residues of their own molecule (intramolecular copigmentation). It seems that colour extraction and retention in the wine is greatly influenced by the levels of cofactors on it. For that reason, co-maceration of different grape varieties could contribute to increase the copigmentation process (Moreno-Arribas and Polo 2008). Likewise, blends from different wines give rise to wines with a more balanced anthocyanin/flavanol ratio (Monagas et al. 2006).

Tempranillo cv. is a very suitable red grape variety to elaborate wines to be aged. The musts produced from Tempranillo show intense colour which represents a good base wine for blending. On the other hand, Graciano cv. is also a red grape variety and its musts show a vivid red colour, very aromatic and with a high acidity, being used to improve the characteristics of Tempranillo, giving long shelf-life, higher colour intensity and aroma to the mixture. The colorimetric study of the original wines as well as their mixtures can lead a better knowledge about the influence of the particular grape variety on the colour of the wine.

From the colorimetric point of view, the copigmentation concerns the entire visible spectrum, not only the 520 nm absorbance. In this respect, Gómez-Míguez et al. (2006) carried out preliminary tests to explain, by means of the tristimulus colorimetry, the copigmentation phenomenon.

The aim of the present work is to study the copigmentation changes in wines from different varieties (Graciano cv. and Tempranillo cv.), making a colorimetric interpretation of the above mentioned effect.

2. MATERIALS AND METHODS

Samples

The wines used in this study were processed by Bodegas Roda (La Rioja, Spain). [T] and [G] wines were made from V. vinifera cv Tempranillo and Graciano fresh grapes, respectively. [M] wine results from a mixture of Tempranillo/Graciano (80:20) grapes and [W] wine from a blending of [T] and [G] wines (80:20) after malolactic fermentation. Samples were collected during winemaking and correspond to the following stages: initial stages (alcoholic fermentation, postfermentative maceration, beginning and mid of malolactic fermentation): step 1-step 4, and final stages (end of malolactic fermentation, after 3, 6, 12 and 14 months in oak barrels, after 5, 9 and 12 months in bottles): step 5-step 12.

Colorimetric study of copigmentation: CIELAB colour space

The colorimetric implications of the copigmentation phenomenon on the total colour of wine have been evaluated by tristimulus colorimetry since the entire visible spectrum (380-770 nm). In this study, the wine colour with copigmentation effect was obtained from the absorbance spectrum of the wines. The wine colour without copigmentation effect was reconstituted from the absorbance spectrum of the wine sample after diluting 20 times with wine-like solution (pH 3.6) and multiplying by the dilution factor. That dilution leads to the dissociation of the copigmentation responsible complex. The spectrophotometric measurement of the original and diluted wines was performed. The whole visible spectrum (380-770 nm) was recorded at constant intervals ($\Delta\lambda = 2$ nm) with a Hewlett-Packard HP8452 UV-vis spectrophotometer (Palo Alto, CA), using 2mm path length quartz cells and wine-like solution (pH 3.6) as a reference. The CIELAB parameters (L^*, a^*, b^*, C^*_{ab}, and h_{ab}) were determined by using the original software CromaLab® (Heredia et al. 2004), following the *Commission Internationale de L'Eclariage's* recommendations (CIE 2004): the 10° Standard Observer and the Standard Illuminant D65. Colour differences (ΔE^*_{ab}) were calculated as the Euclidean distances between two points in the three-dimensional space defined by L^*, a^*, and b^*:

$$\Delta E^*_{ab} = \sqrt{\left(\Delta L^*\right)^2 + \left(\Delta a^*\right)^2 + \left(\Delta b^*\right)^2}$$

Statistical analysis

Significant differences among wines and for each variable were assessed by analysis of variance (ANOVA) using the Statistica, version 8.0, software (StatSoft 2007).

3. RESULTS

ANOVA was carried out with colorimetric data to check differences between the different wines. Table 1 shows the average of colour variables during the early stages and final stages. Regarding the colour parameters, significant differences ($p < 0.05$) were found between wines. In final stages, where wines were more stable, [T] showed lower chroma (C^*_{ab}) values than [G], which means less colour vividness. Accordingly to this result, higher lightness (L^*) and hue angle (h_{ab}) values were found in [T]. All these results indicate that Graciano cv. led to quite darker and more colourfulness wines.

[W] and [M] showed differences for h_{ab} and b* parameters, with more bluish hues for [M] wines. Both wines were significantly ($p < 0.01$) lower in a* and C^*_{ab} values than [G].

Table 1. Mean and standard deviation of red wines colour (CIELAB units).

Variable	Stages	Wine			
		[T]	[G]	[M]	[W]
a*	1-4	54.17±4.20[a]	59.31±2.95[b]	56.90±2.33[b]	
	5-12	43.18±5.02[a]	46.68±5.34[b]	43.50±5.33[a]	43.21±5.01[a]
	Total	46.74±7.02[a]	50.52±7.52[b]	47.97±7.96[a,b]	43.21±5.01[c]
b*	1-4	1.83±2.37[a]	4.67±2.04[b]	1.84±1.15[a]	
	5-12	3.70±1.88[a]	2.57±1.39[b]	2.69±1.66[b]	3.68±1.68[a]
	Total	3.09±2.22[a,b]	3.20±1.87[a,b]	2.41±1.55[a]	3.68±1.68[b]
L*	1-4	48.21±4.54[a]	41.99±2.69[b]	45.91±2.33[a]	
	5-12	55.14±4.83[a]	50.98±4.26[b]	55.35±3.65[a]	54.68±4.83[a]
	Total	52.90±5.73[a]	48.24±5.66[b]	52.20±5.54[a]	54.68±4.83[a]
C^*_{ab}	1-4	54.34±4.22[a]	59.52±3.07[b]	56.95±3.51[b]	
	5-12	43.39±4.92[a]	46.78±5.27[b]	43.62±5.22[a]	43.41±4.90[a]
	Total	46.91±6.93[a]	50.66±7.54[b]	48.06±7.87[a,b]	43.41±4.90[c]
h_{ab}	1-4	1.83±2.48[a]	4.43±1.79[b]	1.84±1.21[a]	
	5-12	5.07±2.89[a]	3.30±2.12[b]	3.81±2.66[a,b]	5.06±2.71[a]
	Total	4.02±3.14[a,b]	3.65±2.08[a]	3.152.46[a]	5.06±2.71[b]

Colour differences (ΔE^*_{ab}) between wines were in the range 1.16-6.12 units (Table 2). According to Martínez et al. (2001) which indicated that ΔE^*_{ab} values up to 2.7 units represent chromatic changes that can be perceived by the human eye, only the pair [W]/[T] can not be clearly detected by a non-trained human eye. So, grape blending [M] yields more different wines than wine blending [W].

Table 2. ΔE^*_{ab} between wines.

ΔE	[T]	[G]	[M]	[W]
[T]	0.00	6.12	2.99	1.16
[G]	6.12	0.00	5.63	5.84
[M]	2.99	5.63	0.00	2.92
[W]	1.16	5.84	2.92	0.00

Colour differences between copigmented and non-copigmented wines ($\Delta E^*_{ab[c-n]}$) allow knowing if colour changes, owed to the copigmentation, are visually relevant. $\Delta E^*_{ab[c-n]}$ was around 14 units in the initial stages, in which the copigmentation phenomenon is more present, and 9 units in the final stages (Table 3). [M] had the highest copigmentation effect in the initial stages, and [G] and [T] had the lowest copigmentation values.

Table 3. $\Delta E^*_{ab[r-c]}$ as measure of the copigmentation phenomenon of different studied wines.

	Stages	Wine				Total
		T	G	M	W	
$\Delta E^*_{ab[r-c]}$	1-4	13.46±1.61[a,b]	12.76±1.19[a]	14.44±1.16[b]		13.58±1.49
	5-12	9.13±2.58[a]	9.01±3.12[a]	9.55±3.26[a]	9.40±4.81[a]	9.27±3.52
	Total	10.53±3.07	10.15±3.19	11.18±3.59	9.40±4.81	10.40±3.63

Colour differences ($\Delta E^*_{ab[5-12]}$) between 5-12 stages (final stages) were calculated to prove the stabilization of the wines (Table 4). [W] wines are the most stable and [M] has a similar behavior to [G]. So, co-maceration of grapes yielded to less stable wines than vinification with wine blending. More stable wines were obtained when 20% of [G] wine was added to [T] wine. [T] showed a stable colour ($\Delta E^*_{ab[5-12]}$ = 12.70), which correspond to high copigmentation values at the initial stages ($\Delta E^*_{ab[c-n]}$ = 13.46). [G] had the lowest copigmentation values at the initial stages ($\Delta E^*_{ab[c-n]}$ = 12.76) and high colour differences were obtained in the final stages ($\Delta E^*_{ab[5-12]}$ = 16.84). Therefore, has been verified that copigmentation influences positively on later stability of wine (Boulton 2001, Hermosín-Gutiérrez et al. 2005).

Table 4. $\Delta E^*_{ab[5-12]}$ as measure of the stability of wines.

	Wine			
	[T]	[G]	[M]	[W]
$\Delta E^*_{ab[5-12]}$	12.70±0.57[a]	16.84±1.59[b]	15.58±0.46[b]	11.87±2.20[a]

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New color scale for virgin olive oils

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ABSTRACT

At present there are two different scales for color classification of virgin olive oils: the Bromthymol Blue (BTB) Scale, and the Uniform Oil Color Scale (UOCS). The BTB Scale has shown some flaws: for instance, it is noteworthy to notice that it does not cover an important part of the actual color gamut from virgin olive oils (Moyano et al. 1999). On the other hand, UOCS, which gives better results than BTB classifying a wide set of virgin olive oils, was based on measurements assuming the Lambert-Beer's law. Recently, it has been reported by us that this law is not completely correct for virgin olive oil color (Gómez-Robledo et al. 2008). In order to improve mainly this deficiency of the UOCS, we report here a new color scale that has been developed from measurements of virgin olive oils at 5mm thickness, without using the Lambert-Beer's law. This modified Uniform Oil Color Scale (mUOCS) follows the same procedure and philosophy than the previous UOCS, improving the classification of virgin olive oil colors in comparison with the previous scales. Specifically, the mean CIELAB color-difference obtained from mUOCS standards to real oil samples is approximately 1 CIELAB unit lower than the one found from the early UOCS standards, with a 50% lower standard deviation.

1. INTRODUCTION

Visual attributes play an important role in food acceptance because visual appreciation is the first sensory impression of quality that consumers normally experience (Calvo et al 2001, Hutchings 1994). Although olive oil color is not included by the International Olive Oil Council (IOOC) as a quality parameter in sensorial analyses, many studies reveal that, for consumers from different countries, texture and color are determinant criteria for choosing specific olive oil brands, ranking ahead of price, taste and odor (Nielsen et al. 1998, Siskos et al. 2001). Moreover, in the United States (one of the major olive oil importer countries), the color of olive oils is considered for commercial classification of the product in relation to its quality (United States Department of Agriculture 1948). An objective and reproducible measurement of color is of great importance for oil producers, because of the strong relationships between consumers' acceptability and color, which has propelled the development of suitable techniques during the past decades (Moyano et al. 1999, Melgosa et al. 2004, Melgosa et al. 2009).

The Spanish Association of Normalization (AENOR) currently recommends the Bromthymol Blue Method (BTB) for determination of virgin olive oil color (AENOR 1997, Melgosa et al. 2000). This is a visual method which does not have very good properties. An alternative color scale was proposed by our group in 2004: the so-called Uniform Oil Color Scale (UOCS) (Melgosa et al. 2004). It was developed from spectrophotometric measurements at 5 mm thickness which were subsequently referred to 10-mm pathlength using the Lambert-Beer's law. Recently, we have demonstrated that Lambert-Beer's law cannot be accurately applied to oil color measurements (Gómez-Robledo et al. 2008).

The goal of the current paper is to report on a modified UOCS, which will be designated as mUOCS. In the development of mUOCS, the initial requirements were to use the same number of standards than BTB and UOCS (60 standards), providing better results (that is, lower color differences between the standards and a wide set of virgin olive oil samples) than these two previous scales.

2. MATERIALS AND METHODS

To elaborate the mUOCS we have used a virgin olive oil dataset of 1700 samples produced in Spain. These oils were extracted in the laboratory of the Almazara Experimental del Instituto de la Grasa (CSIC, Sevilla, Spain) by the Abencor method (Martínez et al. 1975), reproducing the industrial procedure on a small scale, and producing oil with the typical flavor and taste for organoleptic tasting. Olive fruits were transformed into a paste after milling in an electric mill, and the resulting paste was mixed in a malaxator and centrifuged at 3500 rpm to produce the oil. All 1700 virgin oil samples employed in the current work were extracted in the laboratory (i.e., no commercial oil samples were used). The olive samples were processed within 24-48 h after they had been collected, and about 60 ml of oil was obtained per sample. All color measurements of the oil samples were performed, using a spectrophotometer, immediately (<1 h) after extraction.

The oil spectral transmittance was measured in the range 380-770 nm, $\Delta\lambda = 2$ nm, using a Hewlett-Packard 8452 UV-visible light diode array spectrophotometer with quartz cells of 5-mm pathlength. The color of the 60 BTB standards was measured in the same experimental conditions. For color computation, the D65 illuminant and the CIE 1964 Supplementary Standard Observer have been assumed. Color coordinates have been transformed to CIELAB, and also to the DIN99d color space, assuming an n-hexane-measured solution as the reference white.

The mUOCS has been made up following a rhombohedral pattern in DIN99d space. This lattice is a type of "closest packing," where each point of the lattice is surrounded by 12 nearest neighbors. This arrangement of colors was chosen by the Optical Society of America for Uniform Color Scales (MacAdam 1974). As Euclidean distance is necessary in this lattice the DIN99d color space has been chosen here, because of its improved uniformity upon CIELAB.

The construction of the rhombohedral lattice started from the center of gravity of our dataset of 1700 virgin olive oil colors in DIN99d ($L_{99d} = 91.89$; $a_{99d} = 3.54$; $b_{99d} = 33.86$). In order to cover the gamut of colors with a reasonable number of points, we selected a constant lattice equal to 3.0 DIN99d units, and looked for the best 60 standards, without breaking the continuity of the scale.

3. RESULTS AND DISCUSSION

Figure 1 shows the L_{99d}, a_{99d} and b_{99d} coordinates of the 1700 olive oils, as well as the mUOCS, the early UOCS and BTB standards. It can be seen that, for 5 mm thickness, the lightness of the oil samples goes from 100 to 70 approximately, the lowest value corresponding to dark oils. We can notice that the BTB standards do not cover very well the color gamut of the oils. Most BTB standards have oil appearance; however there are a lot of oils that do not have the same appearance than BTB standards. For example there are no BTB standards with the high chroma values shown by some oils. For BTB, it can also be noticed that there is no uniformity in the spread of the standards in this color space: the distance between standards is not constant, as has been shown in previous works (Moyano et. al, 1999).

If we compare UOCS and mUOCS, it is possible to see that the distance between the standards in DIN99d space is always the same. In the plane a_{99d}-b_{99d} the continuity of the early UOCS seems to be broken in the region of $a_{99d} = 2.5$ approximately. Neither the oils with low a_{99d} nor those with low b_{99d} are covered by the UOCS standards, this being explained because this earlier scale was made to classify color of oils after applying the Lambert-Beer law. In other words, UOCS was created to cover the color gamut of a set of virgin olive oils with 10 mm thickness, after applying the Lambert-Beer's law. The mUOCS has been designed to solve this flaw in the previous UOCS. In Figure 1 we can see that the mUOCS has the same geometry than UOCS, but it fits better the color gamut of our set of oils.

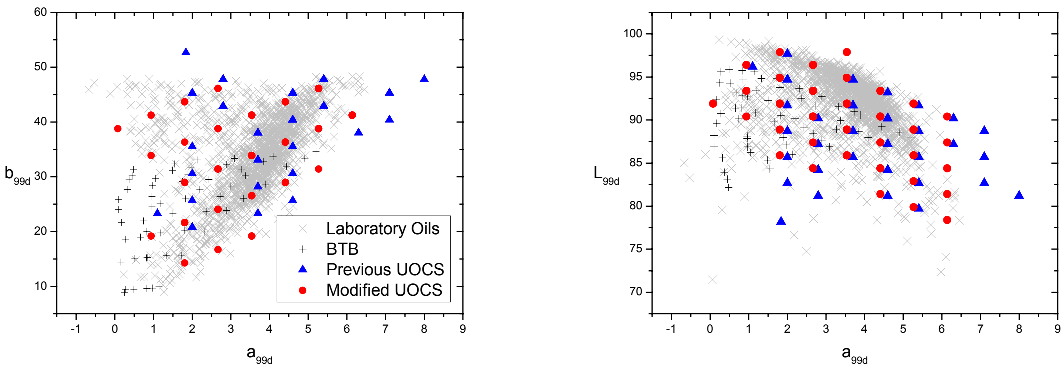

Figure 1. L_{99d}, a_{99d} and *b_{99d} coordinates in DIN99d space for the 1700 virgin olive oils and the 60 standards of each one of the three scales analyzed here: BTB, UOCS and mUOCS.*

To test the performance of the mUOCS, we have computed the CIELAB color-difference between each oil sample in the dataset and its nearest standard. The results found are summarized in Table 1. It shows for each one of the three scales: the average CIELAB color difference between each oil and its nearest standard, the standard deviation (SD) of these color differences, and the percentage of oils classified with a CIELAB tolerance lower than 3 CIELAB units. BTB is the scale whose standards are less similar to the olive oil colors. Therefore for BTB the mean color difference obtained is high (8.17 CIELAB units), the standard deviation indicates that there are a lot of oils with color differences greater than the average, and the percentage of oils classified within the 3 CIELAB units tolerance is low (20.0%). However UOCS improves BTB in a factor near to 3, as can be seen. Finally, mUOCS improves UOCS in more than 1.0 CIELAB units on the average, the SD being also considerably reduced, and a very high percentage of oils (97.2%) are classified using a tolerance of 3.0 CIELAB units.

Table 1. Basic statistics for the three actual color scales and the 1700 virgin olive oils.

Scale	$\Delta\overline{E}^*_{ab}$	*SD*	% *Oils* / $\Delta E^*_{ab} < 3$
BTB	8.17	6.64	20.0
UOCS	3.99	3.05	93.3
mUOCS	2.86	1.43	97.2

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Spectral reflectance analysis of tobacco leaves and fungus infection detection

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ABSTRACT

Optical properties of vegetable matter and associated analytical techniques such as VIS and NIR reflectance spectroscopy were used for several decades in the foodstuff industry. By means of these techniques, is possible to study and determine the plant pathology of crops: health or disease conditions, water stress, growth, etc., being a good alternative to traditional chemical or biological tests, generally very invasive and even destructive. The aim of this work is to analyse and quantify the effect of the presence and development of the pathogen *Fusarium* on spectral signatures of Burley tobacco leaves, and to evaluate the potential of radiometric techniques as tools for diagnosis.

1. INTRODUCTION

Optical radiation impinging on a sample of any material is subject to some processes causing part of the energy carried by radiation being transmitted through the sample, part of it being absorbed, and part being reflected (specular or diffuse), in wavebands and proportions that depend on the particular nature of the sample among other factors. Optical properties seems to be able for use as an important tool in identification and classification of plants, in determination of productivity, yield estimation as well as in measuring and analysing different specific parameters of individual plants and crops. Diffuse reflectance of vegetable matter and associated analytical techniques such as VIS and NIR reflectance spectroscopy were used for several decades in the foodstuff industry (Cozzolino et al. 2003, Norris et al. 1976, Murray 1986). By means of these techniques, is possible to study and determine biophysical and physiological status of individual plants and crops: health or disease conditions, water stress, growth stage, etc. (Hamid and Larsolle 2003, Hamid 2005), being a good alternative to traditional chemical or biological tests, generally very invasive and even destructive. The organized array of reflectance in terms of wavelength, ranging generally from VIS to NIR, is called a "spectral signature" of the given specie. The spectral signature could be modifyed according to biological condition of the sample under analysis, for example its health condition, the presence of diseases, plant growth or maturity, nutritional condition, moisture or nutrient content, etc.

Tobacco is a crop of great socio-economical importance at the north-west region of Argentina. It can be affected by several pathogens in different stages of growing; among these pathogens, the fungus Fusarium oxysporum can make the plant to get withered (Ramallo 2005), causing economical and agricultural damages (yield losses, increased chemical products to control the affection, environmental impact). The aim of this work is to analyse and quantify the effect of the presence and development of the pathogen *Fusarium* on spectral signatures of Burley tobacco leaves, and to evaluate the potential of radiometric techniques as tools for diagnosis.

2. MATERIALS AND METHODS

Measurements of spectral reflectance were performed, ranging from 310 to 1900 nm. The data correspond to two groups: leaves coming from healthy tobacco plants, labelled T; and leaves from plants inoculated with fungus, named F. In the main experiment, samples of each group were taken at 1, 2, 3 and 4 weeks from inoculation. Spectral measurements were performed within 24 hours from the extraction of samples.

Reflectance curves –spectral signatures– were measured by means of a spectroradiometer with double monochromator Optronic OL 750, ranging from 300 nm to 1100 nm by 5 nm steps, and from 1100 nm to 1900 nm by 10 nm steps, on the front of the leaf and without specular component . From these spectral data the chromatic coordinates CIE 1931 (x, y), coordinates UCS 1976 (u', v') and values of (a*, b*) for type A illuminate were obtained.

A pilot experiment was performed taking measurements in three stages (1, 2, and 3 weeks). On each stage, a control sample (T) and inoculated sample were measured. After that, a main experiment was carried on having four stages (1, 2, 3, and 4 weeks). At the last stage, the fungi infection of the inoculated plants was easily visually detectable. For all stages, the spectral signature for 5 samples of each condition (T and F) was determined. Following are presented the obtained spectral signatures, (a*, b*) values and some results obtained applying Principal Component Analysis to the reflectance data of the main experiment.

3. RESULTS

Results of the pilot experiment showed differences in spectral signatures and in chromatic characteristics associated to the healthy (T) and inoculated (F) samples. Those differences were increased on time. In the first stage (a: week 1) there is no significant differences (see Figure 1).

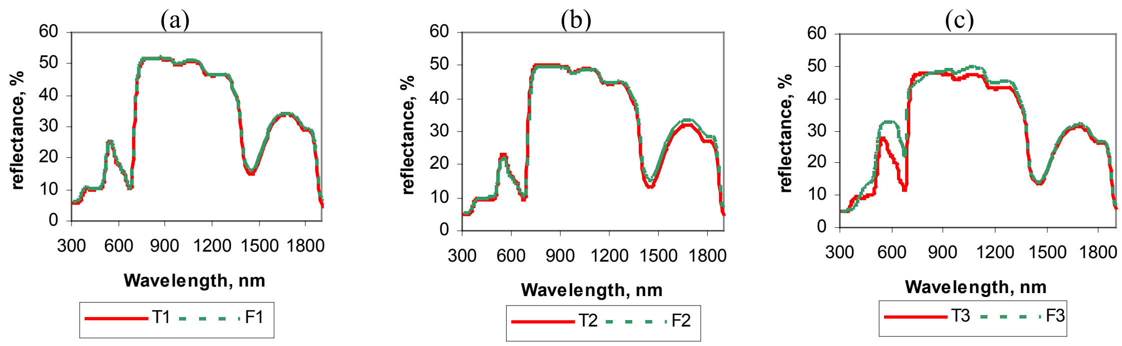

Figure 1. Resulting spectral signatures from pilot experiment: (a) week 1; (b) week 2; (c) week 3.

Differences between samples T's and F's are noticeably incremented as can be seen in Figure 2, that shows the corresponding values (a*, b*).

Figures 3 and 4 show results obtained in the main experiment in which several samples for each condition were measured. Figure 3 shows average spectral signatures corres-ponding to each stage. Averaged values of (a*, b*) for each condition are plotted on Figure 4.

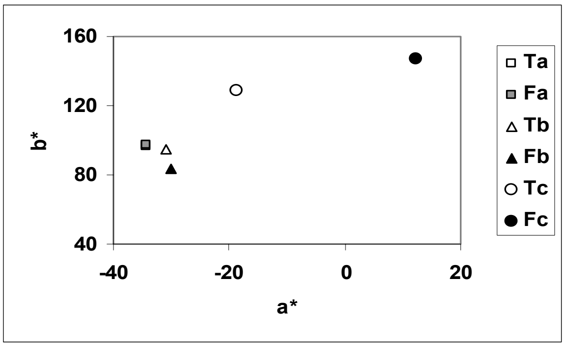

Figure 2. Chromatic values (a, b*) from the pilot experiment: (a) week 1; (b) week 2; (c) week 3.*

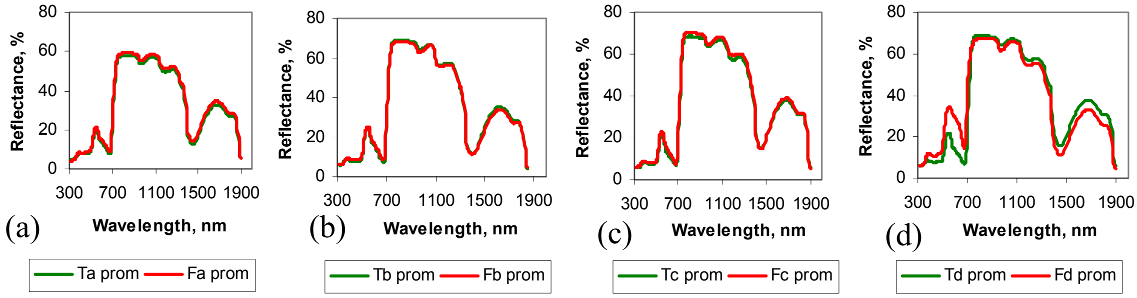

Figure 3. Second experiment: Resulting spectral signatures from the training phase: (a) one week; (b) two weeks; (c) tree weeks, (d) four weeks.

As does the pilot experiment, the second also shows increased differences between samples T and F through successive stages, despite the variability showed by samples at the same condition which in some cases could masks the differences, particularly on weeks 2 and 3, the most important period of time to make the diagnostic effective. Differences in values (a*, b*) for averaged measurements for samples T and F are also markedly increased, as can be seen in Figure 4.

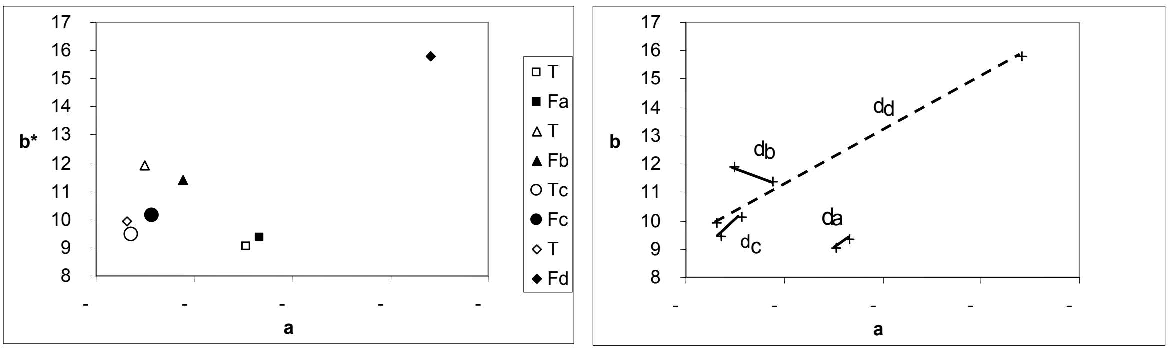

Figure 4. Second experiment: *Left: values (a*, b*) for (a) week 1; (b) week 2; (c)week 3; (d) week 4. Rigth: distance in (a*, b*) space between samples T and F for each stage.*

PCA was performed on the spectral data for samples in each condition (T y F) to analyze the existence of any segregation on the basis of effect of the pathogen *Fusarium* on spectral signatures. Separation between healthy (T) and inoculated (F) simples, showed in Figure 5, right, is sharply noticeable at the week 4, whilst in previous stages there was a trend of the groups to separate, but they were not clearly distinguishable (what is our main interest), as can be seen in Figure 5, left.

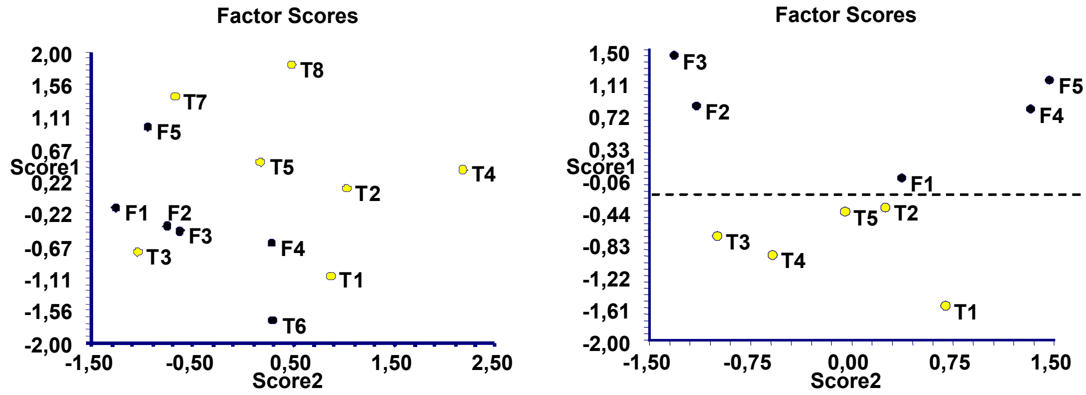

Figure 5. Principal Component Scores plot, for second experiment data.
Left: results for week 2, Right: results for week 4.

4. CONCLUSION

The analysis of the obtained results by means of a chromatic values (a*, b*) and Principal Component Analysis, shows that spectral signatures of tobacco leaves are noticeably modified, in the visible region –associated to colour characteristics– as well as in the NIR region, when the fungus was present. This fact seems to indicate that the application of this analytical technique to the measured spectral signatures could give us important information and criteria to predict when the plant (or crop) could be considered infected with this pathogen and take suitable actions on time to avoid serious losses. However, the intrinsic variability founded in reflectance of samples at any condition make the differentiation between healthy and infected plants harder. Much work have to be done in order to overcome such difficulties, specially in the selection of samples to be analysed, increasing the amount of data suitable to the application of PCA.

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Simple method for simultaneous quantitation of dyes in hydrating beverages (Gatorade and Powerade)

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ABSTRACT

This paper describes a novel method for the quantitation of four artificial dyes: brilliant blue, sunset yellow, allura red and tartrazine, which are usually present in hydrating beverages like Gatorade and Powerade. Interferences present in the sample matrix were removed by pre-filtering the sample using a syringe filter for HPLC. For the experimental analysis, a calibration set was prepared following a central composite design and the absorption spectrums of these mixtures were recorded in the range of 350 to 750 nm. The artificial and commercial samples were processed under the same conditions as the calibration kit. The data obtained was treated with the Matlab program and MVC1 routine, applying the multivariate calibration method PLS-1. The results were satisfactory, with errors between 1.46 and 4.56%. Recovery rates varied between 98.2 and 101.9%. Finally, we conclude that this method can be used for quality control of dyes in commercial beverages in low complexity laboratories, not being necessary the used of more expensive separation techniques.

1. INTRODUCTION

Dyes are the group of food additives responsible for enhance or provide the desired and expected color of each food (Cubero et al. 2002). Its application in the industry today is strictly regulated, because of its adverse health effects. The national and international existing rules, dictated by official organisms, established which colours can be added to foods and in which concentration.

For each authorized dye the value of "acceptable daily intake" (ADI) is determined, which is the amount of a food additive that can be consumed in the diet without representing a health risk and it is expressed in milligrams per kilogram (mg Kg^{-1}). This parameter is calculated by a wide margin of safety for the general population (EUFIC).

It has been shown that moderate doses of synthetic dyes in foods can cause hyperactivity and other behavior disorders in kids. As well, people with special functional features may suffer intolerance, intensification of symptoms of asthma and allergies, etc. (IATP).

This paper focuses its study in four synthetic dyes (Sunset Yellow, Brilliant Blue, Tartrazine and Allura Red) present in hydrating drinks like Gatorade and Powerade. ADI values for these dyes are: 2.5 mg Kg^{-1}, 12.5 mg Kg^{-1}, 7.0 mg Kg^{-1} and 7.5 mg Kg^{-1}, respectively.

There are many methods described for their quantification, such as capillary electrophoresis (Huang et al. 2002, Perez-Urquiza and Beltrán 2000), spectrophotometry (Dinc et al. 2002, Nevado et al. 1999), voltammetry (Nevado et al. 1997) and mass spectroscopy (Harada et al. 1991). Nowadays, the most used method for quantification of dyes is the High Performance Liquid Chromatography (HPLC). This technique is characterized by its speed and power of resolution in the analysis of multicomponent mixtures. However, it has some limitations i.e. the use of expensive equipment, polluting solvents and requires more analysis time for each sample (García Falcón et al. 2005, Chen et al. 1998, Holcapek et al. 2001, Scarpi et al. 1998, Salcedo 1997).

We propose a simple method based in the use of visible spectroscopy and statistical programs for the analysis of complex samples. This is possible because the interferences present in the sample matrix are removed by filtering with a syringe filter for HPLC.

2. MATERIALS

Standard solutions of synthetic dyes: four standard solutions from 2000 mg L^{-1} of the dyes Sunset Yellow, Brilliant Blue, Tartrazine and Allura Red were prepared. In all cases we used solid drug (Sigma) and distilled water.

Commercial samples: nonalcoholic beverages brands "Gatorade" (Quaker Oats Company, a division of PepsiCo, USA) and "Powerade" (The Coca-Cola Company, USA) were used. They were labeled as follows:

Table1. Commercial samples processed and declared colours in each one.

Sample	Brand	Taste	Declared colorants
M1	Gatorade	Cool Blue	Brilliant Blue
M2	Gatorade	Green Mango	Brilliant Blue, Tartrazine
M3	Gatorade	Tropical Fruits	Allura Red
M4	Gatorade	Orange	Sunset Yellow
M5	Powerade	Orange	Sunset Yellow, Tartrazine
M6	Gatorade	Berry	Brilliant Blue, Allura Red
M7	Gatorade	Lime-Lemon	Tartrazine

Buffer solution: a buffer solution of sodium acetate (pH 5) was prepared mixing:
- 643 mL of 0.1 M sodium acetate prepared from solid drug (Mallinckrodt);
- 357 mL of 0.1 M acetic acid prepared from concentrated acetic acid (Cicarelli).

Chromatographic system:
- Mobile phase: consisted of a mixture of methanol and aqueous ammonium acetate (45:55).
- Column (4.6 × 250mm) Zorbax ODS, particle size 5 μm.
- The solutions were filtered through membrane filters of 0.45 μm of pore size.
- Flow rate 1 mL min^{-1}.
- Temperature: room temperature.

Equipment:
- Perkin-Elmer Lamda 20 spectrophotometer, with a glass cell of 1 cm of optical path. The scan rate in all cases was 1920 nm min^{-1}.
- Agilent 1100 Series for liquid chromatography (Agilent Technologies, Waldbronn, Germany).

3. EXPERIMENTAL

In all cases the absorption spectrums of pure dyes were recorded in the range of 350-750 nm of wavelength, every 2 nm.

Calibration mixtures: for the quantification a set of 19 calibration mixtures was prepared, following a central composite design for four components in five concentration levels (from 0 to 12 mg L^{-1}). The mixtures were prepared in 25 mL volumetric flasks by adding the required volume of standard solution of each dye, 5 mL of acetate buffer and leading to final volume with distilled water. The absorbances recorded were arranged in a 201 × 19 matrix and processed with the Matlab program and MVC1 routine applying PLS-1 method. The statistical parameters obtained are reported in Table 2.

Table 2. Calibration's statistical parameters applying PLS-1 method.

	Nº of factors	Wavelength range (nm)	REP^{*1}	R^{*2}	Sen^{*3}	Sel^{*4}	LOD^{*5} (mg L^{-1})
Sunset Yellow	4	414 a 476	1.46	0.999	0.01	0.03	0.86
Brillant Blue	1	622 a 630	3.01	0.996	0.28	1.00	0.21
Allura Red	4	530 a 618	4.56	0.999	0.11	0.40	0.40
Tartrazine	5	426 a 492	2.94	0.996	0.02	0.38	0.29

**1: relative error of prediction, *2: correlation coefficient, *3: sensibility, *4: selectivity and *5: limit of detection.*

Validation mixtures: a validation set of 5 mixtures (V1 to V5) was prepared under the same conditions as the calibration kit. We used standard solutions of the four dyes. Concentrations of each dye were predicted; the obtained results are detailed in Table 3.

Table 3. Results obtained for the validation samples applying PLS-1.

	Sunset Yellow		Billiant Blue		Allura Red		Tartrazine	
	Conc. (mg L^{-1})		Conc. (mg L^{-1})		Conc. (mg L^{-1})		Conc. (mg L^{-1})	
	actual	predicted	actual	predicted	actual	predicted	actual	predicted
V1	3.20	3.14	0.00	0.13	6.40	6.47	0.00	0.03
V2	6.40	6.53	0.00	0.13	3.20	3.27	3.20	3.20
V3	0.00	0.01	3.20	3.28	0.00	0.03	6.40	6.42
V4	0.00	0.26	3.20	2.86	3.20	3.23	0.00	0.04
V5	3.20	3.26	6.40	6.68	0.00	0.05	3.20	3.01
	Average of % recovery							
	100.6		98.7		101.9		98.2	

Commercial samples: the commercial samples were filtered using a syringe filter for HPLC (Chemical Center). Subsequently, to each filtered sample we added 5 mL of acetate buffer and distilled water to complete a final volume of 25 mL in volumetric flasks. In parallel, samples were processed by HPLC. The predicted results by both methods are listed in Table 4.

Table 4. Results obtained for commercial samples by spectroscopy and HPLC method.

	Tatrazine Predicted Conc. (mg L^{-1})		Brillant Blue Predicted Conc. (mg L^{-1})		Allura Red Predicted Conc. (mg L^{-1})		Sunset Yellow Predicted Conc. (mg L^{-1})	
	PLS-1	HPLC	PLS-1.	HPLC	PLS-1	HPLC	PLS-1	HPLC
M1			1.64	1.99				
M2	4.57	4.33	1.95	1.98				
M3					11.07	12.5		
M4							30.10	29.6
M5	0.12	0.33					11.49	12.61
M6			No dect.	0.11	38.29	40.97		
M7	1.84	1.95						

4. CONCLUSIONS

The statistical parameters obtained in the calibration step were satisfactory, with errors of 1.46, 3.01, 4.56 and 2.94 for sunset yellow, brilliant blue, allura red and tartrazine, respectively.

When we predicted the validation samples, the results of the real concentrations and the predicted concentrations were comparable, showing recoveries of 100.6% for sunset yellow, 98.7% for bright blue, 101.9% for allura red and 98.2% for tartrazine.

Standard addition curves were made for the four dyes and in all cases there was no matrix effect, due to the fact that the interferences present in the matrix of the samples were removed by prior filtering.

We can conclude that the concentrations predicted by the method developed (Spectroscopy with multivariate calibration method PLS-1) were comparable with those predicted by the HPLC reference method.

This new method has the advantage of being fast, simple, applicable to low complexity laboratories, is cheaper and does not use polluting solvents.

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Discrimination of five strawberry varieties by spectroradiometry and image analysis

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ABSTRACT

The colour of ripe strawberries (*Fragaria × ananassa* Duch.) is furnished by anthocyanins, which are attributed diverse health benefits (antioxidant, anti-carcinogenic, anti-inflammatory, and anti-angiogenic properties). These pigments are mainly located in the peel, but also in the pulp. The strawberry is non-homogeneous fruit, showing different colour along its surface.

In this work a thorough study of the colour of five strawberries cultivars (Aromas, Camarosa, Diamante, Medina and Ventana) grown in two different soilless systems (with and without recycling nutrient solution) have been carried out. The colour of the samples was measured within 24 hours of the harvest both by Spectroradiometry and Digital Image Analysis. Multivariate statistical methods have been performed to find statistical differences based on the colour and the appearance of the samples. In this sense, differences due to the cultivar were found especially when image analysis was applied since the presence of seeds on the external surface of the strawberries which can have different hues (from pale green to brown) induces important differences on the appearance of the fruit

1. INTRODUCTION

Colour and appearance are very important characteristic for the acceptance and selection of food. Thus it is very interesting to determine adequately these features. Important loss of colour information occurs when a colorimeter is used to measure the colour of sample presenting colour variations within it (this is the case of most of foods, including strawberries) since it measures average colour. However, a digital imaging system records the colour at thousands or even millions points in the sample (each pixel records a separate colour measurement) and also information about other appearance characteristics. This provides much more detailed information about the colour of the sample, giving the colour distribution within the sample. So, digital image analysis appears as a useful methodology to determine the real colour of a non-homogeneous sample.

The soilless cultivation system, also known as hydroponic systems, consists of a method of growing plants using mineral nutrient solutions without soil, based on the fact that plants absorb essential mineral nutrients as inorganic ions in water, and soil acts only as a mineral nutrient reservoir but the it is not essential itself to plant growth. This kind of system has been successfully developed to allow more sustainable use of both water and nutrients, as well as a reduction of the contamination of the soil.

In previous investigations we have stated that the colour of strawberries is conditioned by genetic and agronomic factors such as the type of soilless cultivation system, being possible to differentiate between varieties based on their anthocyanic content and their colour characteristics measured by spectroradiometry (Hernanz et al. 2008). In this work, digital image analysis has been applied to measure colour as well as appearance of the strawberry in order to find differences due to cultivar and/or cultivation system.

2. MATERIALS AND METHODS

2.1 Samples

Five strawberries cultivars (Aromas, Camarosa, Diamante, Medina and Ventana) grown in two different soilless systems (with and without recycling nutrient solution) have been included in the study. The fruits were harvested at the same commercial maturation level, when they presented red colour on the whole surface.

2.2 Colour measurements

For measuring the colour (within 24 hours of the harvest) both spectroradiometry (with a CAS 140B spectroradiometer, Instrument Systems) and digital image (with an Optio 5 Mpixels digital camera) techniques were applied, which mimic the human eye process.

3. RESULTS

Spectroradiometric measurements were taken at six different points along the surface of the strawberries and the average values were considered. The digital measurements were taken into an illuminating cabinet, being the fruit over a white background and under a D65 illuminant emulator. The images were processed by DigiFood® (Heredia et al. 2006) for obtaining each pixel as well as the mean colour parameters, according to CIE specifications (CIE 2004).

Table 1 shows the average colour parameters obtained by digitalization and spectroradiometry for the five strawberry varieties in the two cultivation systems. One-way analyses of variance (ANOVA) were applied and significant differences ($p < 0.001$) were found regarding the colour parameters when all the varieties were considered, for both digital and spectroradiometry techniques. When colour is measured by spectroradiometry (Figure 1a) only the samples having maximum and minimum b^* values are well defined in separate groups. Samples belonging to each cultivar are observed in separate groups when colour is calculated by digitalization (Figure 1b).

It was evaluated the influence of the cultivar on the colour. In the case of digital measurements significant differences ($p < 0.05$) among all the colour variables were found. Nevertheless, no significant differences were found when the cultivation system factor was taken into account. For the spectroradiometric measurements significant differences ($p < 0.05$) among all the colour variables were found taken into account the cultivar factor, and for b^*, C^*_{ab}, h_{ab} and L^* between both groups of samples when the effect of the soilless cultivation was evaluated.

Table 1. Colour parameters by digital analysis and by spectroradiometry for each cultivar and type of cultivation system. Mean values and standard deviation (n = 15).

Cultivar	Cultivation system	L*	a*	b*	C^*_{ab}	h_{ab}
Digital techniques						
	Open	36.36 ± 9.23	48.30 ± 12.62	34.49 ± 17.32	59.99 ± 20.37	33.35 ± 6.14
Aromas	Closed	31.44 ± 5.86	43.94 ± 7.79	31.51 ± 12.74	54.58 ± 14.06	33.82 ± 5.02
	All samples	33.90 ± 7.73	46.12 ± 10.15	33.00 ± 14.42	57.28 ± 16.74	33.59 ± 5.29
	Open	40.65 ± 7.35	52.00 ± 8.79	43.05 ± 13.92	68.24 ± 15.69	37.34 ± 4.35
Camarosa	Closed	34.95 ± 4.26	47.17 ± 5.64	35.86 ± 8.85	59.68 ± 9.81	36.08 ± 3.38
	All samples	37.80 ± 6.40	49.58 ± 7.39	39.45 ± 11.63	63.96 ± 13.13	36.71± 3.73
	Open	46.99 ± 0.54	63.25 ± 11.30	61.59 ± 19.97	88.73 ± 21.76	43.17 ± 5.96
Diamante	Closed	43.58 ± 6.05	58.81 ± 11.30	57.32 ± 10.90	82.74 ± 12.03	42.43 ± 2.48
	All samples	45.29 ± 8.30	61.03 ± 8.97	59.45 ± 15.33	85.74 ± 16.78	42.80 ± 4.31
	Open	43.92 ± 6.93	55.96 ± 9.08	50.11 ± 13.78	76.08 ± 15.93	40.04 ± 3.96
Medina	Closed	43.86 ± 3.03	56.63 ± 7.06	52.86 ± 10.64	78.37 ± 12.40	41.45 ± 2.94
	All samples	43.89 ± 6.26	56.30 ± 7.67	51.48 ± 11.69	77.22 ±13.50	40.75 ± 3.36
	Open	42.26 ± 3.03	57.59 ± 3.89	49.69 ± 4.81	76.51 ± 6.00	39.61 ± 1.20
Ventana	Closed	42.25 ± 6.79	56.63 ± 10.14	47.09 ± 15.46	74.23 ± 17.54	37.85 ± 4.61
	All samples	42.25 ± 4.95	57.11 ± 7.25	48.39 ± 10.88	75.37 ±12.41	38.73 ± 3.30
Spectroradiometry						
	Open	38.34 ± 4.86	40.53 ± 3.77	112.80 ± 16.35	120.02 ± 15.77	69.50 ± 3.80
Aromas	Closed	37.26 ± 3.23	40.70 ± 2.82	121.76 ± 13.86	128.41 ± 13.83	71.41 ± 1.39
	All samples	37.80 ± 4.05	40.62 ± 3.24	117.28 ± 21.00	124.22 ± 20.59	70.46 ± 2.95
	Open	41.44 ± 6.82	34.74 ± 4.80	84.75 ± 16.26	92.30 ± 24.55	64.87 ± 8.97
Camarosa	Closed	40.47 ± 4.30	37.34 ± 3.37	111.00 ± 11.02	117.26 ± 10.31	70.98 ± 3.25
	All samples	40.96 ± 5.57	36.04 ± 4.25	97.88 ± 12.84	104.78 ± 13.41	67.93 ± 7.28
	Open	49.33 ± 5.98	42.30 ± 4.71	38.19 ± 8.34	57.11 ± 8.74	41.61 ± 4.10
Diamante	Closed	50.29 ± 5.52	43.83 ± 3.55	53.92 ± 13.06	69.76 ± 11.92	50.01 ± 5.67
	All samples	49.81 ± 5.82	43.07 ± 4.46	46.06 ± 12.00	63.44 ± 11.14	45.81 ± 5.92
	Open	43.77 ± 3.65	40.63 ± 1.58	59.86 ± 15.22	72.85 ± 12.99	54.49 ± 6.65
Medina	Closed	39.93 ± 2.98	41.47 ± 3.18	90.82 ± 10.56	99.88 ± 10.67	65.35 ± 1.58
	All samples	41.85 ± 4.06	41.05 ± 2.88	75.34 ± 11.2	86.37 ± 19.03	59.92 ±7.24
	Open	40.36 ± 5.40	39.26 ± 3.03	97.07 ± 14.50	104.76 ± 12.88	67.87 ± 6.99
Ventana	Closed	41.71 ± 4.33	40.28 ± 2.69	88.55 ± 9.42	97.67 ± 9.14	64.17 ± 1.97
	All samples	41.04 ± 4.81	39.77 ± 2.69	92.81 ± 9.42	101.22 ± 9.14	66.02 ± 1.97

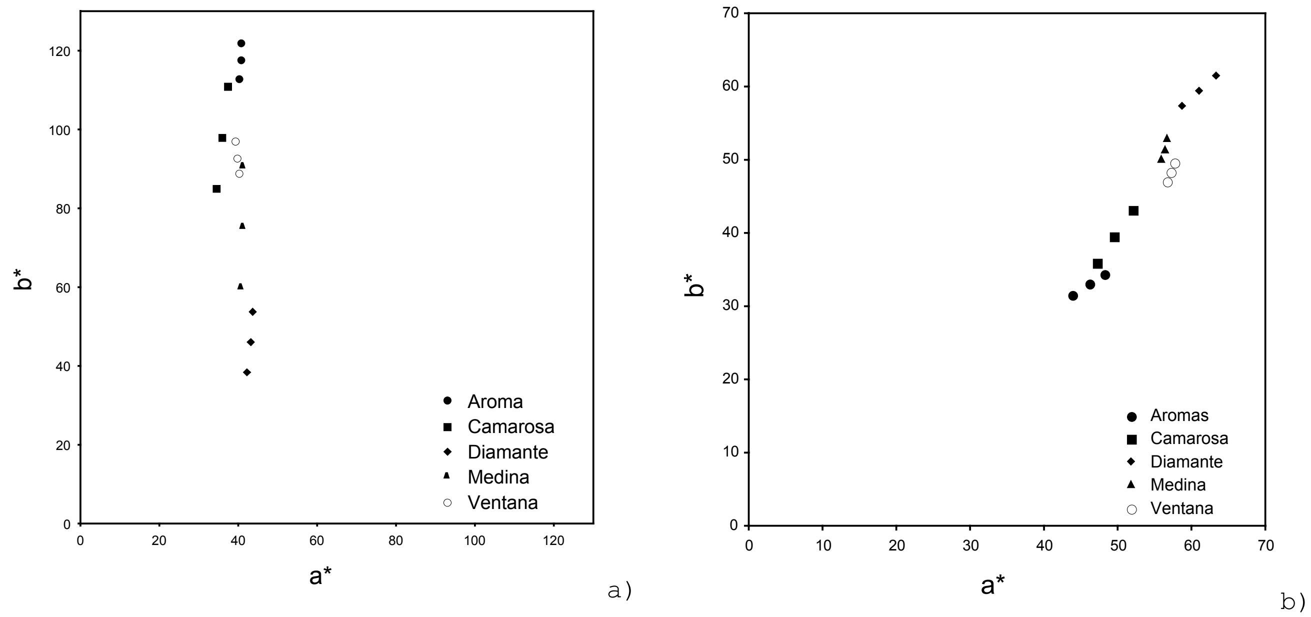

Figure 1. Colour of the samples of each cultivar (considering both open and closed cultivation systems) for a) spectroradiometry and b) digital colour determination.

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To define colour and set up colour tolerances for natural fruit or berry based yogurt and juices

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ABSTRACT

Natural fruit based products such as yogurt and juices are not only be judged according to their flavour, texture, shape or smell but also their colour appearance. The colour will give us visual information and, as such, arouse feelings, thoughts, associations and expectations that make us react. The colour of the juice or yogurt is an important part of the user experience and whether consumer will like to consume the product or not.

By using a colour system, like NCS, Natural Colour System (SIS 2004, Hård et al. 1996.), it is possible to determine the colour of natural fruit or berry-based products such as juice or yogurt in a given situation. It is also be possible to create and determine the colour area that will be accepted and approved by the customer depending on the flavour of the product. This colour area can be visually illustrated by samples that will indicate the borders for the tolerance and work as a practical tool for the producer.

This paper will present some case studies examining the importance of defining colours and how to manage these colours with the help of visual colour tools for products such as yogurt and fruit juices.

1. INTRODUCTION

For natural products, where additive for colours or flavours is absolutely not permitted, the natural colour from the fruit or berry will be the only source from which to add colour to the product. Depending on the season, the origin and the family, the fruit or berry itself will vary in colour, resulting in a colour deviation of the product. For a raspberry-flavoured product most of us will expect it to have a reddish pink appearance. But the question will be how much or little reddish pink it must have and what we can accept in deviation without loosing the raspberry appearance when we will see it. Another question concerns how we form our associations between different raspberry products, natural or artificial. From an early age we will think “ahh raspberry” when we will get a bowl of yogurt or a glass of juice in front of us with a colour we associate with that particular fruit.

2. METHOD

For each product there are some colour expectations from the producer and also what will be an accepted colour and a non accepted colour. To formulate an answer for these questions we have been working with visual assessments of different batches of the same flavours.

2.1 Define and diagnosis

With visual evaluation in controlled daylight lightsource (D65) comparisons with fruit based juices and yogurts have been made. Transparent plastic cups in approx. size 10 cm in diameter and 3 cm depth, filled with the product. Evaluation was made in a viewing angle of 45 degrees between the observer and the cup with the lightsource from above. The colour was then compared with colour samples from the NCS Colour Atlas to find the colour area and the nearest available NCS colour sample (Figure 1).

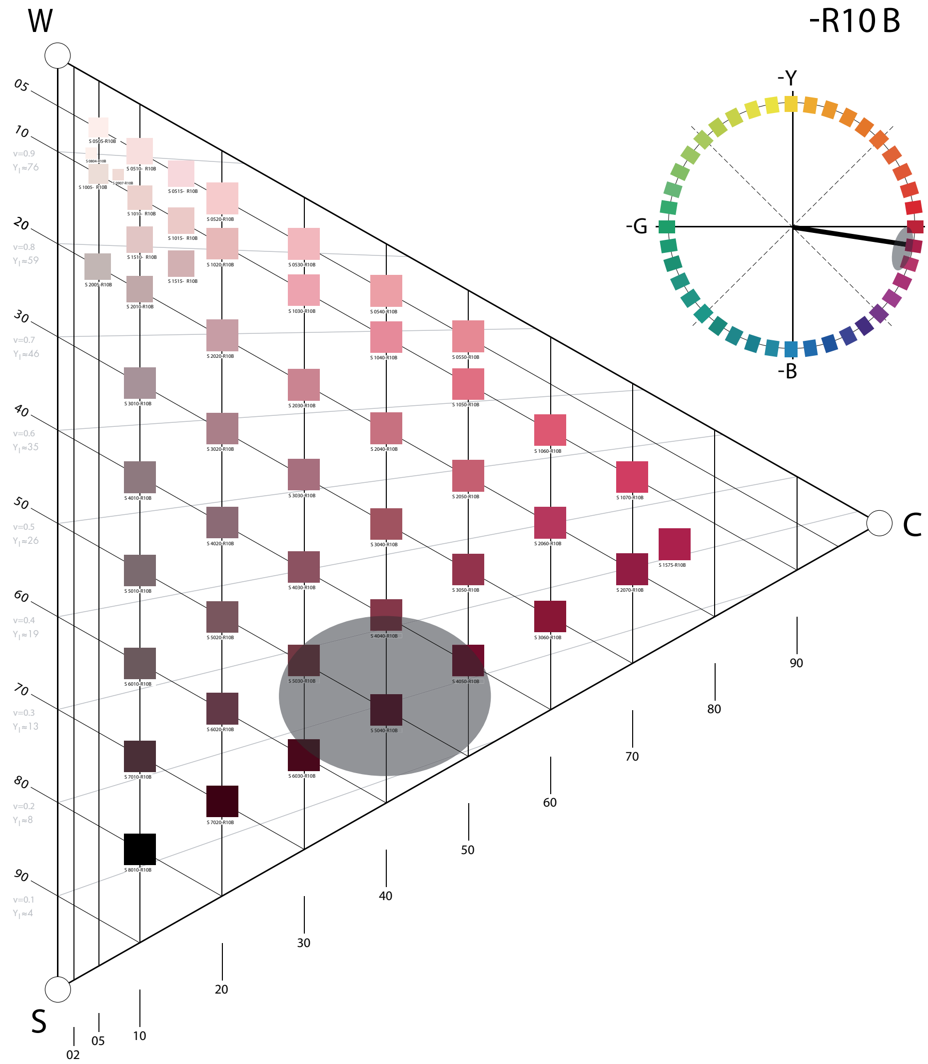

Figure 1. Colour area for a raspberry/pomegranate flavoured fruit juice.

Same analysis was made for different flavours such as mango, pineapple, strawberry and banana and for each of them a colour area was defined.

2.2 Colour standards and tolerances

With the colour area defined for each flavour, different batches of the same flavour will be evaluated and compared with each other. The batches will be organised according to accepted and failed.

For the group of accepted batches, a standard that represent the flavour best will be selected and established as a standard. The failed batches will be arranged according to this standard and the tolerance border will be established. The tolerances can vary depending on the directions and do not have to be with the same colour deviation to the standard.

For the standard and the limit colours colour samples will be matched (Table 1).

Table 1. NCS values for raspberry / pomegranate tolerance area.

Description	NCS exact
Standard	5041-R08B
Hue maximum redness	5041-R01B
Maximum whiteness	5037-R09B
Maximum chromaticness	4545-R09B
Hue maximum blueness	5040-R14B
Minimum chromaticness	5241-R05B
Maximum blackness	5931-R09B

All these samples will then be arranged in a model that can be used as a visual colour tolerance tool. This tool will include the sample of the selected standard in the centre and have the other six colours can that illustrate the visual tolerance area in different directions (Figure 2). In some directions, the colour deviation can vary because of greater acceptance in some colour directions.

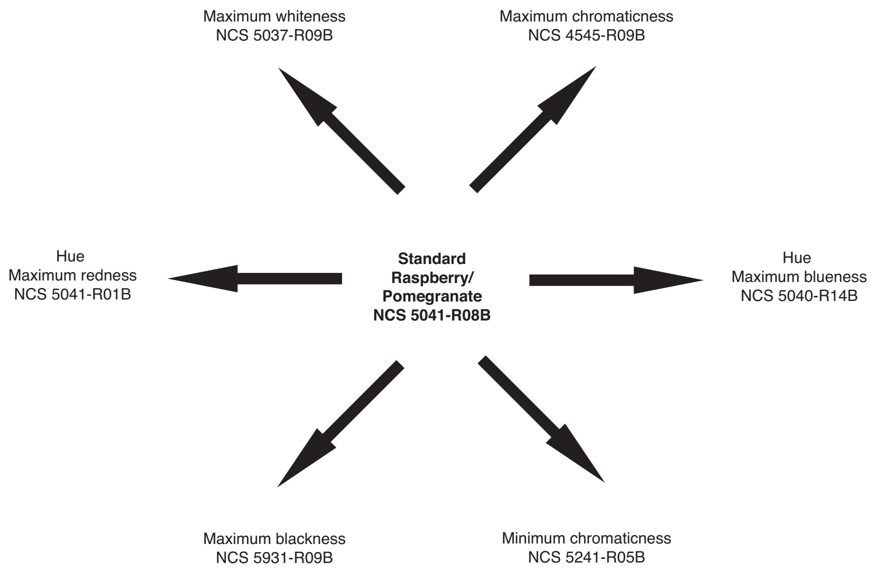

Figure 2. Illustration of the different directions that creates the tolerance.

3. SOLUTION

By first specifying the colour area and the standard colour, and then creating visual colour tolerance tool according to the process described in this paper, producers of natural fruit or berry based yogurt and juices can be able to achieve consistency in colour.

4. DISCUSSION

Through this paper I have been able to share some of my experiences and processes that have been used at the Scandinavian Colour Institute for food purpose. The use of a visual colour tolerance tool can be a very effective way to manage colours for fruit juices and yogurt to enable companies to make colour checks and assure the colour on the final product.

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Color changes in fresh-cut fruits as affected by cultivar, chemical treatment, and storage time and temperature

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ABSTRACT

The objective of this work was to evaluate the color changes of fresh-cut apples and peaches from different cultivars of during storage, studying the effect of an antibrowning solution containing 1% ascorbic acid and 1% citric acid for fresh-cut apples, or different storage temperatures for fresh-cut peaches (1.5; 5; 10 or 15 ºC). Browning development occurred in all fresh-cut apples samples during refrigerated storage but it was significantly lower for Granny Smith samples treated with ascorbic and citric acid. The changes of L*, a* and BR values clearly represented browning development in fresh-cut apples. All color parameters changed with cultivar and storage time and temperature in fresh-cut peaches. Color changes were mainly due to L* and a* for yellow pulp cultivars, and to a* for the white one. No color differences were found between samples stored at 1.5 and 5 ºC. However L* and h_{ab} values decreased with higher storage temperatures and a* values of white pulp cultivar increased with higher temperatures.

1. INTRODUCTION

Visual appearance of a fresh-cut fruit or vegetable is the attribute most immediately obvious to the consumer, and strongly affects the commercial shelf-life. Many unrelated factors influence appearance, from wound-related effects to drying to microbial colonization (Toivonen and Brummell 2008). Wounding of fruit tissues induces a number of physiological disorders that need to be minimized to obtain fresh-like quality products (Gil et al. 2006). This is one of the reasons an important issue in fresh-cut fruit processing is the control of discoloration (pinking, reddening or blackening) or browning at cut surfaces.

Cut-edge browning is a particular problem in fruit with white flesh such as apples and pears, but is also a factor in many other fresh-cut fruit products. Oxidative browning is usually caused by the polyphenol oxidase enzyme (PPO) which, in the presence of O_2, converts phenolic compounds in fruits and vegetables into dark colored pigments. This quality attribute is mainly affected by cultivar, processing techniques, packaging and temperature management. Different strategies may be used to reduce PPO-mediated cut surface discoloration: refrigerated storage, reducing the amount of O_2 in the package, heat treatment, dipping fruits in mildly acidic food grade solution or reducing agents. Nevertheless, enzymatic browning still represents a major challenge with fresh-cut fruit (Beaulieu and Gorny 2002). Therefore, the objective of this work was to evaluate the color changes of fresh-cut apples and peaches from different cultivars during storage, studying the effect of an anti-browning solution or different storage temperatures.

2. MATERIALS AND METHODS

2.1 Plant material and sample preparation

Two apple cultivars (*Granny Smith and Princesa*) and four peach cultivars (yellow pulp: *Early Grande, Flordaking, Hermosillo*; white pulp: *Tropic Snow*) were studied.

Apples and peaches were prepared as fresh-cut fruits. They were washed, peeled, cored, and cut in eight wedges. Then, fruit wedges were washed and drained. Half of apple samples were treated with an antioxidant solution (1% ascorbic acid and 1% citric acid) and drained. Both, treated (TQ) and untreated (STQ) fresh-cut apples were packaged in polyethylene terephtalate (PET) clamshell trays and stored at 2.5 ºC for 14 - 15 days. Fresh-cut peaches were also packed in PET clamshell trays and stored at 1.5, 5, 10 or 15 ºC, for 10 - 11 days.

2.2 Color determination

Color changes of fresh-cut apples and peaches were measured on two packages by sample and storage time. Surface color of 3-4 wedges from each replicate of each treatment was measured. Measurements were made at the middle point of the two cut surfaces of each fruit wedges.

Color (CIELAB and XYZ values) was measured using a Minolta spectrophotometer (Model CM-508d/8, Minolta, Tokyo, Japan), calibrated using the standard white tile. D65 / 10º was used as the illuminant / viewing geometry and specular component excluded (SCE).

Chroma value [$C^*_{ab} = (a^{*2} + b^{*2})^{0.5}$], hue angle ($h_{ab}$ = arctangent b* / a*), and total color difference [$\Delta E^*_{ab} = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{0.5}$], were also determined. ΔE^*_{ab} was calculated for each sample at each storage time with respect to its initial value (t = 0 day). Finally, the Browning Index (BR) was determined [BR = 100 (x-0.31) / 0.172; where x = X / (X+Y+Z)] (Matiacevich and Buera 2006).

2.3 Statistical analysis

Analysis of variance (ANOVA) was used to determine significant differences among sample color parameters in response to fruit variety, chemical treatment and storage time for fresh-cut apples, and in response to fruit variety, and storage time and temperature for fresh-cut peaches. Duncan´s multiple range tests were used to determine significant differences among treatment means. All statistical analyses were performed using Statgraphics plus 7.1.

3. RESULTS AND DISCUSSION

The decrease of L* values (darker), and increase of a* (redder), and BR values clearly represented browning development in fresh-cut apples. Browning development occurred in fresh-cut apple samples during refrigerated storage but it was significantly lower for samples treated with ascorbic and citric acid (Figures 1). Treated samples (TQ) showed higher L* and lower a* and BR values than non treated samples (STQ) for both apple cultivars.

The lowest changes in L*, a* and BR during storage were found for treated fresh-cut *Granny Smith* apples (Figure 1). After 14-15 days of refrigerated storage, ΔE^*_{ab} was about 3.5

and 8 for TQ and STQ Granny Smith fresh-cut apples, respectively, showing the efficacy of the chemical treatment used.

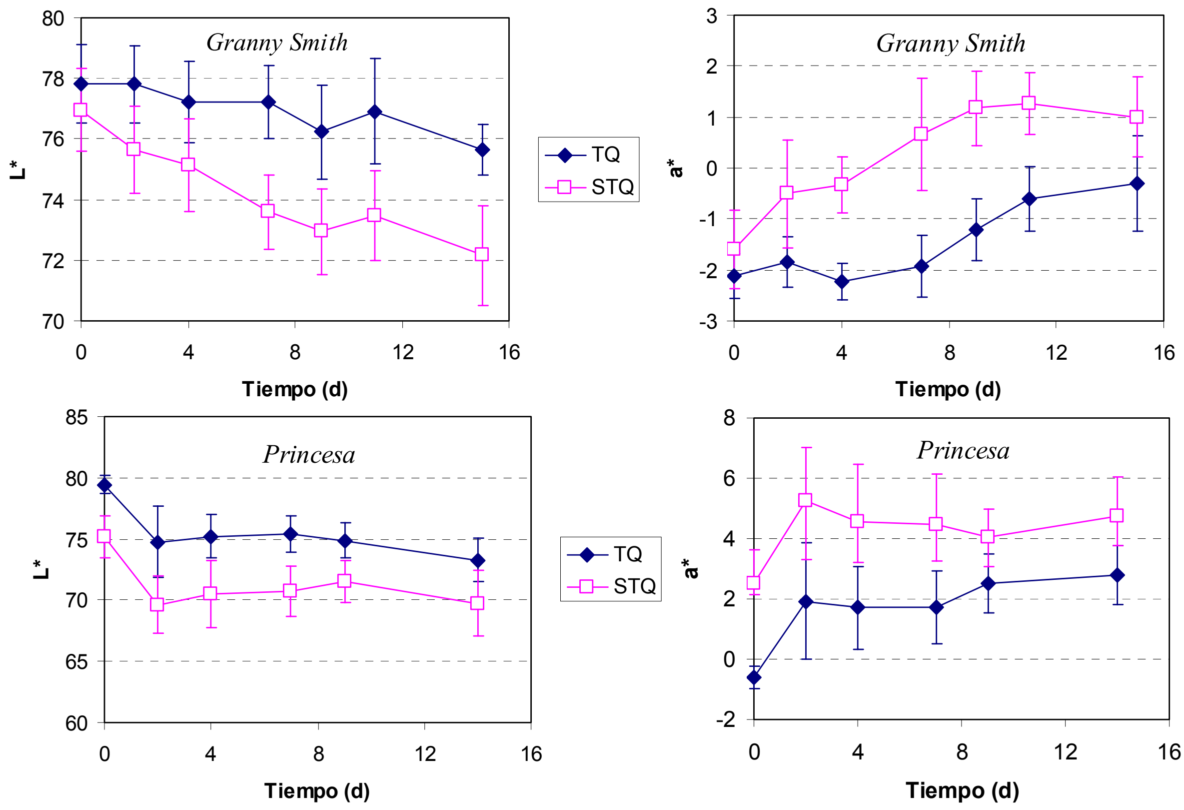

Figure 1. Color changes of fresh-cut Granny Smith and Princesa apples.

In the case of fresh-cut peaches, all color parameters changed significantly with cultivar and storage time and temperature in fresh-cut peaches. After 4 days of storage at 15 ºC, fresh-cut *Early Grande* peaches showed the greatest color changes (ΔE^*_{ab} = 32) followed by *Flordaking* and Hermosillo samples (ΔE^*_{ab} = 10) and finally by *Tropic Snow* samples (ΔE^*_{ab} = 5) (Figure 2). Total color differences were mainly due to L*, a* and b* decrease for Early Grande samples, but for the other yellow pulp cultivars (*Flordaking* and *Hermosillo*), color differences were found mainly in L* decrease and a* increase. For the white pulp cultivar, ΔE^*_{ab} were mainly due to a* increase. No color differences were found between samples stored at 1.5 and 5 ºC for all peach cultivars. However, L* and h_{ab} values of Early Grande, *Flordaking* and *Hermosillo* samples decreased with higher storage temperatures. Fresh-cut *Tropic Snow* peaches, the white pulp cultivar, showed an increase in a* values at the higher temperatures.

Finally, it was found that *Hermosillo* (yellow pulp cultivar) and *Tropic Snow* (white pulp cultivar) fresh-cut peaches stored at 1.5 or 5 ºC showed the lowest browning development, in agreement with Gorny et al. (1999). These authors found that selection of appropriate cultivars and proper storage temperature were one of the most important factors that determines shelf life of fresh-cut peach.

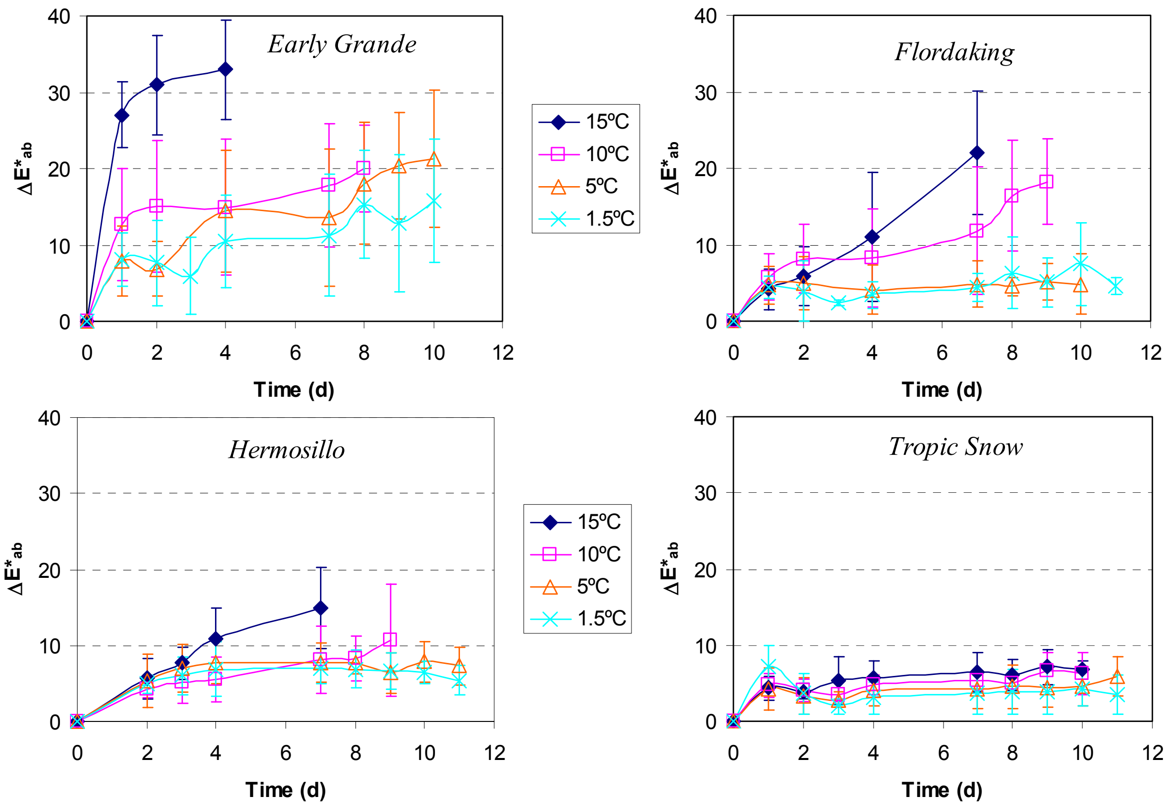

Figure 2. Color changes of four cultivars of fresh-cut peaches.

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Determination of kinetic parameters of color development in evaporated goat milk during heat treatment

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ABSTRACT

Color of evaporated and sterilized goat milk is of considerable commercial importance since it is one of the fundamental characteristics by which the consumer judges the product. The time-temperature relationship during sterilization is the most important factor affecting the color of evaporated milk. Therefore, the purpose of our work was to determine the kinetic parameters (rate constants and activation energy) of color development in evaporated goat milk during heat treatment. Evaporated goat milk samples were heat treated at three different temperatures (100 ºC, 112 ºC and 124 ºC) and for various lengths of time. At each testing time, color (CIELAB and XYZ values) was measured and chroma (C^*_{ab}), hue angle (h_{ab}), total color difference (ΔE^*_{ab}) and browning index (BR) were also calculated. During thermal treatment, milk became darker, redder and more yellow (L* decreased while the other color parameters increased). Changes in color parameters followed a (pseudo)-zero-order reaction model. The activation energy was between 92-109 kJ mol^{-1} for all color parameters and the Q_{10} values obtained were in the range of 2.1 - 2.5. The equations found in this work to model the color development during heat treatment of evaporated goat milk would help to determine the color of this product at appropriate sterilizing conditions.

1. INTRODUCTION

The consumption of goat milk would be an alternative choice for people with allergic reactions to cow milk. Its lactose content is about 10% lower than that of cow milk and the protein and lipid composition is also different. Furthermore, the evaporated and sterilized goat milk is a dairy product that may be utilized as a final product for the consumer, especially in those countries where the availability of fresh milk is difficult (Garrote et al. 2009).

The color of evaporated milk is of considerable commercial importance since it is one of the fundamental characteristics by which the consumer judges the product. (Pauletti et al. 1998) Heating milk at high temperatures promotes the development of brown color. The milk becomes darker as temperature and time increase and the effect is more noticeable for mixtures of concentrated milk and some sugars. Maillard and caramelization reactions are the main factor in color development and occur simultaneously, depending on type of sugars and reaction conditions (Buera et al. 1990). However, severe heating intensity, and extreme pH (T >120 ºC at pH <3 or > 9) are necessary to cause sugar caramelization. Because of that, color and brown compounds formed in milk and milk products are related mainly to the advanced stage of the Maillard reaction. Quantitative measurement of browning rate (brown compounds or color) may be considered an indicator of severity of heat treatment or for evaluating the efficiency of technological industrial processes (Morales and van Boekel 1999) The knowledge of kinetic parameters is necessary to control the extent of the reaction (Carabasa-Giribet and Ibarz-Ribas 2000). Thus, suitable indicators to follow non-enzymatic browning reactions must be defined.

Therefore, the purpose of our work was to determine the kinetic parameters (rate constants and activation energy) of color development in evaporated goat milk (25% total solid) during heat treatment.

2. MATERIALS AND METHODS

2.1 Sample preparation

Fresh milk from Anglo Nubian and Saanen-Anglonubian goats were used. A solution of 10% JOHA® KM2 stabilizing salt was added to fresh goat milk to reach a concentration of 0.03%. Then goat milk was thermally treated in a closed kettle at 90 ºC for 15 minutes for protein stabilisation. After cooling at 30 ºC, goat milk was vacuum evaporated at 50-60 ºC, 0.2 at up to 25% total solid content. Evaporated goat milk was cooled at 30 ºC, a solution of 10% JOHA® KM2 salt was added to reach a concentration of 0.15%, and stored at 4-5 ºC for 6-24h.

Samples of evaporated goat milk were distributed into glass tubes of 10.6 mm diameter, 30 mm length and 0.8 mm wall thickness sealed using a flame. Samples were then heat treated at three different temperatures (100 ºC, 112 ºC and 124 ºC) in a thermostatic oil bath. During heat treatment, samples were removed from the bath at five different times until a series of samples were obtained ranging in color from that of non-sterilized evaporated milk to a deep brown, and cooled in cold water (2 ºC).

2.2 Color determination

Colorimetric measurements of each sample were made using white plastic cells (40 mm diameter, 10 mm high). Color (CIELAB, and XYZ values) was measured using a Minolta spectrophotometer (Model CM-508d/8, Minolta, Tokyo, Japan), calibrated using the standard white tile. D65/10º was used as the illuminant / viewing geometry and specular component excluded (SCE). Chroma value ($C^*_{ab} = (a^{*2} + b^{*2})^{0.5}$), hue angle ($h_{ab}$ = arctangent b*/a*; h = 0º: red; 90º yellow; 180º: green; 270º: blue), and total color difference ($\Delta E^*_{ab} = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{0.5}$), were also determined. ΔE^*_{ab} was calculated for each sample at each heating time with respect to its initial value (t = 0 h). Finally, the Browning Index (BR) was determined (BR = 100 (x-0.31) / 0.172; where x = X / (X+Y+Z)) (Matiacevich and Buera 2006).

2.3 Mathematical modeling of color changes

The rate of color parameter changes can be described by the following general equation:

$$\pm dQ/dt = k_q [Q]^n \qquad (1)$$

where: Q = color parameter; t = time; n = reaction order; k_q = change rate constant for the color parameter Q. The sign (+) refers to attributes with increasing values during time (a*, b*, C^*_{ab}, BR, ΔE^*_{ab}) and the sign (-) to attributes with decreasing values (L*, h_{ab}).

Traditionally, quality change processes of foods are described with zero order and/or first order rate functions (Saguy and Karel 1980, Taoukis et al. 1997). The regression analysis is used to determine the kinetic order of the quality change rate. An analysis of the coefficient of determination (R^2), residuals (e_i, defined as the difference between observed and fitted data points) and estimated value of the intercept would enable determination of the reaction order. Then, the effect of temperature on quality attribute changes is modelled.

The influence of a constant storage temperature on the reaction rate constant can be described using the Arrhenius equation (Saguy and Karel 1980, Taoukis et al. 1997):

$$k_{q(T)} = k_0 \exp [-Ea / RT] \quad (2)$$

where: $k_{q(T)}$ = rate constant for each color parameter; k_0 = pre-exponential factor; Ea = activation energy, [J mol^{-1}]; R = universal gas constant, [8.3145 J K^{-1} mol^{-1}]; T = absolute temperature, [K]. The Ea for each color parameter is obtained by regression analysis.

Another parameter that is often used to describe the relationship between temperature and reaction rate constant is the Q_{10} value. Q_{10} is defined as follows:

$$Q_{10} = \text{reaction rate at temperature } (T+10)/\text{reaction rate at temperature } (T) \quad (3)$$

It can be shown that Q_{10} and activation energy, Ea, are related by the following expression (Singh and Heldman 1993):

$$\ln Q_{10} = (Ea/R) [10/(T (T+10))] \quad (4)$$

2.4 Statistical analysis

All data were analysed using STATGRAPHICS Plus 7.1. The data were fitted to the corresponding models and the regression analyses were carried out.

3. RESULTS AND DISCUSSION

During thermal treatment at 100 ºC, 112 ºC and 124 ºC, milk became darker, redder and more yellow (L* decreased while the other color parameters increased) as can be seeing in Figure 1.

Table 1. Activation energy and Q10 values for color parameters of evaporated goat milk.

Color parameter	**Ea** (kJ/mol)	**Q10**
L*	108,3	2,37
a*	102,8	2,27
b*	92,3	2,09
C^*_{ab}	93,1	2,10
h_{ab}	107,8	2,37
BR	98,8	2,20
ΔE^*_{ab}	102,7	2,27

Changes in color parameters followed a (pseudo)-zero-order reaction model. The temperature dependence for color development (activation energy estimated via the Arrhenius equation) was between 92 - 109 kJ mol^{-1} for all color parameters. These values were similar to those found for other concentrated milk systems. The Q_{10} values obtained (relationship between rate constant at temperature T and T+10º) were in the range of 2.1 - 2.5 (Table 1).

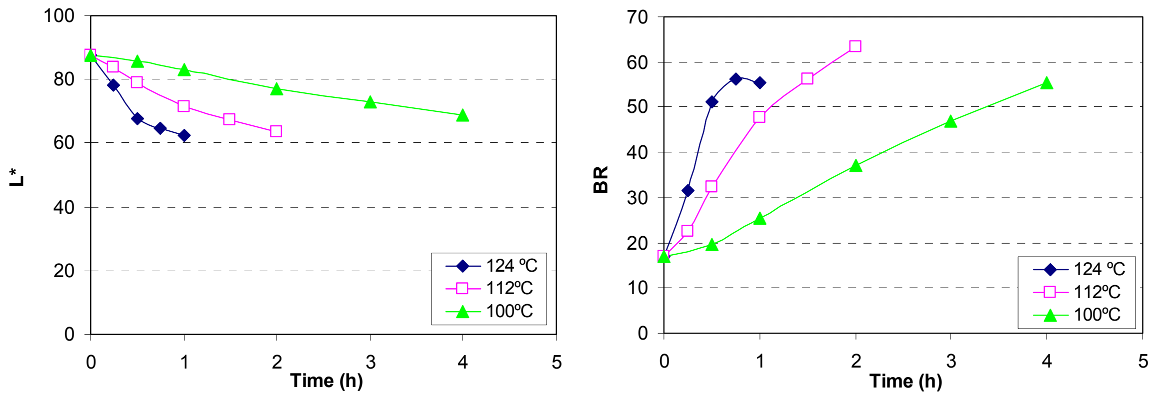

Figure 1. Changes in L and BR values of evaporated goat milk during heat treatment.*

Currently, experiments to determine optimal time and temperature conditions for sterilizing evaporated goat milk are being conducting at retort temperatures in the range of 117 - 123 ºC and times to reach a sterilizing value (F_R) of 5 min. Therefore, the equations found in this work to model the color development during heat treatment of evaporated goat milk would help to determine the color of this product at appropriate sterilizing conditions.

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Evaluation of color changes of maize corn spaghetti made by extrusion-cooking

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ABSTRACT

The objective of this work was to evaluate the color of maize corn spaghetti made from two types of corn (red hard and yellow dent) and under different extrusion-cooking conditions (extrusion temperature and flour moisture). The color of spaghetti samples (CIELAB values) was measured, and Chroma (C^*_{ab}) and hue angle (h_{ab}) were calculated. Total color difference (ΔE^*_{ab}) were determined between each spaghetti sample and its corresponding flour. Results showed that type of corn and extrusion-cooking conditions affected spaghetti color. Spaghettis from hard red corn were darker (lower L*) and redder (higher a*) than those from yellow dent corn. Extrusion temperature affected significantly all color parameters and flour moisture only affected a* and h_{ab} values for red hard corn spaghetti. For yellow dent corn spaghetti, extrusion-cooking temperature modified L*, b*, C^*_{ab} and ΔE^*_{ab} values, but flour moisture did not affected color parameters. L* decreased and b* and C^*_{ab} increased (darker and more yellow) with the increase in extrusion temperature. It was found that good quality spaghettis could be obtained using a single screw cooking extruder, and taking into account the color of pasta, it could be suggested the use of yellow dent corn flour as raw material.

1. INTRODUCTION

Wheat pasta is consumed in large quantities throughout the world. However, there are people intolerant to prolamins of wheat, rye and barley. This serious syndrome, characterized by intestinal malabsorption, is called celiac disease that may lead to severe malnutrition. Many researchers have investigated the possibilities of substituting other starches for wheat flour (Kasarda 2001).

Although rice pasta is commercially available in the argentine market, no corn pasta has been found. Moreover, gluten free pasta is made by forming cooked dough (from rice or corn) in a traditional pasta extruder and then dried (Waniska et al. 1999). The use of cooking extrusion to combine both cooking and forming process is an alternative to produce this type of product and particularly, corn flour can be a good raw material, because its natural color could favor consumer acceptance of corn pasta.

Therefore, the objective of this work was to evaluate the color of corn spaghettis obtained by cooking extrusion as affected by type of corn (red hard and yellow dent) and extrusion-cooking conditions (extrusion temperature and flour moisture).

2. MATERIALS AND METHODS

2.1. Corn flour preparation

Two type of corn were used: red hard and yellow dent. The grains were converted in flour using a previously developed methodology, selecting the fractions between 141 and 420 μm (Robutti et al. 2002).

2.2 Corn spaghetti preparation and experimental design

Corn spaghettis were obtained by cooking extrusion, using two types of corn (red hard and yellow dent) and a two factors three levels (temperature and moisture) experimental design. Spaghetti were made from each maize corn flour pre-wetted to the corresponding humidity level (27, 31 or 35%) and extruded at three temperature levels (80, 90 or 100 ºC) with a Brabender extrusor 10DN, with a die of 3 holes, having 1.5 mm each and at 100 rpm screw rate. Spaghettis were dried at low rate oven with humidity control.

2.3 Color determination

The color (CIELAB values) of each spaghetti sample was measured with a Minolta spectrophotometer (Model CM-508d/8, Minolta, Tokyo, Japan), calibrated using the standard white tile. D65 / 10º was used as the illuminant /viewing geometry and specular component excluded (SCE).

Chroma value [$C^*_{ab} = (a^{*2} + b^{*2})^{0.5}$], hue angle ($h_{ab}$ = arctangent b^* / a^*), and total color difference [$\Delta E^*_{ab} = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{0.5}$], were also determined. ΔE^*_{ab} was calculated for each corn sample at each extrusion-cooking condition with respect to its corresponding flour.

2.4 Statistical analysis

Analysis of variance (ANOVA) was used to determine significant differences among sample color parameters in response to type of corn, moisture level and extrusion temperature. Regressions analyses were also made. All statistical analyses were performed using Statgraphics plus 7.1.

3. RESULTS AND DISCUSSION

Results showed that type of corn and extrusion-cooking conditions (moisture and temperature) affected spaghetti color. Spaghettis from hard red corn were darker (lower L*) and redder (higher a*) than those from yellow dent corn. Extrusion temperature affected significantly all color parameters and flour moisture only affected a* and h_{ab} values for red hard corn spaghetti. Spaghettis with both good cooking characteristics and resistance to overcooking could be obtained at 27% flour moisture for the three temperature levels used. At lower moisture levels (27%), color changes were greater: L* and h_{ab} decreased (darker and redder), and C^*_{ab} increased as temperature increased (Figure 1).

For yellow dent corn spaghetti, extrusion-cooking temperature only modified L*, b*, C* and ΔE* values, but flour moisture did not affected color parameters. L* decreased and b* and C* increased (darker and more yellow) with the increase in temperature extrusion (Figure 2).

We conclude that good quality spaghettis can be obtained using a single screw cooking extruder, and taking into account that color of pasta is an important quality attribute, it is suggested the use of flour from yellow dent corn as raw material.

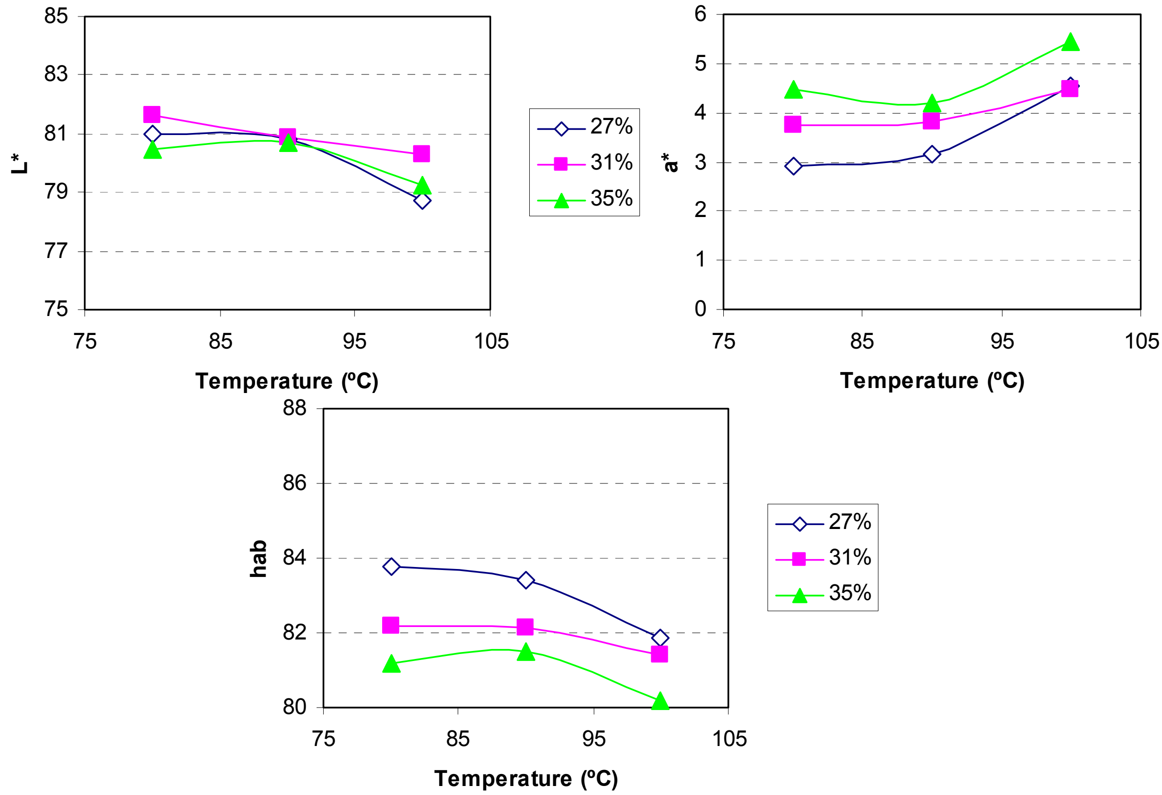

Figure 1. Color of red hard corn spaghetti at different flour moisture levels and extrusion temperatures.

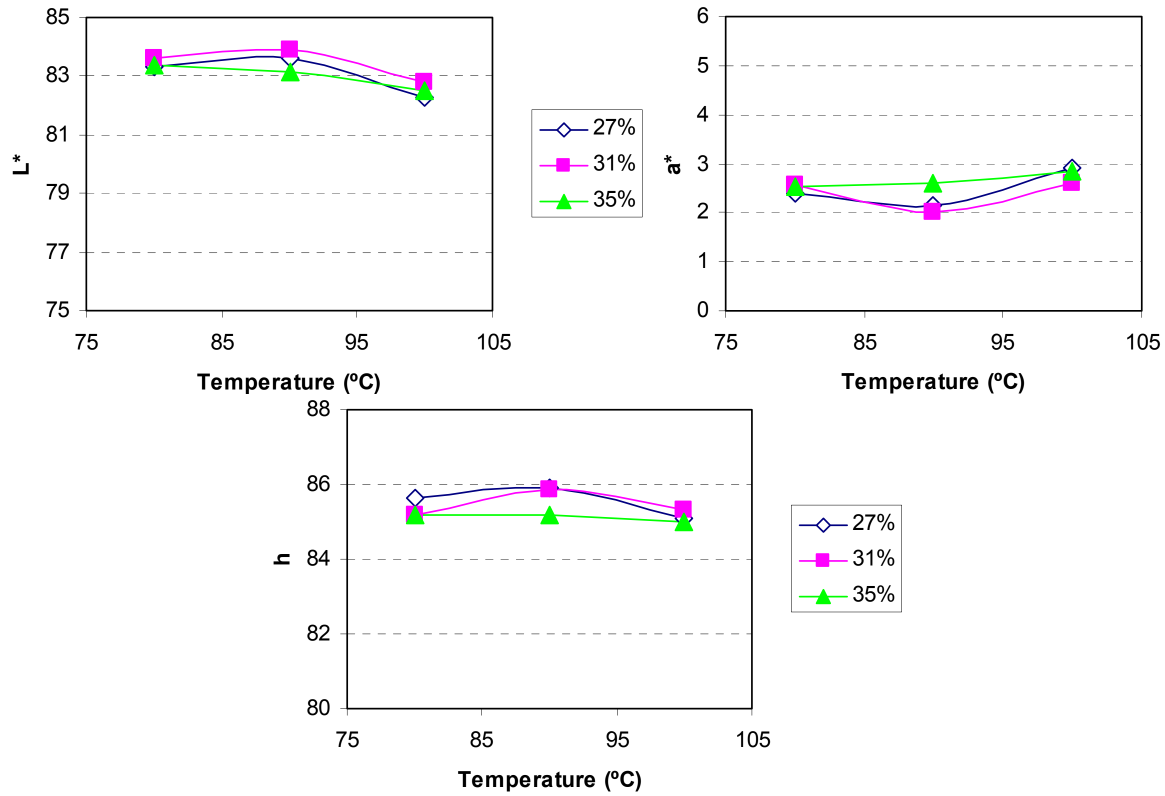

Figure 2. Color of yellow dent corn spaghetti at different flour moisture levels.

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Influence of different backgrounds on the instrumental colour specification of orange juices

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1. INTRODUCTION

Colour is an attribute directly related to the consumer preferences. Thus, for instance, in the United States, the colour of citrus juices is considered for their commercial classification in relation to its quality.

The colour measurement can be approached from two perspectives: objective methods based on instrumental measurements and methods based on subjective sensory analysis. The instrumental colour measurements have the advantage that they are fast and non-destructive. As result of these assessments colour is expressed by means of the colour coordinates. It is very important to define the correct conditions of the colour measurements, not only the standard observer and illuminant established by the CIE, but also other factors that can influence this measurement like the background and the surrounding area. In relation to this, the objectives of this study were to evaluate the effect of these two factors and that of the pulp on the colour specifications of orange juice.

2. MATERIALS AND METHODS

Samples

Four orange juices (OJ) bought in local supermarkets were diluted with their own serum (obtained upon centrifugation) to give 5 levels of pulp concentration (100%, 75%, 50%, 25% and 0%). The total number of samples analyzed was therefore 20.

Analytical procedures

Total pulp content. The total pulp content, by volume of the OJ, was determined by centrifugal method. The results are shown in Table 1.

Table 1. Pulp content in OJ samples (mL pulp/ 100 mL juice).

% Pulp	100	75	50	25
OJ 1	16.0	11.5	8.0	4.0
OJ 2	9.5	7.0	5.0	2.5
OJ 3	9.0	6.5	4.5	2.5
OJ 4	7.5	5.0	3.0	1.5

Colour measurement. The reflectance measurements were taken by means of a CAS 140 B spectroradiometer (Instrument Systems, Germany) fitted with a Top 100 telescope optical probe, a Tamron zoom mod. SP 23A (Tamron USA, Inc., Commack, NY), and an external incandescent lamp as source of illumination. Blank measurements were made with distilled water against a white background. A plastic cuvette (475 x 350 x 10 mm) was used for the measurements.

To study the influence of the surrounding and the background on the colour measurements three backgrounds and surroundings (white, grey and black) were selected. Figure 1 shows the nine combinations used.

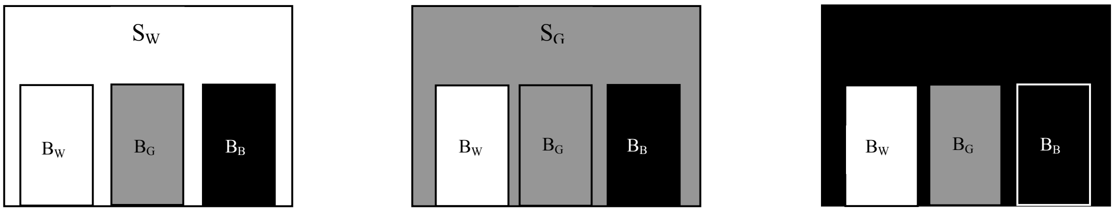


Figure 1. Combinations of backgrounds and surroundings.

Colour differences (Melgosa el al. 1997), were calculated as the Euclidean distance between two points in the three-dimensional space defined by L*, a* and b* according to the following formula:

$$\Delta E^*_{ab} = \sqrt{\Delta^2 L^* + \Delta^2 a^* + \Delta^2 b^*}$$

3. RESULTS AND DISCUSSION

Influence of the surroundings on the colour measurements

The influence of the surroundings on the colour measurements was evaluated by comparing the colour differences for white/black (S_W/S_B), white/grey (S_W/S_G) and black/grey (S_B/S_G) surroundings in the different OJs samples. The results are shown in Table 2.

Table 2. Means and standard deviations of colour differences between surroundings with a white, grey and black background for the OJs.

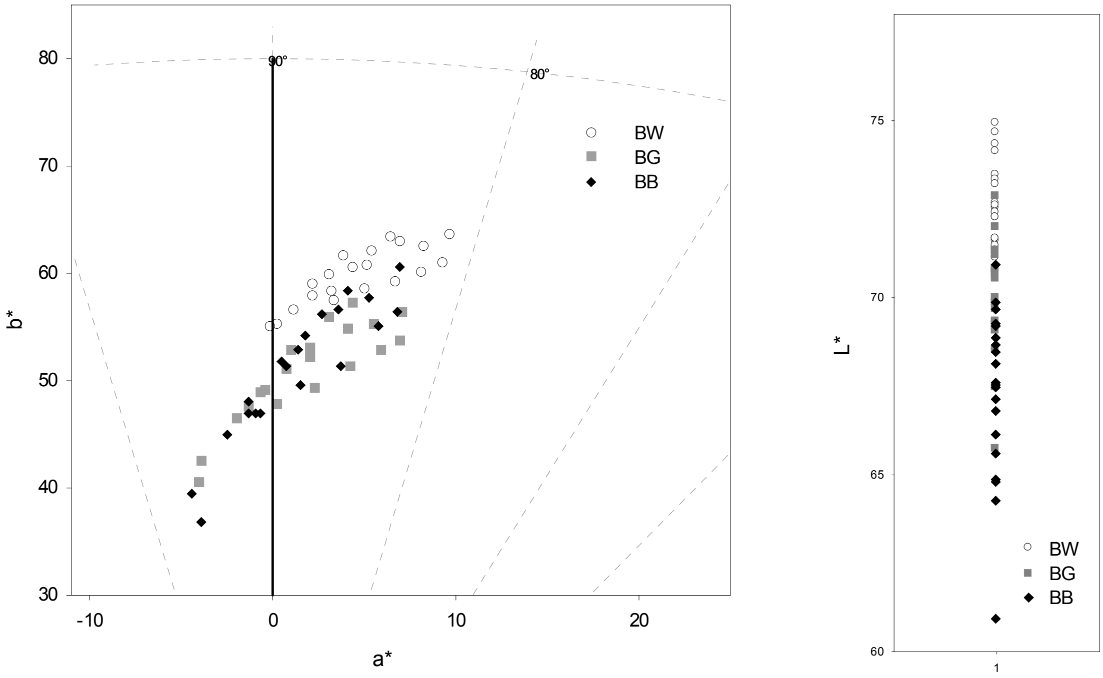
	0%			25%			50%		
	S_W/S_G	S_G/S_B	S_W/S_B	S_W/S_G	S_G/S_B	S_W/S_B	S_W/S_G	S_G/S_B	S_W/S_B
B_W	9.49±1.31	3.07±0.50	12.09±1.06	9.10±0.86	3.33±0.96	12.11±1.20	8.52±0.76	3.62±0.88	11.62±1.34
B_G	7.76±1.91	5.22±0.81	11.56±1.19	8.53±1.68	5.43±0.89	11.44±1.19	8.64±1.52	4.75±1.24	10.84±1.36
B_B	8.39±1.91	3.94±0.86	12.10±2.04	8.10±1.28	3.93±0.78	11.66±1.45	7.69±0.80	3.97±1.28	10.22±0.58

	75%			100%		
	S_W/S_G	S_G/S_B	S_W/S_B	S_W/S_G	S_G/S_B	S_W/S_B
B_W	8.32±0.69	3.04±1.51	11.02±1.51	7.93±0.84	2.75±0.88	10.39±1.11
B_G	8.58±1.20	4.28±0.83	10.26±1.16	8.51±1.83	3.99±1.45	9.89±0.77
B_B	7.18±1.39	3.27±1.15	10.00 ±1.17	6.66±1.42	3.19±1.27	9.40±1.08

The highest colour differences (ΔE^*_{ab}) were observer for the pair S_W/S_B, followed by S_W/S_G. In both cases ΔE^*_{ab} was higher than the visual discrimination threshold ($\Delta E^*_{ab} > 3$ CIELAB units) (Melgosa el al. 2001). The lowest colour differences were obtained when comparing the surroundings S_B/S_G. According to these results and considering the CIE recommendations (CIE 2004), the grey surrounding was selected for the following measurements. It was also observed that, in general, the colour differences decreased as the pulp content increased.

Influence of the background of the colour measurements

To evaluate the effect of the background three possibilities were considered: white background (B_W), grey background (B_G) and black background (B_B). Figure 2 (a) shows the location of the samples in the a* b* plane as function of the background used. Two groups could be somewhat distinguished: one group including the samples measure with grey background (B_G) and black background (B_B) and another corresponding to the samples measure in white background (B_W). Figure 2 (b) shows that the lowest values of L* were obtained when the black background (B_B) was used while the highest values of L* corresponded to the samples measure with white background (B_W).



(a) (b)

*Figure 2. Location of the samples in the diagram a*b*, and L* values.*

As expected the lowest colour differences were obtained when comparing the pair B_B/B_G. Considering this pair the differences ranged from 2 to 5 CIELAB units, while the highest differences (ranging from 6 to 18 CIELAB units) were obtained when comparing the pair B_W/B_B. In all cases ΔE^*_{ab} appeared to have an inverse relationship with the pulp content, that is, the higher pulp content the lower effect of background on the colour measurements (Figure 3).

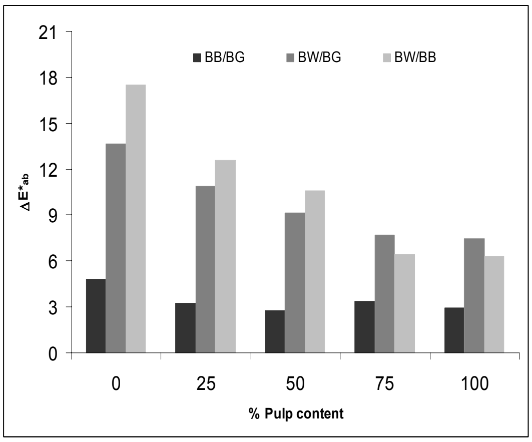


Figure 3. Colour differences between the Ojs.

Figure 4 shows that the background has a clear influence on the lightness L*. It can observed that the lower the % of pulp the higher the values of L* when using the white background, although the inverse trend was observed with the other two backgrounds. As for C^*_{ab}, its values increased as the pulp content did. The contrary was observed for the hue.

Influence of the pulp content on the colour measurements

Considering the backgrounds individually, it was observed that, the worst colour discrimination between samples with different pulp contents was achieved using B_W, since ΔE^*_{ab} were lower than the visual discrimination threshold. By contrast the best discrimination was obtained when the B_B was used ($\Delta E^*_{ab} > 3$) (Figure 5). These data are in agreement with a previous study (Melendez-Martinez et al. 2005) which concluded that the use of black background led to a better arrangement of orange juice solutions as a function of their colour intensity.

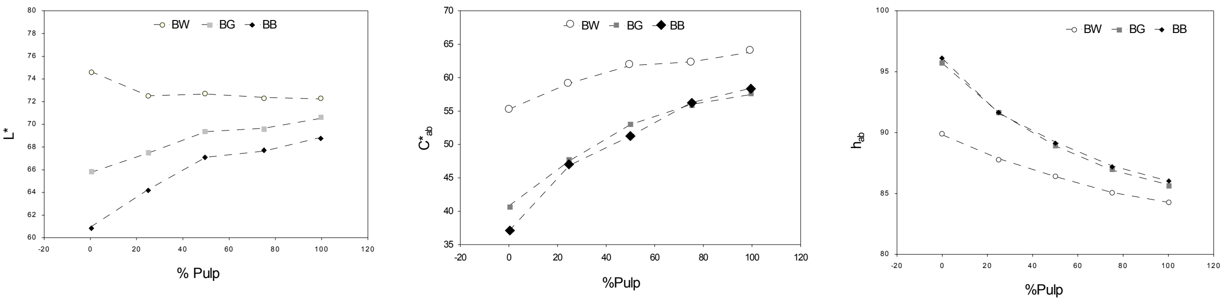


Figure 4. Representation of L, C^*_{ab} and h_{ab} vs % pulp as a function of the backgrounds (sample 2).*

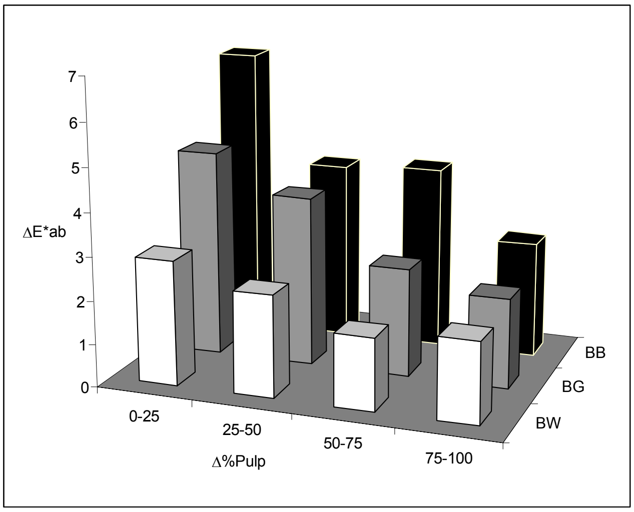


Figure 5.Colour differences between the Ojs.

ACKNOWLEDGEMENTS

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Colour determination in multilayer mini-cakes

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ABSTRACT

Multilayer mini-cakes consist of two sponge cake layers, with a caramel milk spread filling (dulce de leche), covered with chocolate. Colour is very important as it is the first sensory attribute to be perceived by the consumer. When opening the packaging, the first impression is offered by the coating of the confection. This study aimed at determining whether colours of different layers look like the original components or whether there is blending of one product with the other. Results in L∗ parameter measured in chocolate coating showed 38.01[a] and 44.74[b] as results. The a∗ and b∗ parameters values were 9.60[a], 9.80[a], and 4.20[a], 6.10[b] respectively. Results of L∗ parameter measured in caramel milk spread filling were 36.02[a] and 39.56[b]. The a∗ and b∗ parameter values were 11.98[a] and 13.84[a], 11.98[a] and 12.38[a], respectively. Sponge cake L∗ parameter measurements were 67.97[a] and 69.02[a]. The a∗ and b∗ parameter values were 1.88[a] and 8.90[b], 26.99[a] and 29.91[b], respectively. No significant differences were observed when the macroscopic visual analysis was performed by the research team. This may be due to the fact that the red and green parameters, components of brown (a∗ parameter), do not show significant differences either in chocolate coating or caramel milk spread. Sponge cake layers showed high values of the yellowness b∗ parameter.

1. INTRODUCTION

A mini-cake is a kind of confection that is quickly growing in popularity in the confectionery market nowadays. Celiacs constitute a population sector with specific food needs. A wheat flour product available in the market was analyzed in order to determine its suitability to develop minicakes for celiacs. The aforementioned product consists of a top and a bottom sponge cake layers, with a caramel milk spread filling in between covered with a chocolate coating. Colour is very important as it is the first sensory attribute to be perceived by the consumer (Anzaldúa-Morales 1994, Carpenter et al. 2002) when opening the packaging. After being cut into halves, the minicakes display a whole picture of the three components. Colours shown are brown (coating and caramel milk spread) and yellow (sponge cake top and bottom layers). Different layers of a food product may not display clear colour boundaries as products are likely to mix. The objective of this study was to determine if colours of the different layers remain similar to the original colour of the component or if blending of one product into the other occurs causing colour changes.

2. MATERIALS AND METHODS

Ten samples of two different lots of commercial mini cakes (Pic-Nic, manufactured by Nevares) were analysed. A CR300 Minolta colorimeter with standard illuminant D_{65} and 2º observer angle was utilized. L∗ (lightness) parameter, a∗ (red-green components) and b∗

(yellow-blue components) were measured in the CIELAB space (Lozano 1978, Jiménez et al. 2001). In order to determine colour differences between samples, $\Delta E*$ value was calculated using the following formula: $\Delta E* = (\Delta L*^2 + \Delta a*^2 + \Delta\ b*^2)^{0.5}$. Statgraphics plus 5.1 software was used for the statistical analysis. A simple ANOVA test was performed. Significant minimum differences were determined using Tukey test with 95% confidence.

Figure 1. Left, half mini-cake shows the three constitutive layers: chocolate coating, top and bottom sponge cake layers and caramel milk spread filling. Right, a whole minicake.

3. RESULTS AND DISCUSSIONS

Results are shown in Table 1. L∗ parameter measurements in the chocolate coating were 38.01^{a} and 44.74^{b}. The a∗ and b∗ parameters values were 9.60^{a} and 9.80^{a}, 4.20^{a} and 6.10^{b} respectively. Results of L∗ parameter measured in the caramel milk spread filling were 36.02^{a} and 39.56^{b}. The a∗ and b∗ parameter values were 11.98^{a} and 13.84^{a}, 11.98^{a} and 12.38^{a}, respectively. Sponge cake L∗ parameter measurements were 67.97^{a} and 69.02^{a}. The a∗ and b∗ parameter values were 1.88^{a} and 8.90^{b}, 26.99^{a} and 29.91^{b}, respectively. No significant differences were observed when visual analysis was performed at macroscopic level by the research team. This may be attributed to the fact that red and green parameters, components of colour brown (a∗ parameter) do not show significant differences either in chocolate coating or caramel milk spread. Sponge cake layers showed high values of yellowness, b∗ parameter.

The L∗ values for chocolate coating reported in this study are higher than those informed by Popov-Raljić et al. (2009): 30.5 - 36.5 and fall within the 35.1 - 45.1 range reported by Kumara et al. (2003). Total colour differences reported in this study (6.99) are not significant when compared to results obtained by the aforementioned authors when chocolates with different compositions were analysed. Therefore, our results indicate that differences among lots of the same brand are not significant. In addition, no influence of the sponge cake layer on the caramel milk spread colour was detected, despite the fact that they were in close contact.

Castañeda et al. (2004) reported colour values as being in the 26.36 - 41.31 range for L∗; in the 14.72 - 17.09 range for a∗ and in the 26.37 - 31.49 range for b∗ during measurements performed on 8 Argentine caramel milk spread commercial brands. Consequently, L∗ values obtained in this work fall within the range reported by previous studies. However, a∗ and b∗

values are much lower; this may indicate that there was some blending with the sponge cake layer that displays significantly lower a∗ and b∗ values. As for total colour difference between samples 1 and 2, the resulting value was 4.02, which is not significant. This fact indicates that there are similarities between the analysed lots.

A study carried out on different varieties of layer and sponge cakes manufactured with wheat flour only, by Gómez et al. (2008) showed the following values for the latter: 74.51; 0.22 and 22.92 for L∗, a∗ and b∗ respectively. Another study performed by Gómez et al. (2010) on sponge cakes manufactured using also wheat flour showed 72.4, 4.2 and 21.9 values for L*, a*, and b* respectively.

L∗ values in the sponge cake layer reported in this study are slightly lower (67.97 and 69.02), while a∗ and b∗ values are higher, 1.88 and 8.90, 26.99 and 29.91 respectively. This suggests that there may have been blending with the caramel milk spread that has L∗ lower values and a∗ and b∗ higher values than the sponge cake. Again, total colour difference is not significant, indicating that there are similarities between the lots.

Table 1. L, a*, b*parameters and Δe∗ of the mini-cake different layers.*

LAYER	SAMPLE Nº	L∗	a∗	b∗	ΔE∗
Chocolate coating	1	38.01[a]	9.60[a]	4.20[a]	6.99
	2	44.74[b]	9.80[a]	6.10[a]	
Caramel milk spread	1	36.02[a]	11.98[a]	11.98[a]	4.02
	2	39.56[b]	13.84[a]	12.38[a]	
Sponge cake	1	67.97[a]	1.88[a]	26.99[a]	7.67
	2	69.02[a]	8.90[a]	29.91[b]	

Values in the same column with different letter are significantly different ($p < 0.05$).

4. CONCLUSIONS

The a∗ parameter values of both chocolate coating and caramel milk spread showed the natural colour when analysed in isolation, as they rendered brown hues since this parameter has red and green in its composition. Sponge cake layers showed positive b∗ values, in line with the expected yellow colour in this type of preparations. As a consequence, b∗ parameter in both chocolate coating and caramel milk spread, and a∗ parameter in sponge cake did not affect visual perception.

When results were compared to data available in the relevant bibliography, some differences were found. These differences may be due to the blending among layers of the product during industrial manufacturing process or when the confection is cut to be consumed.

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Food colorants: Use in the dyeing of textiles

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ABSTRACT

Concern for the environment and the use of renewable resources and clean technologies in production has increased in recent years, interest in natural materials and in forms of production more sustainable and socially just.

The rescue of craft techniques and production community bodies, registered in the cultural tradition of different regions of the world, was also a response to the negative consequences of globalization on regional economies in developing countries. Within this context, there is a revival of interest in natural dyes for use in cosmetics, food and textile dyeing.

In Argentina, in the field of textiles and clothing design, craft dyeing with natural dyes has been gaining ground, both among designers and between a still small market of users interested in eco design. This circumstance allows incorporate the work of communities where the traditional craftsmanship has not disappeared and the value of these ideas as identity element. Beyond this perspective, the marketing of textiles often involves the need to reproduce the color within certain acceptable ranges for the consumer. This is more difficult to achieve with natural dyeing, that does not have the same controls as the industry.

Although the accuracy requirements on the reproducibility are not as strict in the consumer market in question, we thought it would be interesting the possibility that these standards can be adjusted to some extent.

Given that historically natural dyes have been used for both food and fabric coloring and food industry currently used natural products under control standards that ensure a greater similarity between a game and another, we have begun to explore the use of these products in the dyeing of textile fibers, to see if they can contribute to an improvement in color reproducibility.

1. PROJECT

Given this scenario, within the framework of the internship program of the UBACyTA009 Project "New Contributions to the Interdisciplinary Studies on Color Concerning Architecture and Designs: Color in Dwelling Practices" (director: J. Caivano, co-director: M. López), the following actions have taken place from July 2009 to date:

- a bibliographical survey of natural colorants,
- the production of top, yarn, and wool felt samplers using different types of natural and synthetic colorants as well as the consequent development of dye recipes,
- the implementation of a proper dyeing system for non-industrial installations and which should allow color reproducibility,
- the possibility of using natural colorants in industrial processes as an ecological improvement factor,
- opinion polls among consumers regarding their preferences in connection with the use of natural colorants and among traders with the purpose of discovering market opportunities.

These tasks were carried out with the students of the Textile Design Chair lectured by Nirino (FADU - UBA) and with the students of the last year of Textile Engineering Degree Course (UTN - FRBA).

Their main objective is:

- to introduce design students in the study of natural colorants,
- to acquire knowledge that may contribute to improving their use as added value in design and/or craftsmanship productions.

Wool has been selected as the raw material for the application of all the developments, given the country's production conditions and the need to add value to the wool chain, since the vast majority of production is exported without undergoing any process whatsoever. Regarding this need, an agreement was signed between the Alternative Productions Chair of the School of Agronomy, UBA (www.agro.uba.ar/agro/centros/cpa) and the Sheep Volunteering Program of the School of Veterinary Studies, UBA (www.voluntariadoovino.com.ar). In this presentation we will just explain the practices performed regarding the use of colorants for food applied to wool dyeing.

2. BACKROUND STATEMENT

The marketing of textiles often involves the need to reproduce the color within certain acceptable ranges for the consumer. Even in the use of natural colorants on industrial scale, color reproducibility is a complex requirement. This is even harder to achieve with natural dyeing, because it does not respond to the typical controls of industrial production, a difficulty which has been confirmed when making the first samplers by using vegetable dyes.

Although the accuracy requirements on the reproducibility are not as strict in the consumer market in question, we thought it would be interesting the possibility that these standards can be adjusted to some extent. Given that food industry currently used natural products under control standards that ensure a greater similarity between a game and another, we have begun to explore the use of these products in the dyeing of textile fibers, to see if they can contribute to an improvement in color reproducibility.

3. METHODOLOGY

Three natural colorants in liquid form used for food were selected: red (Coccus Cacti), blue (indigo), yellow (turmeric), produced by the Argentine company Laqi S.A. This choice was due to the fact that the company has ISO 9001:2000 Quality Standards, in addition to Kosher and Halal certifications.

The dyed samples are of clean top fleece, of 5gr each. Samples have been made for a five-value scale of each pure value (primary) and samples for a five-value scale of their mixings (secondary): 30 samples in all.

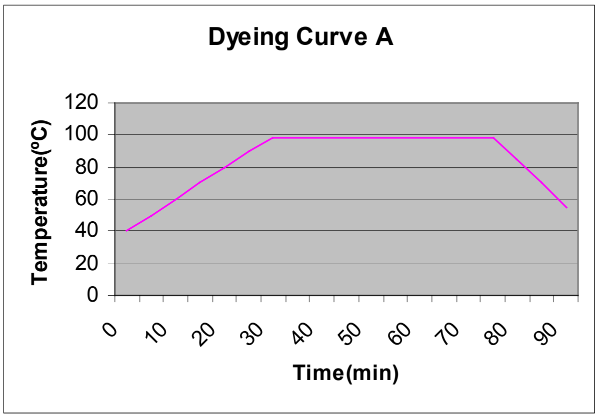
3.1 Dyeing process

A double process was carried out:

A. with industrial products

Performed in the laboratory of the Regional University of Buenos Aires, School of Textile Engineering, by the textile engineering student Pablo Damiano (Table 1).

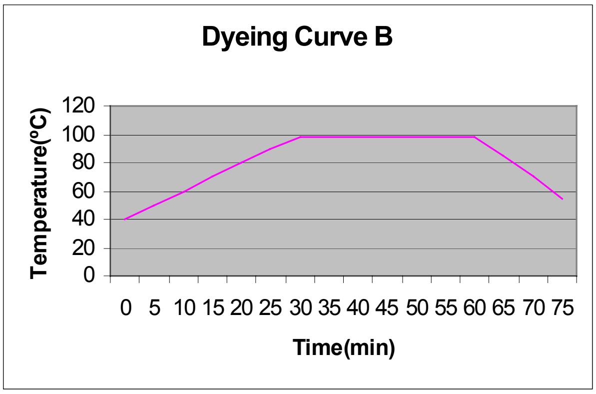
Table 1.



Details
- *Bath ratio 1:40*
- *Distilled water, 200 ml*
- *ph 3.5 to 4.5*
- *Glacial Acetic Acid to97% ,0.7 ml1*
- *dye leveling agent for wool, 2 ml*
  Blue: 10 ml ,Red: 5 ml ,Yellow: 10 ml
- *Gradient 2º / min.*
- *Wash at 60º,10', rinse and dry*

B. with affordable products for traditional dyeing
Performed at home by the interns Soledad Vitullo, Lucía Jamardo, and Josefina Alvarez Gardiol (Table 2).

Table 2.



Green, 3 color value
Details
- *Bath ratio 1:100*
- *Bath 500 ml :running water, 250 ml and vinegar, 250 ml.*
- *Gradient 2º / min.*
- *Colorant : 1 ml blue dye, 1.5 ml yellow dye*
- *Wash at 60º,10', rinse and dry*

3.2 Color reproduction

For the purpose of comparing the degree of similarity of the shade obtained., the dyeing process of the samples corresponding to the third value of the colors carmine, blue, yellow, violet, orange, and green was repeated, respecting the same conditions.

3.3. Fastness to light

Process B wool samples were taken in carmine, blue, and yellow. Half of each sample was covered by black cardboard and the other half was left uncovered. The three samples were exposed to the sun during two whole days (the samples received direct sunlight during approximately 12 hours).

3.4. Fastness to water

Process B carmine, blue, and yellow samples were immersed in room temperature water in a 200 ml container during 24 hours, after which they were removed, rinsed, and left to dry.

4. RESULTS

Process A: is still in the process of being performed since a few difficulties in the gas supply of the laboratory delayed the work. A first counter sample of the color blue in the highest value of saturation seems to have at sight a satisfactory result regarding the level of color reproducibility, which shall be corroborated by measuring it with a spectrophotometer.

Process B: the comparison between the shades obtained in the samples and the counter samples is in the process of being verified by means of measurement with a spectrophotometer at the Textile Research Center (INTI).

Meanwhile, we could observe:

For colour reproduction, at sight the same colors were obtained for the orange and violet samples. In the case of color blue, carmine, yellow, and green, the differences when reproducing color are greater.

For fastness to light at sight no color alterations in the samples as a result of the exposure to direct sunlight and to the elements are observed.

For fastness to water, the water where the samples were immersed is slightly colored; in spite of this, when left to dry, apparently no alterations in color are observed.

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Studies on dyeing by “Kikurage” mushroom (*Auricularia auricula* (Hook.) Underw.) – Research for optimum extracting condition

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ABSTRACT

A kind of mushroom, *Auricularia auricula* (Hook.) Underw. (Jew’s Ear), is used as a dye in this study. Authors tried the dyeing by it changing the extracting and dyeing condition. In the acid extracting condition, reddish dye was obtained, and this dyed acetate, vinylon, and especially wool, silk, and nylon fiber to red. The dye from Jew’s Ear is suitable for the ionic fibers.

1. INTRODUCTION

Auricularia auricula (Hook.) Underw. (syn. *Auricularia auricula-judae*, *Auricularia auricula*, *Hirneola auricula-judae*) is a fungus, commonly known as Jew’s Ear or Judas’s ear fungus. In Japanese, it is called “Kikurage” (lit. “tree-jellyfish”), and is known as a black or brown color mushroom (Figure 1). This species is used often in Asian cooking, especially for Chinese foods, and is also known as a medicinal mushroom. It is familiar to Asian people and they can buy it easily in common supermarkets. The foods application for the dyes is superior from the viewpoint of ecology, safety, and convenience. In the West countries, many people try to the mushroom dyeing. However, just several examples of the mushroom dyeing are recognized in Japan (Takahashi 1988). Authors therefore tried to establish the efficiently dyeing by using Jew’s Ear changing the extracting and dyeing conditions.

2. EXPERIMENTAL METHODS

2.1 Jew’s Ear preparation

The Jew’s Ear (grown in Fujian, China) has been hygienically dried and packaged by the food company (Sanada Co. Ltd.) for food use. It costs about 150 yen per a 25 g package (ca. 6 yen / g) in Japan. Its shelf life to eat is generally one year, and the best before date of the used dried Jew’s Ear is May 7 2011, while the experiment was performed in June to August of the previous year. For experimental use, it was pulverized with a cooking mill-mixer (Sun, FM-33A) for 1 min at 13500 r.p.m. and refrigerated at 4.0 ± 1.0 ˚C until using.

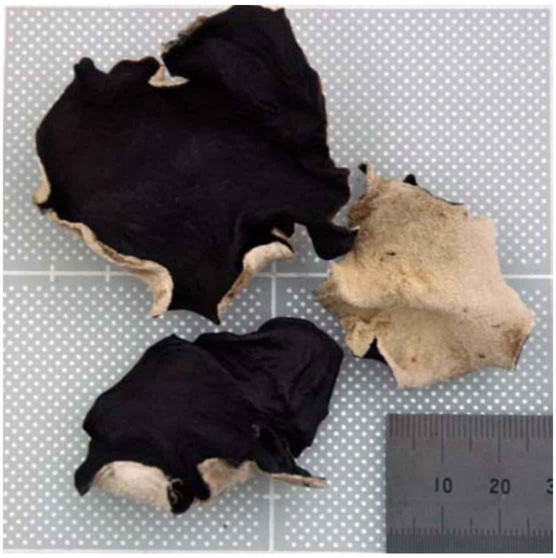


Figure 1. Dried Jew’s Ear mushroom.

2.2 Extraction

Twenty grams of the crushed Jew's Ear was fundamentally extracted with 100 cm^3 of extracting solvent at 50 ± 1.0 ˚C for 3 h in an Erlenmeyer flask (capacity 200 cm^3) set in a shaking incubator (100 s.p.m.). After the extraction, the extracts including the mushroom dye as a solute was filtered by using suction flask with 5.0 µm pored membrane filter (Millipore, JMWP). The absorbance of the solvent was measured by using a UV-Vis spectrophotometer (Shimadzu, UV-1600PC).

2.3 Dyeing

The extracted solution diluted with water to 100 cm^3 in an Erlenmeyer flask (capacity 200 cm^3). The multi fiber (cotton, wool, silk, rayon, acetate, nylon, polyester, acrylonitrile, and vinylon) test fabric was soaked in it, and was dyed at 60 °C for 30 min with 100 s.p.m. shaking. After the dyeing, the test fabric was rinsed twice by reasonable amount of distilled water and dried at room condition. The reflectance of the dyed fabric was measured by using a spectrophotometer (Konica Minolta, CM-2600d).

3. RESULTS AND DISCUSSION

3.1 Solvent for extraction

Some extractions were done by using a variety of solvents. At first, distilled water and hydrochloric acid (0.12 mol dm^{-3} HCl) were used as the solvent. As shown in Figure 2, the absorption of each extracts is large value below the wave length of 300 nm, and the curve has a peak at 273.5 nm. It suggests that the mushroom dye contains naphthalene ($C_{10}H_8$) structure in it, while naphthalene is insoluble in water (Reusch 1999). Further, the small amount of hydrochloric acid has the ability to increase the extracts. Therefore, the extractions using some alcohols with acid or alkaline ingredient were examined. Among those, methanol solvent with small amounts of hydrochloric acid is efficient, and the extract has red color. Figure 3 shows the effect of the volume of hydrochloric acid added to the methanol solvent, and 1 cm^3 of it for 100 cm^3 of methanol effectively raised the efficiency of the extraction.

3.2 Extracting condition

The effect of the dyeing time (*t*) and temperature (*T*) was also investigated as shown in Figures 4 and 5 respectively. The increasing rate of concentration of the extracts is comparatively large until three hours, but it decreased at any more time. On the other hand, higher temperature increased the extracts concentration; however it is still necessary to consider the boiling point of methanol solvent (64.7 °C) to avoid the vaporization.

3.3 Dyeing by mushroom dye

By using the red mushroom dye, extracted by acid methanol solvent (0.12 mol dm^{-3} HCl), the multi fiber test fabric was dyed. As shown in Figure 6, This dyed acetate, vinylon, and especially wool, silk, and nylon fiber to red. According to the more detailed study by spectral reflectance, these fibers can be classified into several types. Namely, 1, cellulose based hydrophilic fibers as cotton and rayon; 2, protein based ionic fibers as wool and silk, 3, slightly hydrophobic chemical fibers as nylon, vinylon, acetate; and 4, extremely hydrophobic synthetic fibers as polyester and acrylonitrile. The red dye from Jew's Ear is suitable for the ionic or slightly hydrophobic chemical fibers.

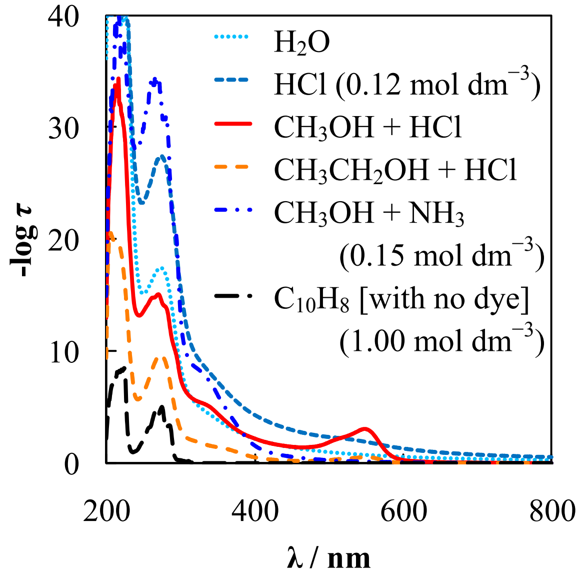


Figure 2. Effect of extracting solvent. 1 cm^3 *of* HCl *or* NH_3 *added to* 100 cm^3 *of solvents.*

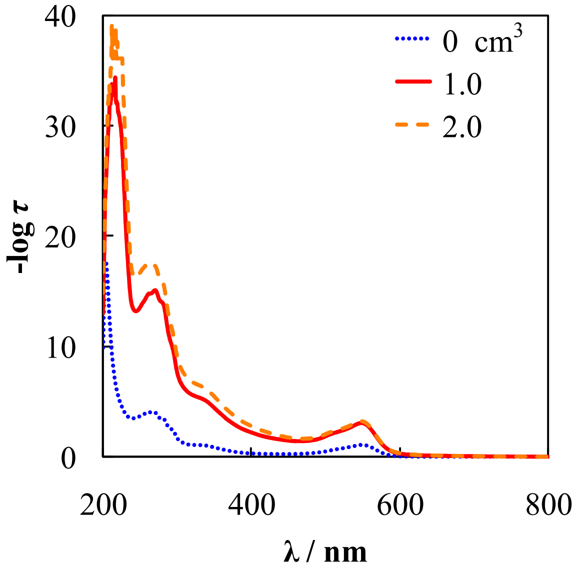


Figure 3. Effect of volume of Hydrochloric acid added in methanol solvent (100 cm^3).

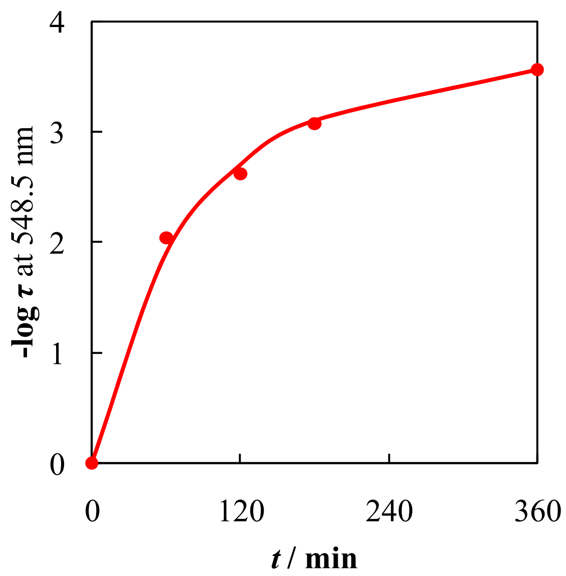


Figure 4. Effect of dyeing time (t).

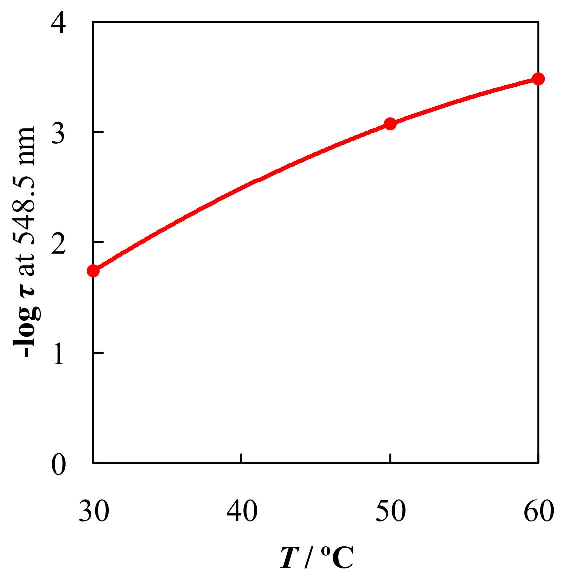


Figure 5. Effect of dyeing temperature (T).

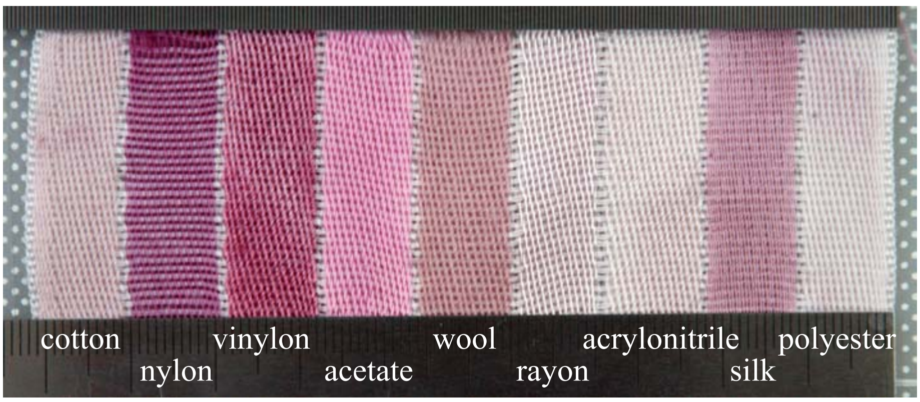
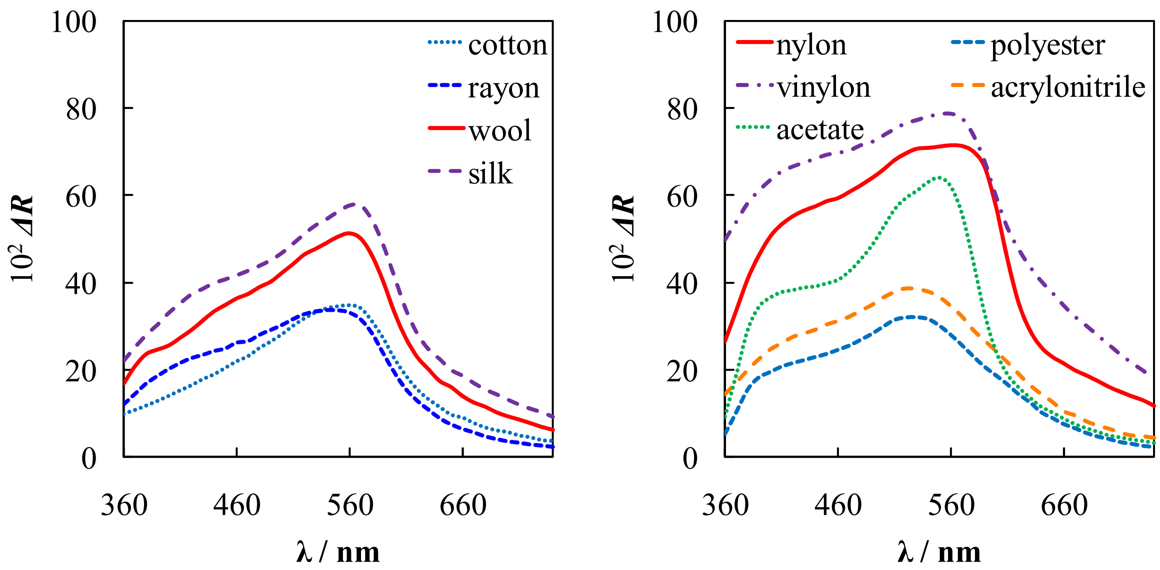


Figure 6. Dyed multi fiber test cloth.



A: Natural and viscose fibers. *B: Semi-synthetic and synthetic fibers.*
Figures 7. Reflectance curves of dyed test fabric.

The differences of the reflectance of the fabrics before and after dyeing are shown in Figures 7 A and B, and each fiber belongs to same type indicates similar reflection curve. It suggests that the red mushroom dye adsorbed in fiber exists in different state by the property of the fibers, or if the dye is a mixture of some components, the adsorbed balances of the components are different.

On the other hand, *Pleurotus salmoneostramineus* is known as a pale red (rose color) mushroom. It was suggested that Jew's Ear has the same chemical component. It nevertheless appears as a black or brown color mushroom.

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Basics of electrode potentials and color for redox indicators applied to food industry

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ABSTRACT

In order to establish the end of a chemical reaction or to test a particular reaction, a substance that changes its color is added to the system. This modification of color occurs at a fixed electrode potential under specific conditions. There are a lot of colorimetric-based commercialized tests applied to control the food quality. A good example of this is the oxygen detection, especially in modified atmosphere food packaging (MAP), in which the food package is flushed with a gas, such as carbon dioxide or nitrogen. The typical indicators are very easy to use and relatively cheap. The reagent is put in contact with the food sample; then its color is compared with a color scale that generally establishes three stages of quality: good, intermediate and poor. There are also colorimetric pH- monitoring test applied to check the rancidity of oils. As the change of color is due to a reversible change between the oxidized and reduced forms of the reagent, the aim of this presentation is to display the theoretical basis of their behavior.

1. INTRODUCTION

Visual indicators have been widely used for more than a century, and they are applied in analytical processes in the industrial laboratories in spite of the development of new physicochemical methods. There exist discussions on the way to select the best indicator for a specific application that can be the establishment of the end of a chemical reaction or the test of a particular reaction or a substance. The most important fact is that it has to change its color when it is added to the system and that this color modification occurs at a fixed electrode potential under specific conditions. Some reviews present lists of chemicals with their fundamental characteristics (Michaelis and Eagle 1930, Hulanicki and Glab 1978).

A lot of colorimetric-based commercialized tests are applied to control the food quality. A good example is the necessity to control the oxygen content, especially in modified atmosphere food packaging (Mills 2009). The developed indicators have different underlying theories such as luminescent, colorimetric or UV activated indicators.

Another type of indicators applied to food industry products is very easy to use and relatively cheap. The reagent is put in contact with the food sample; then its color is compared with a color scale provided by the manufacturer who generally establishes three stages of quality: good, intermediate and poor. There are also colorimetric pH- monitoring test applied to check the rancidity of oils.

As the change of color is due to a reversible change between the oxidized and reduced forms of the reagent, the aim of this presentation is to display the theoretical basis of their behavior.

2. MECHANISM OF ACTION OF THE INDICATORS DEALING WITH THE SOLUTIONS COLOR

The mechanism of the indicator reactions are based on several principles depending on physicochemical characteristics. Three groups can be differentiated.

- *Metallochromic indicators*.

In this case indicator forms a colored complex with the metal ion to be recognized. The uncomplexed indicator may be colorless (*one-color* indicators) or colored in its various protonated form (*two-color* indicators).

- *Extraction indicators*.

The complexation reaction of interest takes place in another liquid phase (generally an organic solvent) in equilibrium with the solution being analyzed.

- *Redox indicators.*

They are usually one-color indicators; the indicator is influenced by a redox system, whose equilibrium is controlled by removal of the metal ions being analized.

Different types of indicators can also be described taking into account the relationship between reactants and products. Thus, they are classified as *reversible, pseudoreversible* and *irreversible*.

The *reversible indicators* are those which, when the cycle of reactions finishes (reduction followed by oxidation), a product identical with the initial indicator is obtained. The relevant potentiometric experimental curve should be within the limits of experimental error being the same in both directions. A reversible indicator should have both forms stable. However, the reversibility depends on the reagents. Ferroin and related indicators are examples of such indicators.

The indicator is called *pseudoreversible* when the product from the cycle of reactions is different from the initial compound or when one of the forms is unstable and decomposes during reaction, but the color of the product is the same, or nearly the same as that of the initial product. An example of such indicator is N phenylanthranilic acid.

The so-called *irreversible indicators* behave in such a way that in the cycle of reactions no reversal to the initial color is observed. An example of such an indicator is Napthyl Blue Black.

3. ELECTROCHEMICAL THEORY

As the redox indicators operate on basis of reduction-oxidation reactions, the electrochemical basics is going to be resumed.

Redox indicators change their color as they are oxidized or reduced and they are selected so that their oxidation-reduction potential is within the range corresponding to the particular reaction being conducted.

For an electrochemical system in equilibrium, a relationship between the electrode potential for the oxidation and reduction reactions and the concentration of the related species known as the Nernst formula has been established (Atkins 1990).

For the redox indicator, the representative electrochemical reaction can be written as follows:

$$\text{IndOx} + \text{ne}^- \longleftrightarrow \text{IndRed} \quad (1),$$

where Ox and Red are the redox species with differential colors.

The Nernst equation applied to this system is:

$$E\,[\text{In}] = E°\,[\text{In}] - (0.0592 / n) \log ([\text{IndRed}] / [\text{IndOx}]) \quad (2),$$

where E°[In] stands for the standard potential of the indicator redox pair, n corresponds to the number of electrons from the electrochemical reaction and the constant value 0,0592 is established for 25 C (Laidler and Meiser 2003).

4. PRACTICAL USE

In a practical determination, a small amount of the redox indicator is added to the system under analysis. Both redox systems, the pair under analysis and the indicator, evolve till they reach the equilibrium state. As the indicator is present in a small amount in relation to the system under study, their quantities remain almost constant. However, the concentrations of the redox pairs have to be known precisely in order to apply the Nernst relationship.
For the added indicator, the relationship of concentrations [IndRed] / [IndOx] determines the final color of the solution. In Figure 1, the schema presents the possible situations, applying equation (2). Thus,

- The solution will have the color established by the IndRed species when [IndRed] / [IndOx] > 10.
- The solution will turn to the color established by the IndOx species when [IndRed] / [IndOx] < 1/10.

There exists a range where the color is a mixture between the corresponding ones of the IndRed and IndOx species.

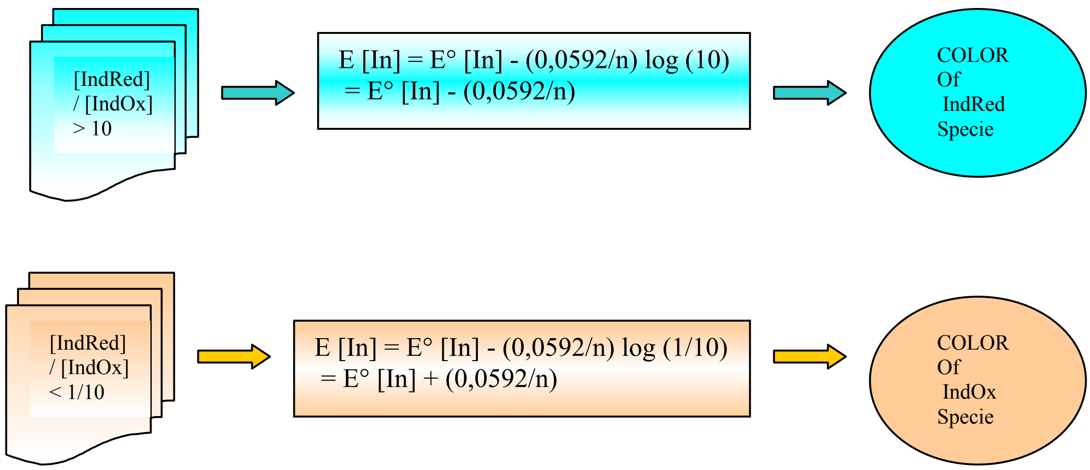

Figure 1. Scheme indicating the conditions and Nersnt equation leading to the final color of the solution under analysis.

In the case of organic compounds that are no ionized, the concentration of the hydrogen ion is taken into account. For biological systems as they are mostly neutral (not acid, not basic systems), it is convenient to establish a concentration of the hydrogen ion of 10^{-7} g/l. Then, as the potential for the indicator in neutral solution is known, it is possible to establish the relation between the concentration of the reduced and oxidized forms through the developed color. Finally, the potential of the system under study can be calculated and the indicator can be properly selected.

In order to detect the changes in color, a certain indicator can be used only if its potential is 0.03 V in the range of the calculated potential. Some of commonly used redox indicators are listed in Table 1 (Glasstone 1961).

There exists a systematic error due to the finite consumption of the oxidant during oxidation of the indicator. This amount is proportional to the amount of indicator and can be determined for two-color reversible indicators. But, for irreversible or pseudoreversible indicators which form intermediate products, or whose oxidized form is unstable and decomposes slowly, it is not easy to establish. With those indicators the correction is always greater than for reversible indicators.

Table 1. Redox potential in neutral dissolution for laboratory redox indicators and their change in color.

Indicator	**E^0 V**	**Change of color [IndOx-IndRed]**
Phenosafranine	-0.252	Red-Colorless
Indigotetrasulfonic Acid	-0.046	Blue-Yellowish
Methylene Blue	+0.011	Blue-Colorless
Toluidine Blue	+0.115	Blue/Violet-Colorless
2,6 Dichlorophenol Indophenol	+0.217	Blue-Colorless

5. FINAL REMARKS

The redox indicators are widely used in the industry laboratories. Their behavior can be predicted as the electrochemical theory is fully developed. However, it must be pointed out that special attention should be paid to,

- the purity of the indicator.
- the preparation procedure of the indicator solution
- the correct use in relation to its amount to be added to a solution to have the best observable change of color.

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Mixture design applied to the development of explicit comestible colorant pastes

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ABSTRACT

The determination of the correct and exact quantities of dye to obtain a specific color is an example of an industrial problem in a wide field of applications including the food industry products. The answer can be found either experimentally or applying statistical techniques. The so-called "Design of Experiments" techniques provide an efficient way to optimize the process through mathematical relationships with a low number of selected experiments. In this work, a simple experimentation test that employs the mixture design is proposed to relate the proportions of predefined pure colorant pastes with the resulting color of the mixture. The goal is the possibility to obtain a predictive model for estimating an entire range in color with few experiments. In this way, the fractions of the different components that produce a color as similar as possible to the corresponding to an arbitrary sample can be established.

1. INTRODUCTION

Industrial experimenters typically turn to two-level factorials techniques as their first attempt to apply statistical tools in their lab work. These methods imply runs that include all combinations of each factor at their high and low levels. However, when the response depends on proportions of ingredients, such as in chemical or food formulations, factorial designs may not make sense. In the optimization of the mixture characteristics, the intensive properties of the mixture depend on the proportions of the components and not on the quantity of the mixture. This case is a special kind of statistical technique in the so-called "design of experiments", DOE, known as Mixture Design (Montgomery 1991).

The formulation of a combination of dyes to obtain a specific color is an example of an industrial problem where the design of mixture can be employed using numerical values for the perceived color. As the perception of color has a subjective interpretation, an improvement in the determination of the color parameters was established in the CIELAB system that was created as an objective tool to standardize the color measurement (Wyszecki 2000). The CIELAB coordinates (L* a* b*) for a solution can be easily obtained.

In this work, a simple experimentation test that employs the mixture design is proposed to relate the proportions of colorant pastes with the resulting color of the mixture. The goal is the attainment of a predictive model for estimating an entire range in color with few experiments.

2. STATISTICAL TECHNIQUES

The first step is to collect quantitative data with the intention of running statistical analysis to compare modes, ranges and outliers and plotting variables against each other in order to obtain a meaningful pattern. The starting point of the theory of DOE with mixtures is that the sum of the fractions of the components must be equal to unity and their proportions must be non-negative. The working region of interest is defined by the value of the proportions in a regular q-1 dimension, where q denotes the number of ingredients of the mixture. In the case of three components (q = 3), the factorial space formed by all the possible fractions of the components is a triangle whose vertices correspond to the pure components.

In mixture problems, the objective is to find a mathematical model, useful for estimating the values of the response variable in terms of its components using polynomial regression. The polynomial equation may have three components, one linear, one quadratic and one cubic. However, due to the restrictions implicit in fractions, the models do not include constant terms. First order coefficients indicate the response for the pure components. If a linear model is successful, it can use these terms to determinate the relative efficiency of each component. The second-order terms such as AB reveal interactions.

It must be pointed out that positive interaction coefficients indicate synergism and negative interaction coefficients indicate antagonism (Montgomery 1991).

The most common types of mixture experimental designs are *simplex-lattice*, *simplex-centroid*, and *augmented simplex design.* Since in the simplex-lattice model, three parameters are considered, this design is not able to estimate the experimental error or to prove the validity of the adjustment. This limitation can be solved using a simplex-centroid design that adds a central point of coordinates (1/3, 1/3, 1/3). A more complete study can be performed augmenting the simplex-centroid with additional points known as axial runs (Yandell 1997).

3. APPLICATION OF *DOE* TECHNIQUES TO COMESTIBLE COLORANT PASTES

DOE technique is a useful and quite easy way to optimize processes. In order to illustrate how to apply it, this work develops its application to the formulation of comestible colorant pastes.

3.1 Experimental determinations

Three food commercially available colorants were used as received and added to a paste to cover cakes. The colors of the colorants selected were blue (b), yellow (y) and red (r). The study started with the schedule of the experiments using the Statgraphics Centurion XV software (StatPoint Technologies 2009). It was necessary to define the name of the factors and response variables. The factors were the different colorants. The levels were the mass fraction of each individual pastes (x_r, x_b, x_y) and the response variables were the color coordinates.

Different proportions of the three basic pastes were mixed and the resulting samples were inspected to obtain the coordinates in the color space CIELAB using a HunterLab Miniscan XEPlus colorimeter. The type of mixture design can be selected in the computer or can be a user-specified design. An augmented simplex – centroid design with axial runs was chosen, obtaining the factor combinations shown in Table 1.

3.2 Statistical analysis

After performing the statistical analysis, a mathematical function that relates the fractions of each mixture to the CIELAB coordinates is obtained. To select the order of canonical mixture models, the highest R^2 value was used. This parameter indicates the percentage of the variation of the response variable that is explained by the factors. In the present case, quadratic models were considered adequate to represent all the color coordinates. The second step was to simplify the models discarding the non-significant interactions between factors. Thus, the mathematical predictive models colors coordinates were:

$$L^* = 57.7308\ x_R + 59.7008\ x_B + 82.8035\ x_Y - 29.7836\ x_R\ x_B - 26.1782\ x_R\ x_Y - 34.7582\ x_B\ x_Y$$

$$a^* = 28.9804\ x_R - 19.4786\ x_B + 7.1913\ x_Y - 47.9188\ x_B\ x_Y$$

$$b^* = 10.7474\ x_R - 18.80008\ x_B + 25.572\ x_Y - 24.4138\ x_R\ x_Y - 21.\ 3102\ x_B\ x_Y$$

Then, the interpretation of the model for each coordinate has to be done. In the case of a*, the most important factor is x_R owing to the high value of its coefficient; the factors x_B and x_Y present an antagonistic effect because the coefficient corresponding to their product is negative. In Table 2, the statistical results obtained for the coordinate a* are presented. Accuracy was calculated using a T test in order to verify the hypothesis that the sum of the differences between the values predicted by the model and the observed ones was zero. Parameters showing probabilities lower than 5% were kept in the model (Cornell 1990). The representation of the response surface using the software is presented in Figure 1.

The second objective was the estimation of the fractions that produce a color as similar as possible to an arbitrary paste. Other mixtures, different from the announced ones in Table 1, were made and their color coordinates were measured. For these values, the color difference (ΔE_{00}) was calculated applying the CIEDE 2000 formula. The obtained ΔE_{00} values fell within the normal tolerance range for industrial applications (Melgosa et al 2001).

Table 1. Color coordinates from the different experiments.

Factors			Responses		
X_R	X_B	X_Y	L*	a*	b*
1	0	0	57.66	31.86	10.82
0	1	0	59.20	-17.30	-18.69
0	0	1	83.60	5.79	26.18
1/2	½	0	50.26	-0.02	-3.98
1/2	0	1/2	64.01	24.46	13.36
0	½	1/2	62.42	-16.64	-1.00
1/3	1/3	1/3	57.34	-1.48	0.84
1/6	1/6	2/3	65.00	-1.18	8.28
1/6	2/3	1/6	57.04	-10.53	-7.70
2/3	1/6	1/6	55.48	11.40	4.13

Table 2. Quadratic model fitting results for a.*

Parameter	**Estimate**	**Standard error**	**T Statistic**	**P-Value**
A: x_R	31.0421	3.12442		
B: x_B	-15.8934	3.12442		
C: x_Y	5.4221	3.12442		
AB	-34.607	14.4	-2.40326	0.0741
AC	13.5839	14.4	0.943326	0.3989
BC	-48.047	14.4	-3.33659	0.0289

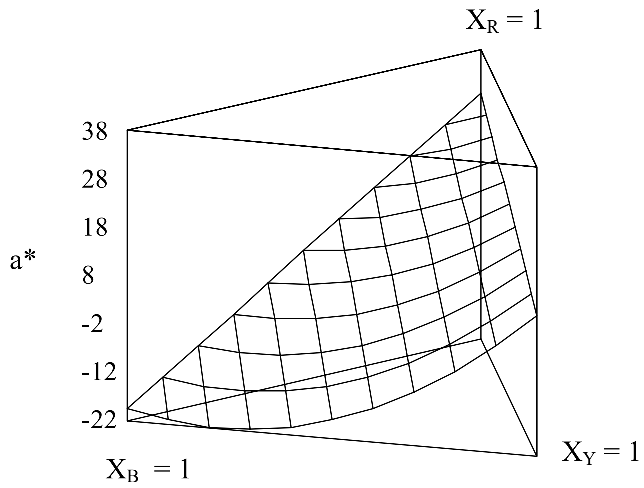

Figure 1. Estimated response surface for variable a.*

5. CONCLUSIONS

The mixture design is a very useful technique for the optimization of mixture fractions commonly used in the chemical industry. Using a number of measurements from different paste samples following the rules of the DOE, this paper demonstrates the advantage of becoming a model to predict the proportions of the pure color pastes to be mixture to obtain a desired color in the final mix paste.

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Temperature abuses during lettuce postharvest: Impact on color and chlorophyll

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ABSTRACT

The objective of the present research was to describe greenness indices behavior when whole lettuce plants were exposed to three isothermal environmental conditions: 0-2, 10-12 and 20-22 °C during first 24 hours after harvest. Greenness indices were: a) total chlorophyll content (C) and b) color changes (L*, a*, b*). Relative humidity was kept at the optimal recommended for lettuce (97-99%). Temperature, leaf age and time significantly affected the quality parameters. Even though lettuces were stored under optimal temperature (0-2 °C), significant C decreases were observed in outer leaves, increasing the loss at higher temperature. A high correlation (R^2 = 0.93) was found between C and a* in older leaves at the three assayed temperatures. Although the younger leaves presented changes in redness/greenness color parameter, no significant changes in C were detected in these leaves.

1. INTRODUCTION

Lettuce is one of the most popular leafy vegetables in the world. The lettuce head is an assemblage of heterogenic morphological leaves that are packed together over the growing point of the plant. Its formation results from the accumulation of young leaves under the layers of leaves covering the growing point (Wien 1997).

In Argentinean farms, lettuce is usually exposed to inadequate field conditions (usually high temperature) while it is waiting to be transported from the field to distribution centers. In the field, the combination between the heat of the sun and the respiration of the produce provokes the heat up of the produce, reducing its postharvest life. The appearance of fresh vegetables strongly affects the purchase decision. Color is an appearance component and a transcendental property, since it impacts directly on consumer visual perception.

The objective of the present research was to describe the response of lettuce to the exposure at three isothermal conditions (0-2, 10-12 and 20-22 °C) during the first 24 hours after harvest. Leaf color behavior was evaluated through total chlorophyll content and L*a*b* color indices. Parameters were measured in three different lettuce sections: external (outer and older leaves), middle (mid leaves) and internal (inner leaves), to evaluate the colorlability of lettuce related to leaf age. Correlations between greenness indices were investigated in each section.

2. MATERIALS AND METHODS

Heads of greenhouse butter lettuce (Lactuca sativa var. 'Lores') were grown in Sierra de los Padres, Mar del Plata, Argentina; and were harvested at optimal maturity after reaching a marketable size (approximately 24-30 leaves per head, corresponding to a weight of 500 ± 60 g). Once harvested, lettuce heads were immediately transported to the laboratory (20 km, approximately) maintaining temperature and relative humidity conditions at optimal levels (0-2 °C and 97-99% RH, respectively). Once arrived to laboratory, plants were not subjected to any preconditioning operation; they were just put in environmental chambers (SCT, Pharma, Argentina) at 0-2, 10-12 and 20-22 °C, maintaining the relative humidity levels in 97-99%. Temperatures of 10-12 and 20-22 °C were chosen to simulate abusive refrigerated and room warm temperatures, respectively. Sampling was carried out at 0, 3, 6 and 24 h. Three independent experimental runs were done.

All parameters were measured in three different sections of the lettuce head called external (outer and older leaves), middle (mid leaves) and internal section (inner and younger leaves).

The total chlorophyll content of each section was determined following the methodology described by Moreira et al. (2003). C is reported as mg of chlorophyll/100 g fresh weight (mg chl/100g fw). Color determination was carried out using a Minolta colorimeter CR 300 Series (Osaka, Japan). Mean values for L, a* and b* were calculated for each section.

Data were analyzed using SAS, software version 8.0 (SAS Inc. 1999). PROC GLM (general linear model procedure) was used for the analysis of variance (ANOVA).

3. RESULTS AND DISCUSSION

3.1 Total chlorophyll content

Initial chlorophyll content (C) in harvested lettuce was: 51.74 ± 1.93, 22.13 ± 2.11 and 10.60 ± 1.76 (mg chl/100 g fw) for external, middle and internal sections, respectively. Great differences ($p < 0.0001$) detected among lettuce sections could be related to the higher exposure of outer leaves to sun light respect inner leaves. Agüero et al. (2008), working with butterhead lettuce, found similar relations between C in each section.

The exposure of almost all vegetables to inadequate temperatures (higher than the optimal one) brings about certain degradation on chlorophyll pigments (Yin et al. 2007, Zhang et al. 2008). ANOVA applied to C data showed a significant interaction between *section* and TIME factors. This fact implies that each section have a particular postharvest behavior. In this way, while the external section exhibited chlorophyll pigments degradation throughout 24 h at any assayed temperature, the middle and internal sections showed no C changes during such period. Figure 1 depicts the evolution of C in external section during 24 h after harvest. The chlorophyll degradation of external section was more pronounced at higher temperatures (36, 20 and 12% at 20-22, 10-12 and 0-2 °C, respectively). Differences in chlorophyll degradation between sections could be related to the higher exposure of outer leaves to environmental factors such as light and oxygen, which could fasten pigment deterioration.

During natural leaf senescence, nutrients are usually mobilized from the leaf to be used in other parts of the plant. At harvest, senescence process is induced artificially as a result of the removal of nutrient supplies (Page et al. 2001). As a rapid response, the degradation of C was evident in outer leaves, which started showing signs of chlorophyll losses.

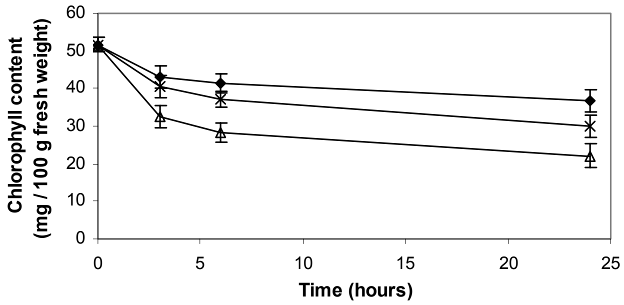

Figure 1. Chlorophyll content evolution in external section of lettuce heads during 24 h of exposure to isothermal conditions: (△) 20 °C; (×) 10 °C; (♦) 0 °C.

3.2 Color

Lightness parameter (L*) in lettuce at harvest showed significant differences among sections. The highest L* value was observed in internal section (76.06 ± 2.00), decreasing towards the external one (65.71 ± 3.38 and 59.13 ± 1.95 for middle and external sections, respectively). The exposure of lettuce heads to different temperature conditions during 24 h did not introduce significant changes in L* parameter as a function of time or temperature (data not shown).

Redness/greenness parameter (a*) in lettuce at harvest resulted negative in all sections indicating the predominance of green color in the product. Results showed significant differences between a* values in each section at harvest, being more negative (greener) in external (-19.73 ± 0.83) and middle (-19.25 ± 1.28) sections (without significant differences between them) than in internal one (-16.30 ± 1.25). Table 1 presents a* values obtained during sampling time. ANOVA applied to a* data showed no significant interaction between factors considered in the analysis (neither triple nor doubles). However, each factor individually resulted significant ($p < 0.0001$ for *section*, $p = 0.0064$ for *temperature*, and $p = 0.0006$ for *time*). For the *section* factor, the significant differences detected between sections at harvest were maintained as time advanced at the three evaluated temperatures; i.e. at each sampling time, outer and mid leaves resulted more green (lower a* values) than inner ones. For *temperature* factor, samples exposed to the highest temperature registered the lowest absolute value of a* parameter in the three lettuce sections. Finally, for *time* factor, significant decreases in the absolute value of a* (less green) were observed during 24 h in the three sections and the three assayed temperatures. A high correlation ($R^2 = 0.93$) was found between chlorophyll content and a* in external section at the three assayed temperatures.

Table 1a. value in external (E), middle (M) and internal (I) sections of lettuce heads during 24 h of exposition to three different isothermal conditions (0-2, 10-12 and 20-22 ºC).*

Time (h)	Section	*a** values		
		0-2 ºC	10-12 ºC	20-22 ºC
3	E	-19.37 ± 0.32	-19.35 ± 0.56	-18.89 ± 0.24
	M	-19.49 ± 1.52	-18.85 ± 0.56	-18.90 ± 1.07
	I	-15.89 ± 0.88	-13.47 ± 3.86	-12.88 ± 1.52
6	E	-19.51 ± 1.09	-18.13 ± 2.37	-18.93 ± 0.03
	M	-18.43 ± 0.90	-16.84 ± 0.21	-18.03 ± 1.61
	I	-12.86 ± 1.04	-12.49 ± 0.58	-12.43 ± 2.41
24	E	-19.32 ± 0.34	-19.07 ± 0.35	-18.87 ± 0.06
	M	-19.14 ± 0.16	-17.94 ± 2.26	-17.44 ± 0.40
	I	-15.26 ± 0.76	-12.22 ± 1.86	-11.06 ± 2.04

Blueness/yellowness parameter (b*) in lettuce at harvest resulted positive in all sections indicating the predominance of yellow in this scale. Significant differences between sections were found in b* values at harvest, being higher (more yellow) in inner leaves (40.50 ± 0.78) than in mid (37.26 ± 0.85) and outer leaves (34.64 ± 0.88). ANOVA applied to b* data showed neither double nor triple interactions among the factors considered in the analysis (data not shown). Furthermore, *time* factor resulted non significant indicating that no changes were registered in b* values as time advanced at any analyzed temperature and section. *section* and *temperature* factors resulted significant ($p < 0.0001$, and $p = 0.0021$, respectively). For the *section* factor, significant differences in b* values detected among lettuce sections at harvest were maintained as time advanced at the three evaluated temperatures. For the *temperature* factor, it was found that samples exposed to high temperatures registered lowest values of b* parameter.

4. CONCLUSION

Leaf age had a significant effect on both the initial greenness indices of butterhead lettuce and their evolution during first hours after harvest. Detriment in butterhead lettuce quality was also affected by temperature. The knowledge of the effect of leaf age on the evolution of quality indices is of fundamental importance for producers because they can take decisions based on this differential behavior related to the degree of development of tissue. In this way they could use different lettuce leaves for alternative uses as fresh consumption, minimally processed products, among others.

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Evaluation of color changes (instrumental and sensorial) of commercial pasteurized juices of cranberry (*Arandano*), elderberry (*Sauco*) and blackcurrant (*Cassis*) – from El Bolsón, Río Negro – during accelerated storage at 40 ºC

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ABSTRACT

Color changes of pasteurized juices of cranberry, elderberry and blackcurrant (produced and bottled in El Bolsón, Rio Negro, Argentina) were evaluated using sensorial and instrumental methods, during storage for four months at 40 ºC.

Color parameters a*, b*, L*, C^*_{ab} and h_{ab} changed during storage and the relative intensity of the changes were characteristic of each fruit. The parameter a* decreased significantly in cranberry and elderberry, while remaining relatively constant for blackcurrant. The parameter h_{ab} increase significantly during the first 50 days of storage in the case of cranberry ($p < 0.001$) and blackcurrant ($p < 0.01$), and remained stable for elderberry.

Through the ASTM Test Triangle, the sensory panel described a change in color of all the juices from an initial red to a more brownish color, being more marked for the cranberry. In elderberry juice changes were described as a darker red. This agreed with the decrease in the parameter a* measured instrumentally.

Overall, the color changes observed during storage can be useful for determining the shelf life of these products.

1. INTRODUCTION

Sensory attributes are one of the most important quality characteristics for consumer acceptance of foods. In the case of red fruit-based products such as sauces or juices, attractive color is a factor that plays a vital role in the choice of a product, and should remain relatively constant throughout the shelf life of the product. However, during storage, chemical and physical agents could lead to deteriorative color changes (Alighourchi and Barzegar 2009, Ochoa et al. 1999).

The aim of present work was to study the change in color of pasteurized commercial juices of cranberry, elderberry and blackcurrant produced in El Bolsón, Río Negro, during storage of these products at 40 °C.

2. MATERIALS AND METHODS

Materials

Juices of cranberry, elderberry and blackcurrant were obtained from a local factory from El Bolsón, Río Negro. They were elaborated with fresh or frozen fruit pulp, with the addition of sucrose, xanthan gum and ascorbic acid. The juices were packaged in 500 ml glass bottles and pasteurized. Commercial shelf life estimated for products was 3 years.

Storage conditions

Juice bottles were stored in a dark at 40 ºC for 185 days; two bottles of each juice were removed at selected times and measured.

Color

The color of juices was analyzed using a Minolta Spectro photometer CM-600d (Konica Minolta Sensing Inc, Japan) using the illuminant D65 and an observer angle of 2º (CIE 1931 Standard Observer). CIELAB parameters were L* for lightness, a* for redness, and b* for yellowness. With these, calculations of C^*_{ab} for chroma and h_{ab} for hue angle were made. Color measurement was made by duplicate on 0.4 g of sample in white containers of 3 cm diameter.

Sensory evaluation

Triangle test (ASTM 1977) was performed to evaluate differences in color and viscosity between samples during the storage period. Evaluation was performed in duplicate by a panel of 15 assessors (students and staff from Facultad de Ciencias Agrarias, Pontificia Universidad Católica, Argentina).

Statistical analysis

All assays were made at least by duplicate and the average was reported. The analysis of variance of the results and the Student-Newman-Keuls test for means comparison were determined using GraphPad Instat software, version 1.2, 1998.

3. RESULTS AND DISCUSSION

The initial and final values of color parameters during storage are shown in Table 1. Cranberry color parameters showed significant variation in a* ($p < 0.05$), b^*($p < 0.01$) and h_{ab} ($p < 0.001$), elderberry parameters in L^* ($p < 0.01$), a^* ($p < 0.001$), b^* ($p < 0.001$), and C^*_{ab} ($p < 0.001$). In the case of blackcurrant, no significant differences were observed in any of the color parameters ($p > 0.05$).

*Table 1. Color parameters of each fruit juice at the beginning and the end of storage.**

CIELAB parameters	CRANBERRY Time (days) 0	CRANBERRY 185	ELDERBERRY Time (days) 0	ELDERBERRY 185	BLACKCURRANT Time (days) 0	BLACKCURRANT 185
L^*	21.04 ± 3.15	21.15 ± 2.39	2.92^a ± 0.06	1.63^b ± 0.10	4.64 ± 0.52	5.15 ± 0.46
a^*	19.09^a ± 1.41	11.17^b ± 0.81	19.52^a ± 0.31	10.48^b ± 0.43	28.76 ± 1.81	25.6 ± 0.99
b^*	7.35^a ± 0.72	15.23^b ± 0.85	5.03^a ± 0.11	2.78^b ± 0.16	8.00 ± 0.89	8.87 ± 0.79
C^*_{ab}	20.46 ± 1.58	18.89 ± 1.17	20.16^a ± 0.33	10.85^b ± 0.45	29.86 ± 1.98	27.16 ±1.17
h_{ab}	21.02^a ± 0.45	53.81^b ± 0.54	14.45 ± 0.07	14.80 ± 0.39	0.27 ± 0.01	0.33 ± 0.02

*Mean ±. Standard error. For each juice: Means with different letter in each row are significantly different (significance level in text).

Figure 1 shows changes in a^*, b^* and L^* during storage. For cranberry, an important decrease in a^* was observed at the beginning of storage (30 days), and a gradual increase in b^*; a gradual decrease in all the parameters was observed for elderberry. Blackcurrant parameters remained stable during storage, in agreement with the results shown in Table 1.

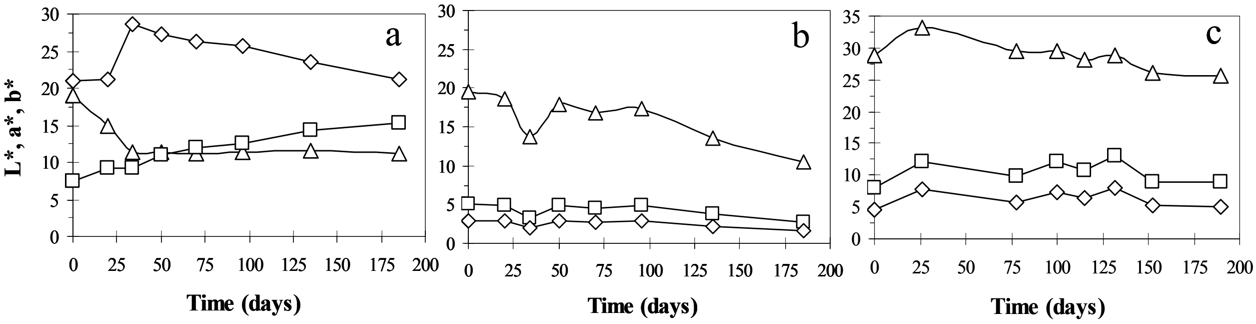

Figure 1. Color parameters L (◊), a(Δ), b(□) changes during storage at 40 ºC for cranberry (a), elderberry (b) and blackcurrant (c).

Figure 2 shows changes in hue angle. The increase in h_{ab} and the decrease in a* for cranberry was correlated with less red color and a more brown one. In accordance with these parameters, the sensory evaluation showed significant differences ($p < 0.001$) in color and viscosity (decrease in viscosity) up to 45 days; then, no significant differences were observed.

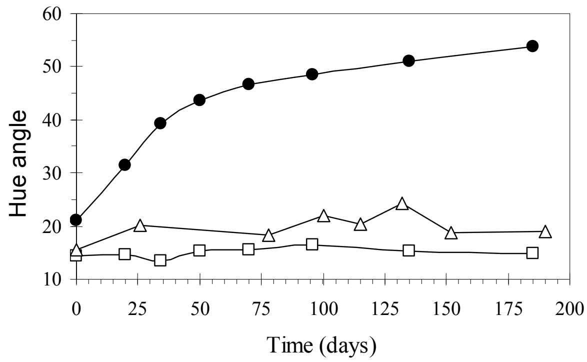

Figure 2. Hue angle (h_{ab}) changes during storage for cranberry (●), elderberry (□) and blackcurrant (Δ) juices.

A decreased in a* and b* with a constant h_{ab} value was observed in elderberry. The decrease in C* and L* was reflected in the darkening of the sample. Changes in color (more red) up to 45 days ($p < 0.001$) and viscosity up to 90 days ($p < 0.05$) were described by sensory panel.

Although no significant differences between initial and final values were observed for blackcurrant, the sensory panel described changes in color (brownish) and viscosity (lower viscosity) up to 75 days ($p < 0.001$).

Figure 3 shows visual appearance of cranberry and blackcurrant samples at the beginning and after 100 days of storage.

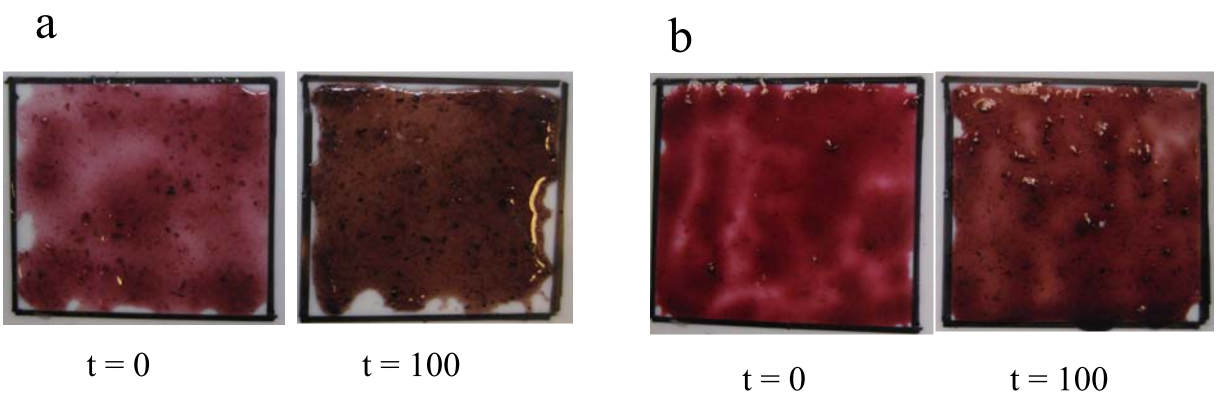

Figure 3. Appearance of cranberry (a) and blackcurrant (b) juices at the beginning and after 100 days of storage at 40 ºC.

4. CONCLUSION

Color changes were observed for all the juices. The most important differences were observed in cranberry, both by instrumental parameters and sensory evaluation.

The study of color during storage can be very useful to determine the shelf-life of these juices, in which this parameter is very important in relation to its acceptability by consumers.

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Changes in color and anthocyanin content of different dried products based on sweet cherries

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ABSTRACT

It is widely known that quality properties of fruits can be affected by drying processing. The effect of different pretreatments and dehydration methods on color and anthocyanin content of two products, discs and dices, obtained from sweet cherries (*Lapins var.*) was analyzed. The applied pretreatments and drying methods caused different effects on color and anthocyanin (Acy) retention when compared to the fresh fruit. In general, both discs and dices, exhibited an increase in h values upon dehydration, in agreement with Acy pigment decrease. Total Acy content was higher in the freeze-dried fruits; however, SI pretreatment caused an important decrease in the anthocyanin content. Samples with sugar infusion prior to air drying presented the highest Acy degradation index. Better quality products were obtained from cherry dices (small pieces) than discs (halves).

1. INTRODUCTION

Cherry consumption has an increasing impact, due to the health benefits associated with regular intake of anthocyanins (Kirakosyan et al. 2009). Due to harvest losses an excess production it is important to develop industrially-processed cherry products. Drying at high temperatures and long times may cause damage in the nutritive and sensorial characteristics, affecting flavor, color and nutrients of the dried food (Lin et al. 1998). A way of obtaining dried fruits of good quality is to use pre-drying treatments. Among the best food dehydration techniques, freeze-drying is known to produce the highest quality dehydrated products (Khalloufi and Ratti 2003). Anthocyanin pigments readily degrade during processing and storage of foodstuffs, which can have a dramatic impact on color quality and may also affect nutritional properties (Wrolstad et al. 2005). The objective of this work was to analyze the effect of different pretreatments and dehydration methods on color and anthocyanin content of two products obtained from sweet cherries (*Lapins var.).*

2. MATERIALS AND METHODS

Sample preparation, pretreatments, and drying process: *Lapins* cherry cultivar grown in Valentina Norte, Neuquén (Patagonia, Argentina) was used. Fruit characterization was performed according to AOAC methods (1990): moisture 77.5 ± 1.8 %, soluble solids 20 ± 2 °Brix, acidity 0.82 ± 0.06 g % citric acid, pH 3.54 ± 0.07, ash 0.499 ± 0.009 %. Water activity (a_w) measured at 25 °C was 0.974 ± 0.005.

Fruits were washed, peduncles were removed, and pitting was done with a manual cherry pitter. A group of cherries was cut into halves and another group was chopped in eighth pieces in order to obtain different dried product geometries: discs and dices respectively. Then they were subjected to the following pretreatments prior to drying:

- *Dry Sugar infusion (SI)*: fruits were placed in a mixture of solutes (sucrose and preservatives). The amount of sugar was calculated to attain a_w equilibration value of 0.87. Potassium sorbate (1,000 µg/g) and sodium bisulfite (150 µg/g) were used. Two different systems were prepared: one for discs and other for dices.
- *Blanching (B):* was done by exposure of samples (discs only) to saturated steam during 90 seconds and then cooling by submerging them in water at 4 °C during the same time.
- *Control (C):* cherry discs and dices without pretreatments were used as control.

Cherry discs and dices, with and without pretreatments, were dried by:

- *Freeze-drying (F):* condenser temperature –84 ºC and chamber pressure 0.04 mbar, 48 h.
- *Air-drying (A):* in a forced convection oven, air temperature 60 °C and 10% HR, during 24 h.

Color analysis: Superficial color was measured by photocolorimetry, in the CIELAB color space; with C illuminant and 2° observer. Measurements were performed on skin and pulp in 40 discs for each condition. In the case of dices, 20 measurements were taken from a pull of samples randomly arranged in Petri dishes. L*, a* and b* values were used to calculate global color change function ΔE^*_{ab}, taking $\overline{L}^*_0$, $\overline{a}^*_0$, $\overline{b}^*_0$, medium tristimulus values, from fresh cherry. Hue angle values were calculated to analyze the red color evolution.

Total Anthocyanin content (T Acy) and anthocyanin degradation index (ADI): T Acy was determined using the pH-differential method. Extracts were obtained with ethanol 95% - HCl 1.5 N (85:15). Absorbance was measured at 510 nm and 700 nm and calculated as $A = (A_{510} - A_{700})_{pH1.0} - (A_{510} - A_{700})_{pH\ 4.5}$. Acy content was expressed as Cyaniding-3-glucoside (MW: 445.2 and ε: 29,600 L $cm^{-1}mol^{-1}$). ADI is the ratio of the total degraded and nondegraded content of anthocyanins (Michalczyk et al. 2009).

Water content: Determined by difference in weight before and after vacuum drying over desiccant at 60 °C. Dry matter content was introduced in anthocyanin calculation.

3. RESULTS AND DISCUSSION

The applied pretreatments and drying methods caused different effects on color (Table 1) and anthocyanin retention (Figure 1) when compared to the fresh fruit. Air-drying caused darkening (L* decrease) mainly due to non-enzymatic browning enhanced at high temperature, particularly on the pulp side of cherry discs (Table 1). Regarding the freeze-dried samples, in all the analyzed cases they showed a clearer appearance, which could be due to the porous structure generated in this process. Usually, after drying there is an increase in chromatic values due to concentration. In the case of air-drying, the Maillard reaction turned the cherries brownish. The SI pretreatment caused discoloration which could be explained by three reasons: first the diffusion of pigments into the solution during osmosis; second some monomeric anthocyanins are in colorless sulfonic form due to acid addition of bisulfite, and finally to the presence of sugar crystals on fruit surface. In the case of cherry dices a more homogeneous behavior was observed because the measurement was performed in bulk (mixture of pulp and skin). The drying method did not cause an important difference in the color variables but the SI pretreatment allowed retaining the color values more similar to the fresh sample.

Table 1. L, a*,b* and global color change, Δ E*ab, for cherry discs and dices after drying.*

Samples		L*		a*		b*		Δ E*ab	
		Mean†	SD	Mean†	SD	Mean†	SD	Mean†	SD
Discs Skin	Fresh	26.13 c	1.68	14.03 d	3.74	3.19 d	1.33		
	A-C	23.47 a	2.15	9.47 b	1.44	3.99 e	1.10	5.86 a	1.31
	A-B	24.93 b	2.04	9.96 b	2.73	4.60 e	2.28	5.76 a	1.79
	A-SI	36.94 e	1.83	5.63 a	1.79	2.19 c	1.00	13.90 d	1.71
	F-C	34.91 d	1.06	9.21 b	2.10	1.54 b	0.55	10.33 b	1.47
	F-B	36.42 d	1.54	11.88 c	3.34	2.34 c	1.03	11.23 c	1.84
	F-SI	35.24 e	1.34	4.44 a	1.16	0.82 a	0.38	13.52 d	0.99
Discs Pulp	Fresh	32.84 c	1.73	5.26 a	1.69	0.81 a	0.60		
	A-C	15.64 a	1.62	7.65 c	1.76	4.18 c,d	1.65	17.88 e	1.24
	A-B	18.59 b	2.37	8.46 c	1.82	4.35 d	1.76	15.28 d	2.01
	A-SI	35.10 e	0.94	5.46 a	1.38	3.57 b,c	1.25	3.94 a	1.22
	F-C	35.02 d,e	1.83	13.18 d	1.99	4.65 d	1.60	9.24 c	2.57
	F-B	34.00 d	1.14	12.17 d	1.80	3.08 b	1.13	7.45 b	2.10
	F-SI	35.06 e	1.20	6.77 b	1.55	3.33 b	1.05	4.02 a	1.49
Dices	Fresh	27.38 a	1.55	8.25d	2.73	2.30 c	1.21		
	A-C	31.02 c	1.15	2.85 a,b	0.98	1.11a,b	0.50	6.76 b,c	0.77
	A-SI	32.04 d	1.09	4.66 c	1.32	2.57 c	1.03	6.17 a	0.70
	L-C	29.47 b	0.58	1.98 a	0.67	0.51a	0.25	6.87 c	0.70
	L-SI	31.42c,d	1.08	3.91b,c	1.40	1.36 b	0.54	6.23 a,b	0.65

† For each group, means with the same letter superscript were not significantly different ($p < 0.05$).

In general, total Acy content was higher in the freeze-dried fruits; however, SI pretreatment caused an important decrease in the anthocyanin content. Dices showed higher T Acy than discs for all the analyzed conditions (Table 2). Moreover, A-SI samples presented the highest ADI values.

Table 2. Total anthocyanin content and ADI for discs and dices after drying.

Discs	Acy (mg/100g d.w)		ADI	
	Mean†	SD	Mean†	SD
Fresh	236.42 a	38.13	1.20 a	0.01
A-C	37.95 d	4.13	1.92 a	0.06
A-B	49.98 d	16.46	1.65 a	0.26
A-SI	6.25 e	1.68	6.71 b	1.73
F-C	120.75 c	8.45	1.46 a	0.04
F-B	164.86 b	21.74	1.29 a	0.06
F-SI	30.76 d,e	6.23	2.07 a	0.27

Dices	Acy (mg/100g d.w)		ADI	
	Mean†	SD	Mean†	SD
Fresh	236.42 a	38.13	1.20 a	0.01
A-C	124.54 b	6.48	1.37 a	0.03
A-SI	22.50 c	4.31	2.36 b	0.02
F-C	211.63 a	29.93	1.26 a	0.03
F-SI	88.79 b	8.31	1.36 a	0.03

† Means with same uppercase letter superscript were not significantly different ($p < 0.05$)

Both products, discs and dices, exhibited an increase in h_{ab} angle upon dehydration, in agreement with Acy pigment decrease. For a certain pretreatment, freeze-dried samples showed higher anthocyanin retention than air-dried samples (Figure 1).

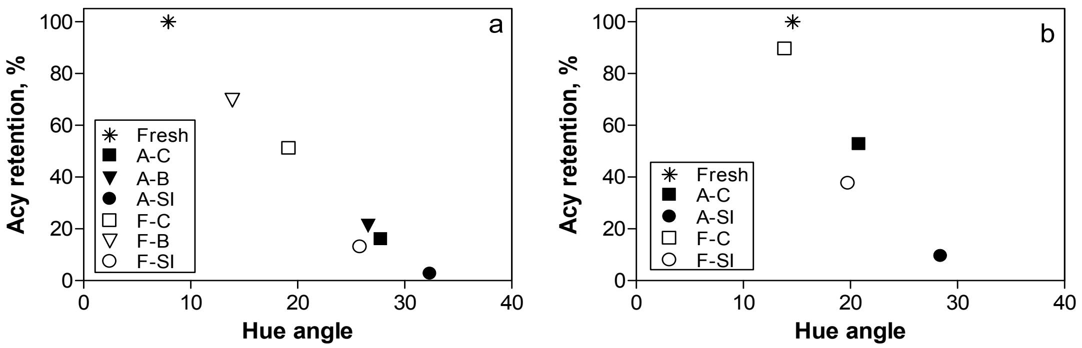

Figure 1. Anthocyanin retention vs superficial red color (h_{ab}) on cherry discs pulp (a) and dices (b) after air and freeze drying.

4. CONCLUSION

Better quality products regarding color and anthocyanin content were obtained from cherry dices (small pieces) than discs (halves). The SI pretreatment caused an important decrease in anthocyanin pigments retention and a clearer appearance. Therefore, this procedure should be carefully performed in berries in order to keep the nutritional quality of the product.

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Nonenzymatic browning in dehydrated food liposomes

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ABSTRACT

Microencapsulation of food ingredients is a very valuable technique in order to improve delivery, stability and controlled release of many beneficial food components. Liposomes are common microencapsulation systems, composed by phospholipids. Many functional phospholipids contain amino groups, making them reactive in the browning development. The most studied browning reaction involves sugars and proteins. The nonenzymatic browning involving phospholipid components has been less explored. The objective of this work was to analyze color changes in dehydrated liposome model systems containing soy lecithin, as a source of phospholipids, considering different drying methods and storage conditions.

Model systems contained soy lecithin liposomes (prepared by sonication or extrusion) in phosphate buffer pH 6, with the addition of either glucose or glycine or both reagents. Each liposome system was dehydrated by two different drying techniques: freeze-drying or spray-drying. The samples were then humidified at different relative humidites (RH). Afterwards, the samples were stored at the temperatures 45 and 60 ºC. Color was measured using a photocolorimeter, using the CIELAB color space, 2º observer and D65 illuminant.

During storage, L* values decreased while a* and b* values increase in all the analyzed systems. These color changes and the chromatic displacement in the CIELAB color space were characteristic of non-enzymatic browning reactions. The changes were more pronounced at 60 ºC than at 45 ºC and at the higher RH analyzed. No significant differences of color changes between were observed in samples dehydrated by the two drying methods employed.

Many dehydrated foods and ingredient formulations, especially liposomes contain lipidic compounds like phospholipids that can participate in non-enzymatic browning reactions causing color changes that might be deteriorative. Therefore, it is important to analyze the conditions for the occurrence of such reactions. This work shows that both freeze-dried and spray-dried food model systems containing soy lecithin liposomes can develop browning even in mild storage conditions.

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Color measurement of "Nova" mandarins submitted to heat and degreening treatments during long storage

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ABSTRACT

Bearing in mind the successful application of thermal treatments to prevent the development of CI in fruits and vegetables, the purpose of the present work was to characterize the effect of heating treatments on color parameters of sensitive fruits that required long periods of postharvest storage. "Nova" mandarins were divided into four lots, one was thermally treated (HS), another one degreened (D), the third was submitted to a combination of both treatments (HS+D), the last lot was used as control. Immediately after treatments, the fruit was stored at 2 °C. Color Index (IC) was used as the parameter to detect color changes. The evaluations were performed at harvest, immediately after treatment application and fortnightly during the postharvest storage. When IC was evaluated after treatment application, fruit submitted to treatment D showed the highest IC value, while the other treatments showed lower values in the decreasing order HS+D > HS > C. Samplings performed during the storage period showed that fruit submitted to D and HS+D treatments had the highest IC values. No significant differences were found among treatments in IC after 60 days of storage. The results found after 7 days at 20 ºC following cold withdrawal showed a similar behavior. Results confirmed that the degreening treatment is appropriate to the color of citrus fruits.

1. INTRODUCTION

The external color is one of the most important quality factors of citrus fruits that drive the purchasing decision of consumers. In the case of mandarins, some early season varieties reach the required standard of internal maturity before the skin is fully colored, and thus fruits have to be degreened with ethylene gas to become commercially apt. To control this process, the objective measurement of color is the most important activity carried out in any degreening research as well as in packinghouse color grading and citrus fruit inspection.

From the technological point of view, low-temperature storage is the most significant method to maintain the quality of citrus fruits and extend shelf life. However, some varieties, when exposed to temperatures below 12 °C, can undergo certain physiological disorders, collectively known as chilling injury (CI), which cause significant deterioration of the overall quality (Lyons 1973). It was found that the development of CI symptoms can be reduced by the application of heat treatments prior to fruit storage at chilling temperatures (Lurie 1998, Porat et al. 2000). Among mandarin fruits, the cultivars which are usually susceptible to low-temperature storage are Nova and Fortune (Cuquerella et al. 1990, Martínez-Jávega et al. 1991). In spite of the economical importance of this problem, investigations addressing the application of heat treatments on this commodity are still scarce.

Therefore, the aim of the present study was to investigate the effect of postharvest treatments (heat shock and degreening) on color attributes of “Nova” mandarins stored for long period at low temperature.

2. MATERIALS AND METHODS

2.1 Plant material and treatments applied

“Nova” mandarins (*Citrus Clementina* Hort. ex. Tanaka x (*Citrus paradisi* Mc-Fadyen x *Citrus reticulata* Blanco) grown in Entre Rios (Argentina) were harvested and divided into four lots: one was incubated at 20-21 °C in a chamber for 48 h in the presence of ethylene atmosphere (5 ppm, ethylene degreening, D); the second was incubated in a chamber at 36 °C for 48 h (heat shock, HS); the third was first heat treated at 36 °C for 48 h and then incubated at 20-21 °C for 48 h with ethylene 5 ppm (HS+D); finally non-treated fruit was used as control (C). After the applications of the treatments, the fruit was evaluated every 15 days for 60 days of storage at 2 °C (chilling temperature) under two conditions: immediately after cold withdrawal, and after 7 days at 20 °C in chamber to simulate commercial conditions.

2.2 Color measurements

Color measurements (L^*, a^* and b^* parameters) were performed with a Minolta Chroma Meter. Average values were calculated for each fruit and converted into IC = (1000*a)/(L*b) (Jiménez-Cuesta et al. 1981). The evaluations were performed at harvest, immediately after treatments applications ($M1_0$), and periodically every 15 days under the two conditions mentioned above: immediately after cold storage withdrawal ($M15_0$, $M30_0$, $M45_0$, $M60_0$), and after submitting the fruit –withdrawn from cold storage– to 7 days at 20°C, in order to simulate commercial conditions ($M15_7$, $M30_7$, $M45_7$, $M60_7$).

2.3 Statistic analysis

The experiment was designed as a 4 × 5 factorial. Main effects were treatments (C, D, HS, HS+D), and times (1, 15, 30, 45 and 60). The initial measurement (at harvest) was used as a covariable to analyze both storage conditions. ANOVA and covariance analysis were analyzed by using SPSS® software (version 12.0 Illinois, USA). LSMEANS was utilized for means comparison.

3. RESULTS AND DISCUSSION

Table 1 shows the results of IC analysis, immediately after the application of the treatments, and every 15 days during the conservation at 2 °C. Except for control fruits, no significant differences were observed within each treatment along the cold storage for 60 days. Control fruits (C) showed an increase in IC values after 15 days at 2 ºC ($M15_0$; 9.4), with no further significant difference up to the end of the storage period. In the comparison among treatments, fruit submitted to D showed the highest IC value (16.6, $p < 0.05$) immediately after treatment application ($M1_0$). The combination of this treatment with the heating one (HS+D) was found to reduce IC values from 16.6 to 12.7. The application of the heat treatment alone (HS) rendered an even smaller IC, which was slightly higher than the one of control fruit (9.0; 7.0, respectively), though significantly different. It can be speculated that the application of heat affected the metabolism of the pigments responsible for the color changes of the fruit, attenuating the effect of the degreening treatment. Fruits analyzed during the storage period showed that IC values attained after treatments application remained unchanged thereafter. Treatments that included degreening produced the highest IC values. Instead, no difference was found between HS treatment and C along the storage period. This result highlights the advantages of using the ethylene treatment, which is usually applied in packinghouses to accelerate fruit color development by inducing the synthesis of carotenoids and the catabolism of chlorophylls. Considering that the combined treatment (HS+D) rendered lower IC values than D, it can be speculated that the heat applied previously to ethylene treatment caused a delay in these processes. Regarding this effect, it is well known that color changes brought about by the degreening process involve both the destruction of chlorophylls already present in the cell, and the development of carotenoids pigments responsible for the orange color (Wheaton and Stewart 1973). The enzymatic reactions involved in these processes have different optimal temperatures. For chlorophyll degradation, inducing and inhibitory temperatures are respectively 28 and 40 °C, while for carotenoids synthesis, these temperatures are 18 and 30 °C, respectively (Cuquerella 1997). Therefore, the condition applied in the heat treatment (36 °C, 48 h) would have induced an inhibition of carotenoids synthesis, rendering a lower IC value.

Table 1. IC evolution in mandarin "Nova" during the conservation at 2 °C. Measurements were accomplished in control (C) or treated fruit (D, HS, and HS+D), after treatments applications ($M1_0$) and periodically each 15 days ($M15_0$, $M30_0$, $M45_0$, $M60_0$) during the conservation.

	Periods of sampling				
Treatment	**$M1_0$**	**$M15_0$**	**$M30_0$**	**$M45_0$**	**$M60_0$**
C	7,0 ± 0,3 d	9,4 ± 0,3 c	9,7 ± 0,3 c	10,2 ± 0,3 c	10,5 ± 0,3 c
D	16,6 ± 0,3 a	17,2 ± 0,3 a	16,2 ± 0,3 a	16,0 ± 0,3 a	17,3 ± 0,3 a
HS	9,0 ± 0,3 c	10,2 ± 0,3 c	9,7 ± 0,3 c	9,7 ± 0,3 c	9,7 ± 0,3 c
HS+D	12,7 ± 0,3 b	13,8 ± 0,3 b	13,8 ± 0,3 b	13,7 ± 0,3 b	13,7 ± 0,3 b

Means with different letters are significantly different ($p < 0.05$ LSMEANS).

Table 2 shows IC values obtained in fruits withdrawn from cold after 7 days at 20 °C to simulate commercial conditions. The IC values in control fruits (C) reached the highest value after 45 days of storage ($M60_7$). In general, the IC behavior was coincident with the one found for fruits analyzed immediately after withdrawal. D treatment had the highest IC values, with the other treatments showed lower IC values in the order HS+D > HS >C. This result suggests that the exposure of fruits for 7 days at room temperature after the withdrawal from cold storage have no effect on the changes induced by the treatments themselves.

The results found in this work indicate that the application of gas ethylene (D) alone induced the maximum mature color of the fruits (IC values), which is thereafter maintained during the cold storage. The additional storage of 7 days at 20 °C to simulate commercial conditions had no important effect on these results.

Table 2. IC evolution in mandarin "Nova" during the conservation at 2 °C and subsequent 7 days to room temperature to simulate commercial conditions. Measurements were accomplished in control (C), or treated fruit (D, HS, and HS+D), after treatments applications ($M1_0$) and periodically each 15 days+ 7 days to room temperature ($M15_7$, $M30_7$, $M45_7$, $M60_7$).

	Periods of sampling				
Treatment	**$M1_0$**	**$M15_0$**	**$M30_0$**	**$M45_0$**	**$M60_0$**
C	6,9 ± 0,3 e	7,9 ± 0,3cde	9,1± 0,3 cd	10,1 ± 0,3 c	10,1 ± 0,3 c
D	16,4 ± 0,3 a	16,1± 0,3 a	15,6± 0,3 a	15,6 ± 0,3 a	15,7 ± 0,3 a
HS	9,0 ± 0,3 cd	9,6± 0,3 c	9,5 ± 0,3 c	9,9 ± 0,3 c	9,9 ± 0,3 c
HS+D	12,7 ± 0,3 b	13,1± 0,3 b	13,2 ± 0,3 b	13,3 ± 0,3 b	14,0 ± 0,3 b

Means with different letters are significantly different ($p < 0.05$ LSMEANS).

4. CONCLUSION

The results of the present investigation highlight the importance of the degreening process as an additional step to be used in combination with heat shock treatments for mandarin fruits to attain a commercially suitable color.

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Kinetics of melanosis in shrimp. Effect of pretreatment using chemical additives

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ABSTRACT

The objective of this work was to study the effects of sodium metabisulphite (MBS: 0.6 - 1.25% w/v), 4-Hexylresorcinol (4-HR: 0.0025% - 0.01% w/v) and ficin (F: 0.5 - 2% w/v) to prevent melanosis of shrimps. The melanosis kinetics of Pleoticus muelleri from Chubut, Argentina, stored at 4 ºC for 96 hours were studied following the color change (darkening) of fresh samples during iced storage. An experimental device was designed to capture digital images of the samples which were analyzed by means of Adobe Photoshop CS3 Extended Version 10.0 software. For each treatment the percentage of darkened area (*PDA*) was calculated from total area and darkened area. A significant reduction of darkness (60%) was observed at 24 hours for pretreatment samples in comparison with control sample (*PDA*: 30.3%). Darkness during ice storage of shrimps was modeled assuming zero order reaction kinetics. The value of rate constant was 0.18 h^{-1}, 0.078 h^{-1}, 0.049 h^{-1} and 0.068 h^{-1} for control, MBS (0.6%), 4-HR (0.0025%) and F (2%) respectively. The analysis revealed that the best results were obtained using 4-Hexylresorcinol with a significant reduction (65.2%) of darkened area due to melanosis.

1. INTRODUCTION

The Argentine fishing industry is basically oriented to exportation, and within that sector marketing of crustaceans is the activity of higher economic value. Melanosis or blackening of the shrimps can reduce their market value between 10 and 25%, or it can even mean its rejection (SAGPyA 2007).

The polyphenol oxidase (PPO) is the enzyme responsible for the phenomenon of melanosis, and it is present in an inactive form in the hemolymph of crustaceans. After their death, different physiological processes involve its activation and production of colored pigments. These pigments are not harmful and do not affect flavor or aroma, but consumers reject them for their appearance (Díaz López et al. 2003).

Crustaceans are marketed with sulphiting agents in order to prevent and control melanosis, since the PPO remains active during refrigeration. Sodium metabisulphite is most often used for its effectiveness and low cost (Lucien-Brun 2006). However, numerous publications about possible adverse effects and cases of allergies (for example: urticaria, angioedema, bronchial constriction, pruritus, contact eczema, rhinitis, anaphylactic shock) in sensitive or asthmatic individuals, have led to the search for alternative treatments in the prevention of melanosis (Brasó Aznar 2003).

The aim of this work was to study the effects of several chemical additives to prevent melanosis of Argentine red shrimps (*Pleoticus muelleri*). Three chemical additives were used: Sodium metabisulphite, 4-Hexylresorcinol and Ficin. An untreated sample was adopted as control. The monitoring of the progression of melanosis during 96 hours was made through digital images of the samples, captured with an experimental device designed for that purpose. Digital images were analyzed using a computer program that enabled calculation of the percentage of darkened area for each treatment. The kinetics of shrimps blackening was modeled by means of zero order reaction.

2. MATERIALS AND METHODS

2.1 Material and chemicals treatments

Atlantic white shrimps (*Pleoticus muelleri*) with the size of 31-70 g were purchased from the dock in Rawson, Chubut, Argentina. The shrimps were washed and stored for two hours in ice until used. Chemical treatments were performed using the following aqueous solutions. Sodium metabisulphite (0.6%; 1.25%, g/100 ml of solution) was purchased from Química Oeste SA (Buenos Aires, Argentina), 4-Hexylresorcinol (0.0025%, 0.005%, 0.01%, g/100 ml of solution) was obtained from Aldrich (St. Louis, MO, USA) and Ficin (0.5%, 2%, g/100 ml of solution) was procured from Enzyme Development Corporation (New York, USA).

The shrimps were immersed in each solution at a shrimp/solution ratio of 400g/1 liter at 20ºC for 1 minute (Mc Evily et al. 1991). As control was adopted a sample soaked in pure water. The soaked shrimps were drained and stored in sealed bags at -20ºC for a month until melanosis was determined.

2.2 Color measurements

Quantification of the color change (darkening) of fresh samples during iced storage (96 hours at 4 ºC) was based on measurement of the percentage of darkened area (PDA). The lighting conditions in the measuring chamber and the location of the samples were standardized. An experimental device, where the sample was illuminated with daylight fluorescent lamp, was designed to capture digital images of the samples at predetermined times of storage. For each treatment the percentage of darkened area (PDA) was calculated from total area and darkened area by counting the pixels of the image:

$$PDA = \frac{Darkened\ Pixels}{Total\ Pixels} * 100 \tag{1}$$

A digital camera Sony Cyber-shot (DSC-W80, Sony Corp.) was used to capture a 18.7 cm × 14.5 cm objective area. All measurements were carried out by duplicate. Digital images in JPEG format (3072 × 2304 pixels) were analyzed by means of Adobe Photoshop CS3 Extended Version 10.0 software.

3. RESULTS AND DISCUSSION

The effect of melanosis in shrimps can be appreciated in Figure 1 where the fresh material was shown together with untreated specimen and optimal specimen treated by chemical additive. Melanosis was characterized by the appearance of melanin black spots in the exoskeleton of shrimp, it is started on the last pair of appendages (paddles), gills, carapace inter-segmental area, in the coxae of the legs and the bottom of the cephalothorax.

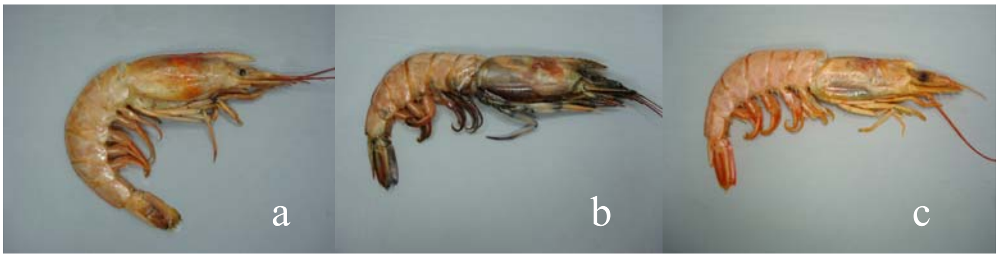

Figure 1. a) fresh specimen, b) untreated specimen at 96 hours, c) specimen treated by 4-HR (0.0025%) at 96 hours.

Digital images of control and treated samples were obtained and analyzed according to procedure described. Percentage of darkened area (*PDA*) was calculated by means of eq. (1). Experimental data of *PDA* obtained during ice storage of shrimps are shown in Table 1 being the relative experimental error of 2%. A significant reduction of darkness (60%) was observed at 24 hours for pretreatment samples in comparison with control sample (*PDA*: 30.32%). *PDA* mean values were higher for control and Ficin treatments in comparison with MBS and 4-HR treatments independent of storage time investigated.

Table 1. Percentage of darkened area obtained using different chemical treatment to avoid melanosis in shrimps.

Time (hs)	Control	MBS 0,6%	MBS 1,25%	4-HR 0,0025%	4-HR 0,005%	4-HR 0,01%	Ficin 0,5%	Ficin 2%
24	30.32^{a}	$8.67^{c,3}$	$11.02^{c,3}$	$8.86^{c,3}$	$8.55^{c,3}$	$8.91^{c,3}$	$14.52^{b,3}$	$12.93^{c,3}$
48	37.17^{a}	$10.6^{c,2,3}$	$11.99^{c,2,3}$	$9.55^{c,2,3}$	$10.31^{c,2,3}$	$11.23^{c,2,3}$	$16.47^{b,2,3}$	$15.28^{c,2,3}$
72	41.42^{a}	$12.79^{c,1,2}$	$14.82^{c,1,2}$	$10.83^{c,1,2}$	$12.82^{c,1,2}$	$12.74^{c,1,2}$	$31.18^{b,1,2}$	$16.12^{c,1,2}$
96	$44.05^{a,1}$	$14.2^{c,1}$	$19.12^{c,1}$	$12.42^{c,1}$	$15.31^{c,1}$	$16.06^{c,1}$	$31.47^{b,1}$	$18.09^{c,1}$

[a,b,c]Means in the same row with the same letter do not differ significantly at the level of 0.05 significance.
[1,2,3]Means in the same column with the same number in the same kind of sample do not differ significantly at the level 0.05 significance.

In all treatments it can be observed that darkening was significantly ($p < 0.05$) increasing during ice storage. This fact is evidenced by comparison between *PDA* mean values of initial (15.19%) and final (25.14%) storage times. PDA values shown in Table 1 were satisfactorily ($r^2 > 0.85$) modeled by an apparent zero order reaction

$$\frac{d(PDA)}{dt} = k \rightarrow PDA = PDA_0 + k^* t \qquad (2)$$

where k is the melanosis rate constant and t is time. Kinetics constants, obtained by linear regression, are shown in Table 2. It can be appreciated that *PDAo* values of treated samples were smaller than control which had not protective effect of chemical additive after thawing.

4-HR (0.0025%) showed a value of k: $4.98 \times 10^{-2}\ h^{-1}$, which was 73.65% lower than the control (k: $18.9 \times 10^{-2}\ h^{-1}$) in return Ficin (0.5%) had a k: $27.3 \times 10^{-2}\ h^{-1}$, being 44.44% higher than control. The results indicate that 4-HR at very low concentration significantly retards melanosis.

Table 2. Kinetics constants of melanosis in shrimps.

Treatment	PDA_0 (%)	K *10^2 (h^{-1})	r^2
MBS 0.6%	6.87 ± 0.30	7.82 ± 0.46[a]	0.9931
MBS 1.25%	7.46 ± 1.44	11.3 ± 2.2[b]	0.9298
4-HR 0.0025%	7.43 ± 0.39	4.98 ± 0.59[c]	0.9719
4-HR 0.005%	6.05 ± 0.35	9.5 ± 0.53[b]	0.9938
4-HR 0.01%	6.49 ± 0.67	9.57 ± 1.01[b]	0.9780
Ficin 0.5%	7.02 ± 5.31	27.3 ± 8.08[d]	0.8510
Ficin 2%	11.53 ± 0.54	6.8 ± 0.82[a]	0.9719
control	26.88 ± 1.84	18.9 ± 2.8[d]	0.9582

[a,b,c,d]Data in column followed by the same letter do not differ significantly at the level 0.05 significance.

4. CONCLUSION

The use of 4-HR, additive considered GRAS, at very low doses (0.0025%) prevented melanosis during frozen storage and thawing. In addition there are not side effects caused by sulfites, which indicates a very convenient alternative. Moreover the maximum Ficin concentration tested (2%) showed an efficacy of less than 4-HR.

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Color of dried pears as affected by prior blanching and sugar infusion

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ABSTRACT

Sugar infusions and/or blanching have been proposed in combination with air dehydration to improve color attributes of pear dried products. All dried samples showed a decrease in L* values, except for SI pears pretreated at 0.87 water activity (a_w) which maintained a lightness similar to that of fresh fruit. An increase in a* values was observed, mainly in dried control samples (C) and those pretreated at 0.97 a_w. According to browning index, dried samples pretreated at 0.97 a_w developed higher browning than those with SI at 0.87a_w, which retained a light color due to the presence of sugars on tissue surface. The more important changes in global color occurred in blanching samples due to the lightness developed. According to these results, an adequate control of blanching and infusion treatments seems to be useful as a tool for improving the colour stability during air drying of pears.

1. INTRODUCTION

It is well known that, among the dehydration techniques, air drying causes browning discoloration in foods. The use of osmotic dehydration -also known as sugar infusion (SI)- as a pre-drying step has received increasing attention in the field of fruit preservation processes as a medium to improve quality of fruit products. The main advantages are the inhibition of the enzymatic browning, the retention of volatile compounds, the partial dehydration of the food and therefore reduced energy consumption during further drying (Karathanos et al. 1995, Torreggiani and Bertolo 2002). Sugars added during osmotic step combined with other factors, such as a slight thermal treatment, the addition of antifungal and antimicrobial agents and texture preservatives before drying, would allow extending shelf-life and developing products with fresh quality attributes (Alzamora and Salvatori 2006). Pear fruits have not been traditionally used as matrices for these technologies but offer an alternative to obtain novel minimally processed products.

The objective of this study was to investigate the effect of blanching and/or sugar infusions prior to drying process on color of dried fruits obtained from pears (*Packham's var*) produced in Argentine Patagonia.

2. MATERIALS AND METHODS

Fresh pears (*Packham's var.*) from Upper Valley zone of Río Negro (Argentine) were selected. Fruits (85.1 % water content; 0.97 water activity (a_w); 14 ºBrix) were washed, peeled and cut into discs (3 cm diameter and × 0.6 cm thickness).

Blanching (B): on water vapor at 100 ºC during 1.5 min, then cooling on cold water at 4 ºC during 1.5 min. It was used in order to inactivate the enzymes responsible for enzymatic browning.

Dry sugar infusion (SI): osmotic dehydration processes were done by immersing the fruits into a mixture of humectants (sucrose or glucose) and antioxidant and antimicrobial preservatives (potassium sorbate and sodium sulphite). The amount of sugars and chemical agents were determined according to the weight of the fruit and the final levels required after equilibration of the product (a_w = 0,83 and a_w = 0.96). Final system pH was adjusted to 3.5 with citric acid. The cut material was pretreated as follows: a) SI1: SI with sucrose (a_w = 0,83); b) SI2: SI with sucrose (a_w = 0,96); c) B + SI1: blanching + SI with sucrose (a_w = 0,83); d) B + SI2: blanching + SI with sucrose (a_w = 0,96); e) GI2: SI with glucose (a_w = 0.96); f) B + GI2: blanching + SI with glucose (a_w = 0.96); g) C: control corresponding to pears without pretreatments.

Drying process: Pears, with and without pretreatment, were subjected to convective dehydration in a fluid bed dryer operated at 65ºC temperature, 4m/s air velocity and 6% relative humidity during 4 h. After drying, samples were analysed for water and soluble solids content, water activity and surface color.

Color measurement: Color of dehydrated pears was measured by a photocolorimeter MINOLTA CR400 (2° observer, illuminant C, CIELAB color space) in the central point of both sample surfaces. A white background of reflectance provided by the manufacturer was used. Color changes of pears were evaluated through L*, a*, b* components where L* indicates lightness, a* indicates chromaticity on a green (–) to red (+) axis, and b* chromaticity on a blue (–) to yellow (+) axis. These numerical values were converted into global color change ($\Delta E^*_{a,b}$) and browning index (BI) functions, calculated with respect to fresh fruit (F).

Statistical analysis: ANOVA and a multirange test were done with STATGRAPHIC PLUS 5 software in order to evaluate significant differences ($p < 0.05$) between dried samples.

3. RESULTS AND DISCUSSION

All dried samples (with and without pretreatments) showed a decrease in L* values ($p < 0.05$), except for SI pears pretreated at 0.87 a_w which maintained a lightness similar to that of fresh fruit. A significant decrease of lightness was observed in all blanched fruits (Figure 1A). All dried pears exhibited an increase in a * values, mainly C samples and those pretreated at 0.97 a_w (Figure 1B).

Many authors had reported that a decrease in L* value and an increase in a* value are indicative of darkening in apples and pears (Gómez et al. 2010, Sapers and Douglas 1987, Taiwo et al. 2001). As observed in Figure 1, the simultaneous change in both values, L* and a*, would be a useful indicator of browning during drying, probably resulting from enzymatic and non enzymatic reactions. After drying, pear surfaces were darker (lower L* values), and less green (higher a* value) when compared to fresh-cut.

According to calculated browning index (Figure 2B), dried samples pretreated with less humectants (a_w = 0.97) developed higher browning than those with infusion at 0.87 a_w, which retained a light color due to the presence of sugars on tissue surface. Samples infused in glucose at 0.97 a_w showed minor color retention during drying than those pretreated in sucrose at the same a_w. In spite of the more important changes in global color occurred in blanched samples (Figure 2A), probably due to the significant changes in lightness developed, the thermal treatment promoted enzymatic inactivation and led to less discolored pears

(Figures 2B and 3) in all cases when compared with the corresponding dried pears non previously blanched.

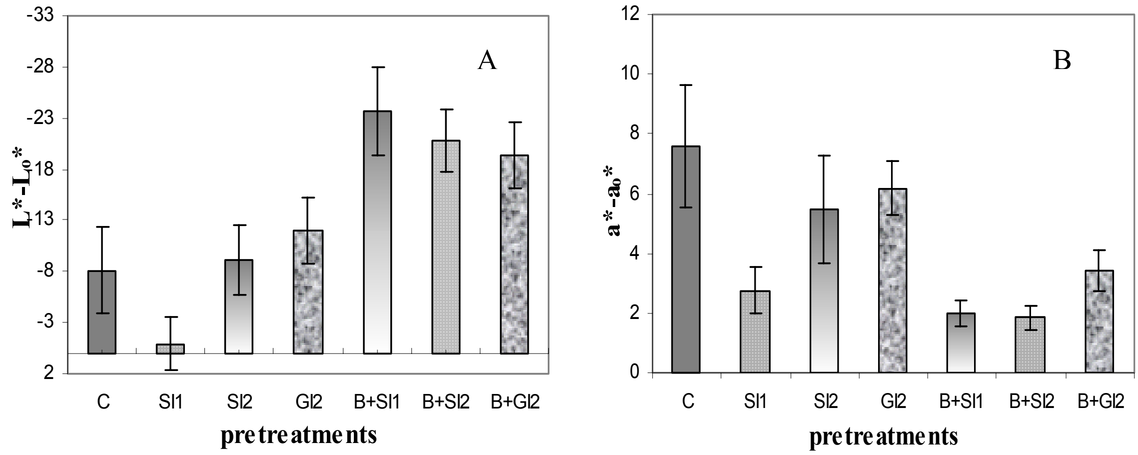

Figure 1. Color values obtained after drying compared to the fresh sample: A) lightness change ($L^* - L_0^*$); B) redness change ($a^*-a_0^*$).

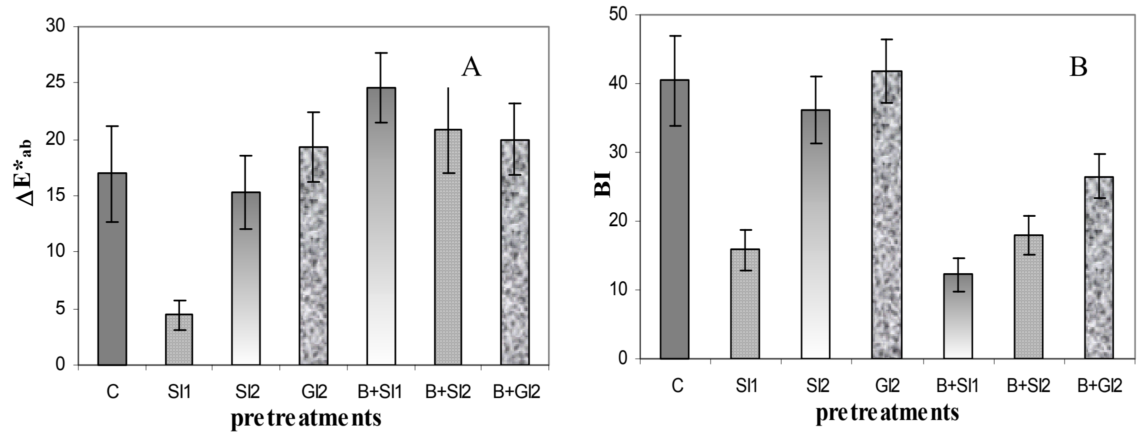

Figure 2. Total color difference ΔE^*_{ab} (A) and browning index BI (B) of pears after drying.

4. CONCLUSIONS

The different behaviors obtained in samples after drying show that the type of pretreatment significantly affects the browning reactions that occur during drying.

Since pears slices pretreated with sucrose infusion at 0.87 aw before drying appeared with minor browning, the protective effect of sugar concentration was confirmed. The colour preservation may be seen because these samples showed no changes in lightness and a small increase of redness without being affected by a previous blanching.

According to the results obtained, an adequate control of blanching and infusion treatments prior to drying seems to be useful as a tool for improving product colour.

ACKNOWLEDGMENTS

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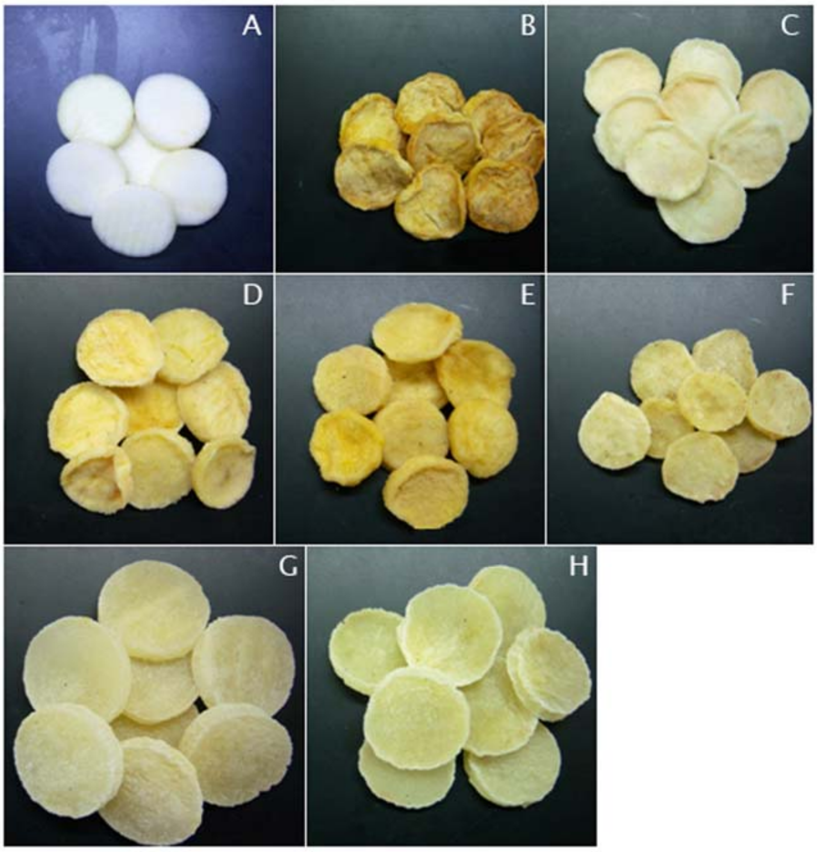

Figure 3. Photographs taken from fresh and dried pears with and without pretreatments: A) fresh; B) control; C) SI1; D) SI2; E) GI2; F) B+GI2; G) B + SI1; H) B + SI2.

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Storage effects on blueberry color

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ABSTRACT

Chile is a big producer of blueberries. Computer vision is actually applied for quality food measurements. The objective of this work was to study the storage effects on color of blueberry cultivars using computer vision. *Duke, Brigitte* and *Jewell* (with and whitout epicuticular wax) cultivars were stored at 4 and 15 ºC and at 75 and 90% relative humidity. Color (L*, a*, b*) and fungal growth were obtained through image analysis captured using computer vision system. Sensorial evaluation was also performed. Significant differences ($p < 0.05$) were observed for initial color among cultivars and blueberries without epicuticular wax. Along storage time, color changed from blue to red with temperature and total ligthness (L*) increased with fungi growth for three cultivars. Sensorial evaluation showed that consumers preferred blue than red berries and accepted ($p > 0.05$) color of blueberries without epicuticular wax at initial time. The acceptability along time was principally affected by flavor than color. Important quality factors of blueberries as color were significantly influenced only by temperature and cultivars. Unprotective blueberries had high deteriorative effects (fungal growth, color change and acceptability) along time. Therefore, a low storage temperature and epicuticular wax presence are beneficial to maintain quality of intact blueberry fruits after harvest.

1. INTRODUCTION

World blueberry consumption has risen mainly because of its health benefits (Sinelli et al. 2008). Chile is the biggest blueberries producer of South America and the largest exporter to the northern hemisphere. Blueberries are blue little fruits from genus *Vaccinium* with high nutritional value and potential anti-diseases effects but with a short shelf life. The main quality indicators in blueberry are fruit appearance (color, size and shape), firmness or texture, flavor (soluble solids, tritable acidity and pH) and nutritive value (Vitamins A, C and antioxidants) (Duarte et al. 2009). However, changes in texture and color during blueberry storage can have a profound effect on consumer acceptability. Computer vision analysis is an useful tool, based on its simplicity, to assess optical properties of fruits and also allows the analysis of heterogeneous materials.

The objective of this work was to study the storage effects on color from different cultivars of blueberries using computer vision.

2. MATERIALS AND METHODS

Blueberry cultivars *(Elliot, Duke, Briggitte and Jewell)* from Hushbush Northern variety were obtained from the Metropolitan Region crop fields in Chile (Curacaví, Hortifrut SA). Blueberries were manually picked at full maturity (100% blue) and transported to the laboratory the same day. Blueberries were stored during 0, 7, 14 and 21 days at constant temperature of 4 and 15ºC and relative humidities (RH) of 75 and 90%; cv. *Jewell* with and whitout epicuticular wax were stored during the same periods of time and temperature as above at 75% RH. Blueberries were pre-sorted by hand; discarding excessively small, soft and visually damaged for all experiments (n = 25 with duplicate).

Digital images of each blueberry were captured at each storage time through computer vision system, which consisted of a black box with four natural daylight tubes of 18W (Phillips) and a Cannon 4 Megapixels Powershot G3 camera placed in vertical position at 22.5 cm from samples (the camera len angle and light was 45°, according to Pedreschi et al. (2006). All images were acquired at the same conditions using remote control of ZoomBrowser program (v6.0 Canon). Surface color measured in CIELAB space were obtained from analysis images performed using software Matlab, Balu Toolbox[1] (Mery and Soto 2008), which extracts intensity characteristics of regions. Fungal growth was also obtained through image analysis, considering visually the presence of fungal filaments.

Sensorial evaluations of color and acceptability were also performed by 10 consumers using 9 levels hedonic scale.

Statistical analysis was performed by one-way Anova, and Tukey test ($P \leq 0.05$) was applied when significant differences appeared.

3. RESULTS AND DISCUSSION

Results showed that significant differences ($p < 0.05$) were observed for initial color (time 0) among cultivars (Figure 1), where cv. *Duke* showed lower L* than other cultivars. Along storage time, color changed from blue to red (Figures 2 and 3), mainly in blueberries without the protective epicuticular wax, and total ligthness (L*) increased due to fungal growth for all cultivars (Figure 3d), which was due by *Botritys cinerea development*. Color changes and fungal growth were observed during storage time for all cultivars, which were mainly due to higher temperature but not to relative humidity. These important quality changes were more remarkable increased on blueberries without epicuticular wax than intact blueberries. Fungal growth increased as storage time increased and was lower at 4 °C (2%) than 15 °C (14%) for all intact blueberries cultivar.

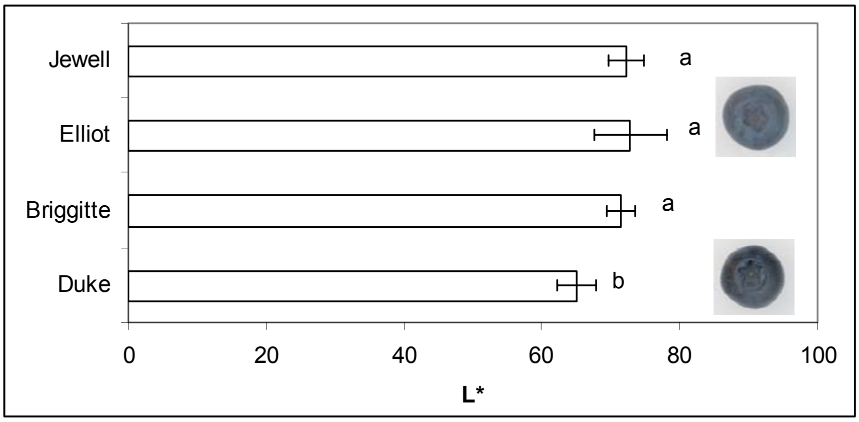

*Figure 1. Total luminosity (L *) initially for four fresh blueberry varieties.*
Different letters show significant differences (p < 0.05 obtained by Tukey test).

The extraction of protective epicuticular wax changed the initial blue and opaque characteristic color to dark blue and bright color (Figure 3). Sensorial evaluation showed that consumers preferred ($p < 0.05$) blue than red berries and accepted ($p > 0.05$) color of blueberries without epicuticular wax at initial time. The acceptability along time was principally affected by flavor than color and it was not accepted after 14 days for all storage conditions without epicuticular wax and after 21 days for intact blueberries for all cultivars.

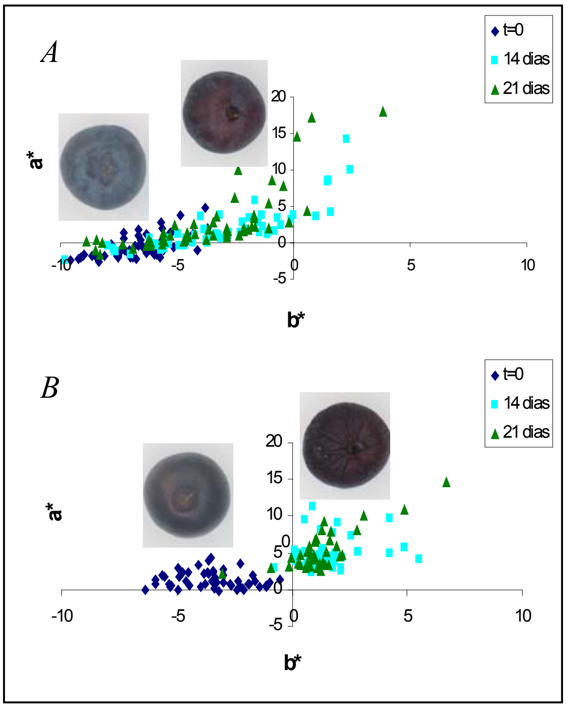

*Figure 2. Variation of color parameters analyzed by computer vision (a * vs b*) during storage time at 15 ºC and 75% HR. (A) Intact blueberries (with epicuticular wax). (B) Blueberries without epicuticular wax.*

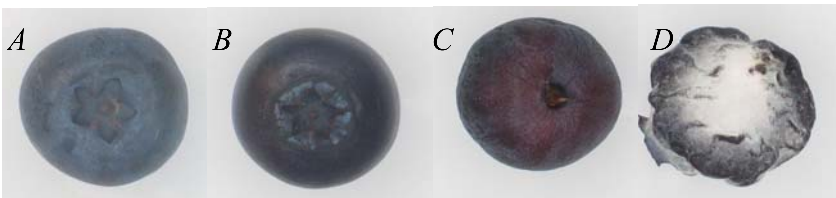

Figure 3. Variation of color parameters analyzed by computer vision during storage time. (A) Intact blueberry (with epicuticular wax) at initial time (B) Blueberry without epicuticular wax at initial storage time. (C) Intact blueberry after storage during 21 days at 15 ºC and 90% HR. (D) Blueberry without epicuticular wa x after storage during 21 days at 15 ºC and 90% HR.

4. CONCLUSIONS

Computer vision analysis showed to be an useful tool to assess optical properties of fruits such as color and fungal growth based on its simplicity, allowing the analysis of heterogeneous materials. Differences among cultivars were observed mainly on initial blue color (L* was lower in cv. *Duke* than other cultivars), however their behavior during storage were similar among cultivars from the same variety.

Important quality factors as color of blueberries under storage conditions were significantly influenced by temperature but not by relative humidity. Color changes from blue to red were observed during storage. Fungal growth increased as storage time and temperature increased. Unprotective blueberries (without epicuticular wax) underwent high deteriorative effects (fungal growth, color change and acceptability) along storage time. Consecuently, it is necessary to maintain the epicuticular wax on blueberries, which is extracted easily by hand manipulation.

Therefore, low storage temperature is beneficial to maintain quality of intact blueberry fruits after harvest.

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Color variation in nut kernels during storage under different dry methods

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ABSTRACT

In the present work were evaluated the effect of drying processes and storage conditions on kernels of three walnut varieties (*Juglans regia* L.) through instrumental color assessment. The walnuts were harvested in the province of Catamarca, Argentina. After collected, they were subjected to two drying methods: natural and in oven. The color of the kernels was determined every 45 days using a BYK Gardner ColorView. At the beginning of storage, statistically significant differences ($p < 0.05$) were observed between the three varieties on L* parameter. Being Chandler kernels the brightest (54.0 ± 1.4), followed by California (49.0 ± 0.66) and Criolla (42.0 ± 3.5). Parameters a* and b* showed significant differences between Criolla and Californian varieties (Chandler and California), even tough no differences were observed among them. It was observed a decrease of the parameter L* during storage for the three varieties, being statistically significant ($p < 0.05$) in Californian walnuts after 180 days. Parameter a* increased significantly in the three varieties while the parameter b* decreased significantly only in California walnuts. Comparing oven and natural drying methods, it was observed that kernels from the first method were less brightness, redder and less yellow.

1. INTRODUCTION

Color is a useful indicator of food quality, being a factor that influences the purchase decision of consumers. Color intensity depends on the composition of the product, processing and preservation conditions (Buera et al. 1986).

In nuts, darkening is a phenomenon that depends on the variety, harvest and postharvest conditions; furthermore is an important element in commercial practice (Lopez et al. 1995). Dark colors are often associated with poor quality and is related to exposure of nuts to adverse conditions (Senter et al. 1984).

In dry nuts, it is important the effect of drying operations, which should ensure the preservation of its original properties. Therefore, drying process constitutes a key element in the final quality of dried fruit (Prunet and Herman 1995).

It is generally recognized that exposure of the grains at temperatures above 38°C for prolonged periods causes deterioration in their color. Also, certain temperatures could accelerate autoxidation and lead to undesirable changes in color and flavor (Erickson et al. 1994, Forbus et al. 1980, Senter et al. 1984).

The aim of this study was to evaluate the effect of drying and storage conditions of cultivars of walnut (*Juglans regia L.*) through color determination by instrumental methods.

2. MATERIALS AND METHODS

2.1 Sample preparation and storage

Three varieties of nuts were used in the study: Criolla, California and Chandler. Nuts were harvested between the months of February and March of 2007 in a commercial orchard located in the town of Mutquín, Pomán department, Catamarca province, Argentina.

After collected, nuts were submitted to two drying methods: natural (in trays exposed to the sun) and dried in the oven (48 hours with hot air at 38 ± 2 ºC) to a moisture content of the 4-6% range. The samples were stored in bags for 225 days at an average temperature of 21.1 ºC (maximum of 23.1 ºC and a minimum of 19.0 ºC).

2.2 Color assessment

The color of the nuts was determined every 45 days using a BYK Gardner Color View spectrocolorimeter (model 9000), CIELab scale, large area of vision and illuminant D65. Nuts were stripped and kernell that showed intact integument were placed in a cylindrical optical cell (2.4 int. 60 mm CC-6136) in different layers to cover the entire surface of the cell (Forbus 1980). Data were analyzed using ANOVA with the SPSS® (version 12.0 Illinois, USA).

3. RESULTS AND DISCUSSION

The results at the beginning of storage are presented in Table 1. Statistically significant differences were observed between the three varieties for L* parameter, being the nuts of Chandler variety lighter (54.0) than California (49.0) and Criolla (42.0).

For the parameters a* and b*, significant differences were observed between Criolla and California (Chandler and California) varieties, not presenting these latest differences between them.

Regarding drying treatments, significant differences were observed among varieties for the parameter a*, being the higher values for nuts dried in oven (T2).

Table 1. L, a* and b* values in Criolla, Chandler and California nuts subjected to natural (T1) and oven (T2) drying at the beginning of storage.*

Variety	L*		a*		b*	
	T1	T2	T1	T2	T1	T2
Criolla	42,22 ± 3,50 C	41,25 ± 0,74 C	9,73 ± 0,97 A b	10,56 ± 0,55 A a	29,62 ± 1,77A	29,25 ± 1,20 A
California	49,28 ± 0,66 B	48,33 ± 2,74 B	7,06 ± 0,28 B b	7,69 ± 0,24 B a	27,34 ± 1,14 B	26,95 ± 0,74 B
Chandler	53,74 ± 1,41 A	50,72 ± 0,86 A	6,67 ± 0,30 B b	7,20 ± 0,64 B a	29,11 ± 0,38 AB	27,74 ± 0,40 AB

T1:Natural drying T2: Oven drying

Capital letters indicate significant differences (p<0,05) betwen varieties by Tukey test

Lowercase letters indicate significant differences (p<0,05) betwen treatment by Student test

During storage, significant differences were observed at 225 days for the parameter a* in Criolla variety.

Regarding the treatments, significant differences for the parameters L* and b* were found. In both cases, the values of oven drying treatment were below that those obtained for natural drying. (Table 2)

Table 2. L, a* and b* parameters for Criolla nuts subjected to natural (T1) and oven (T2) drying along 8 months of storage.*

Time (days)	L* T1	L* T2	a* T1	a* T2	b* T1	b* T2
0	42,22 ± 3,50 a	41,25 ± 0,74 b	9,73 ± 0,97 AB	10,56 ± 0,56 AB	29,62 ± 1,77 a	29,25 ± 1,20 b
45	42,23 ± 1,13 a	37,78 ± 0,88 b	9,98 ± 0,11 AB	10,39 ± 0,61 AB	28,26 ± 0,59 a	26,33 ± 0,43 b
90	43,76 ± 1.60 a	38,70 ± 3,38 b	10,73 ± 0,39 AB	10,28 ± 0,95 AB	30,35 ± 1,33 a	26,19 ± 2,52 b
135	42,93 ± 1,99 a	39,75 ± 2,63 b	10,00 ± 0,14 B	10,17 ± 0,75 B	28,06 ± 1,54 a	24,64 ± 2,99 b
180	41,10 ± 2,95 a	38,10 ± 2,62 b	10,64 ± 0,22 AB	10,19 ± 0,47 AB	29,09 ± 1,16 a	25,94 ± 1,39 b
225	40,11 ± 0,83 a	39,19 ± 2,55 b	11,38 ± 0,14 A	10,86 ± 0,49 A	27,49 ± 0,69 a	27,04 ± 1,76 b

T1: Natural drying Secado T2:Oven drying

Capital letters indicate significant differences (p<0,05) in the effect of time

Lowercase letters indicate significant differences (p<0,05) betwen treatment by Student test

For the Chandler variety a in L* is observed, ranging from (53.74) at the beginning of storage to a value of (47.56) at 225 days.

The parameters a* and b* showed statistically significant differences during store, a* increased up to 225 days, whereas b* decreased from 180 days.

In this variety there is a significant difference between drying treatments for the three parameters. T1 being greater than T2 for L* and b*, while for the parameter a*, T2 treatment yields the highest values (Table 3).

Table 3. L, a* and b* parameters for Chandler nuts subjected to natural (T1) and oven (T2) drying along 8 months of storage.*

Time (days)	L* T1	L* T2	a* T1	a* T2	b* T1	b* T2
0	53,74 ± 1,41 a A	50,72 ± 0,86 b A	6,67 ± 0,30 b A	7,20 ± 0,64 a A	29,11 ± 0,38 a A	27,73 ± 0,40 b A
45	51,48 ± 1,38 a AB	50,47 ± 1,86 b AB	7,49 ±0,30 b B	8,09 ± 0,17 a B	28,51 ± 0,19a A	28,60 ± 0,98 b A
90	51,40 ± 0,53 a AB	49,04 ± 0,60 b AB	7,62 ±0,26 b B	7,90 ± 0,18 a B	28,55 ± 0,91 a A	27,50 ± 0,75 b A
135	52,07 ± 1,87 a AB	50,16 ± 0,65 b AB	7,88 ±0,25 b B	8,44 ± 0,16 a B	28,08 ± 0,87 a A	27,76 ± 0,57 b A
180	48,64 ± 1,88 a B	50,51 ± 0,87 b B	8,46±0,36 b B	8,20 ± 0,248 a B	25,89 ± 0,50a B	26,17 ± 0,30 b B
225	47,56 ± 1,44 a C	45,71 ± 1,30 b C	10,04±0,58 b C	10,32 ± 0,32 a C	27,16 ± 0,23 a B	26,48 ± 0,25 b B

T1: Natural drying Secado T2:Oven drying

Capital letters indicate significant differences (p<0,05) in the effect of time

Lowercase letters indicate significant differences (p<0,05) betwen treatment by Student test

For the California variety, parameters L* and b* decreased from 135 and 180 days respectively. However, it is noted an increase of parameter a* statistically significant after 225 days.

Differences between treatments were observed in parameters a* and b*, being T1 lesser than T2 for a*, while this relation is reversed for b*.

Table 4. L, a* and b* parameters for California nuts subjected to natural (T1) and oven (T2) drying along 8 months of storage.*

Time (days)	L*		a*		b*	
	T1	T2	T1	T2	T1	T2
0	49,27 ± 0,65 *AB*	48,32 ± 2,74 *ABC*	7,06 ± 0,28 b C	7,68 ± 0,24 a C	27,33 ± 1,14 a BC	26,94 ± 0,74 b BC
45	47,70 ± 1,52 *ABC*	48,14 ± 0,65 *ABC*	8,14 ± 0,85 b B	8,30 ± 0,47 a B	28,79 ± 0,72 a A	29,41 ± 1,17 b A
90	48,81 ± 0,96 *AB*	46,21 ± 1,95 *BC*	7,67 ± 0,39 b B	8,68 ± 0,68 a B	28,68 ± 0,42 a AB	28,08 ± 1,35 b AB
135	50,85 ± 1,31 *A*	44,40 ± 1,02 *C*	8,19 ± 0,17 b B	9,37 ± 0,18 a B	30,09 ± 0,29 a A	27,74 ± 0,49 b A
180	47,28 ± 1,93 *ABC*	44,41 ± 0,83 *C*	8,83 ± 0,17 b AB	10,06 ± 0,41 a AB	28,84 ± 1,31 a AB	27,44 ± 0,44 b AB
225	45,13 ± 0,44 *BC*	44,51 ± 1,26 *C*	9,69 ± 0,55 b A	10,05 ± 0,35 a A	26,46 ± 1,26 a C	26,42 ± 1,18 b C

T1: Natural drying Secado T2:Oven drying

Capital letters indicate significant differences ($p<0,05$) in the effect of time

Lowercase letters indicate significant differences ($p<0,05$) betwen treatment by Student test

4. CONCLUSION

The results confirm that both drying process in post-harvest and storage time modified the color characteristics of the grains that dependents on the variety under study. Instrumental color determination became a useful tool in order to characterize these changes.

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Effects of postharvest treatments in ruby red grapefruit quality

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ABSTRACT

The objective of this research was to study the overall quality for Ruby Red (*Citrus paradise* Macf.) grapefruits, simulating different treatments that included the normal postharvest handling of citrus fruits: temperature conditioning, cold storage, shipment periods to overseas markets such as Japan and U.S., marketing conditions, and storage at nonchilling temperature (control treatments). No significant differences were observed in color index, juice percentage and deformation index values between treatments at the beginning stage (S) with or without temperature conditioning prior to start of the cold storage. Fruits submitted to T5 and T6 showed the highest IC values (3.5 and 3.7, respectively, $p < 0.05$). The other treatments showed lower IC values in the following order: T3 = T2 = T1 > T4. This result suggests that the exposure fruits to higher temperatures have positive effect on the color changes. Fruit submitted to T5 and T6 showed the highest values of deformation (DI variable), indicated that fruit subject to upper temperatures could be more susceptible to softening during storage period. Regarding juice percentage, it was lower for T3 in compared to other treatments. It could be that cold quarantine treatment and temperature conditioning have an important commercial application for Ruby Red grapefruit (*Citrus paradise* Macf.) without adversely affecting their quality.

1. INTRODUCTION

Argentina is one of the most important citrus producers in the southern hemisphere (SAGPyA) and Ruby Red (*Citrus paradisi* Macf.) grapefruit is a variety cultivated in NOA (Noroeste Argentino) region of Argentina. International trade often requires fruit to be stored for long periods at low temperature. This condition could be detrimental to the quality of subtropical fruits such as citrus, because they are known to be susceptible to chilling injury development during cold storage (Chalutz et al. 1985). This sensitivity to low temperatures has serious economic implications, because cold storage also provides an important quarantine treatment which is required by many countries to export citrus to Mediterranean fruit fly *Ceratitis capitata* (Wield) free zone (USDA 1985). One approach to avoid chilling injury under quarantine treatment is to apply postharvest heat treatments to induce cold tolerance and to reduce the development of chilling injury symptoms (Wang 1994). However, the conditions employed in these postharvest treatments can induce several physiological and biochemical alterations such as peel injury, changes in color, that greatly reduces fruit marketability. Therefore, the objective of the present research was to study the effect of color index (CI), juice percentage (J%) and deformation index (DI) on the quality of Ruby Red grapefruit using different postharvest handling regimes.

2. MATERIALS AND METHODS

2.2 Plant material and treatments applied

The variety of grapefruit (*Citrus paradisi* Macf.) used was “Ruby Red”, selected in the Argentinean northern province of Salta. Grapefruit, subjected to temperature conditioning, were harvested 7 days earlier than fruit for other treatments. Fruit were degreened for 80 h with 3.5 mg / kg ethylene and 1.5 mg / kg CO_2 at a temperature of 26 °C and 90% relative humidity. Then, all fruit were washed, disinfected with 0.5/ 100 g sodium orthophenylphenate (SOPP), rinsed, dried, and coated with a polyethylene-based wax (18/ 100 g solid matter) containing 5000 mg / L thiabendazole (TBZ). After that, all fruits were packed and the boxed were randomly distributed among different treatments before being transporting to the laboratory, located about 1200 km south (a 36 h trip), in refrigerated transport at 7 ± 1 °C. Six different treatments, simulating different steps used in postharvest handling, were applied: normal postharvest treatments (temperature conditioning and cold storage), simulated shipment periods to overseas markets such as Japan and USA, marketing conditions, and storage at non chilling temperature (control treatments) as described in the Figure 1.

Three boxes with 40 fruits each were used for the analysis of each of the six treatments. Grapefruits were sampled immediately after transportation (S), and marketing conditions (SC). Color measurements (*L**, *a** and *b** parameters) were performed in triplicate and average values were calculated for each fruit and converted into CI = (1000. a*) / (L*. b*) using a Byk Garden color view model 9000 with D65 illuminant and large vision area was measurement. J% was performed on 3 fruit pool. Each pool was obtained by squeezing six randomly chosen fruit. ID was performed by means of an Instron tests machine. Grapefruit equatorial deformation was measured after applying a force of 2 kg.

2.2 Statistical analysis

The experiment procedure consisted of a randomized design, with three replicates per treatment, with each box being replicate. The data were analyzed using ANOVA considering stage and treatment effects, using SPSS® (v 12.0 Illinois, USA).

<table>
<tr><th colspan="2">Treat \ Days</th><th>1 to 18</th><th>19 to 22</th><th>23 to 29</th><th>30 to 35</th><th>36 to 42</th></tr>
<tr><td>T1</td><td>R</td><td>Q</td><td colspan="3">Storage</td><td>Marketing</td></tr>
<tr><td>T2</td><td>R</td><td>Q</td><td>Storage</td><td>Marketing</td><td colspan="2"></td></tr>
<tr><td>T3</td><td>C + R</td><td>Q</td><td colspan="3">Storage</td><td>Marketing</td></tr>
<tr><td>T4</td><td>C + R</td><td>Q</td><td>Storage</td><td>Marketing</td><td colspan="2"></td></tr>
<tr><td>T5</td><td>R</td><td colspan="4">Storage</td><td>Marketing</td></tr>
<tr><td>T6</td><td>R</td><td colspan="2">Storage</td><td>Marketing</td><td colspan="2"></td></tr>
<tr><td>Stage</td><td>S</td><td>SA</td><td colspan="2">SB</td><td colspan="2">SC</td></tr>
</table>

R= transport under refrigeration to laboratory; C= Conditioned, 7 days at 15-16°C in packing house; Q= Quarantine simulation, 2°C 85% HR; Storage= 13°C 85% HR; Marketing= simulation of marketing conditions at 20°C.

Figure 1. Scheme of treatments applied and sampling time.

3. RESULTS AND DISCUSSION

In this study, quality parameters were analyzed at the beginning of the assay and at the end of the marketing simulation period. The results corresponding to CI, J% and DI values for the different treatments at the end of refrigerated transport (S) were no significant differences among postharvest treatments were observed (Table 1).

Table 1. Means and standard deviations of IC, juice% and DI from each treatment in the stage S.

	Treatments	IC	Juice %	DI
S	**T1** and **T2**	2.8 ± 0.4	47.9 ± 1.7	0.60 ± 0.004
	T3 and **T4**	2.9 ± 0.6	48.9 ± 2.1	0.54 ± 0.007
	T5 and **T5**	2.8 ± 0.4	49.7 ± 2.8	0.57 ± 0.006

Grapefruits were sampled immediately after transportation (S), and marketing conditions (SC). The six treatments were applied. In Table 2 can be observed the results corresponding to the same variables analyzed on the stage SC. Analysis of variance showed significant differences between treatments for CI ($p < 0.005$), J% ($p < 0.01$) and DI ($p < 0.005$).

Fruits submitted to T5 and T6 (that only were exposed to refrigerated transport to laboratory plus storage and marketing periods to 13 °C and 20 °C, respectively) showed the highest IC values (3.5 and 3.7, respectively, $p < 0.05$). The other treatments showed lower IC values in the following order: T3 = T2 = T1 > T4. This result suggests that the exposure fruits to higher temperatures have positive effect on the color changes. Regarding this effect, it is well known that the color change processes involve both, the destruction of chlorophylls already present in the cell, and the development of carotenoid pigments responsible for the orange color (Wheaton and Stewart 1973). These enzymatic reactions have different optimal temperatures. For the chlorophyll degradation, the induction and inhibition temperatures are 28 °C and 40 °C respectively, while for carotenoids synthesis are 18 °C and 30 °C, respectively. Therefore, the condition applied in the T5 and T6 treatments would have induced the carotenoids synthesis, rendering a higher IC value.

Fruit submitted to T5 and T6 showed the highest values of deformation (DI variable), indicated that fruit subject to upper temperatures could be more susceptible to softening during storage period. Instead, the other treatments that involved quarantine showed less deformation index.

Regarding juice percentage, it was lower for T3 in compared to other treatments.

The response of a particular fruit to the heat treatments results from a combination factors including physiological age of the commodity, time and temperature of exposure, treatment methods, and storage temperature (Lydakis and Aked 2003).

In general, the longer treatments, including conditioning for 3 to 7 days and heat treatments for 2-3 days, significantly increase fruit weight loss, enhanced changes in fruit peel color, and decrease in juice acid content. On the other hand, the enhancement of fruit pigmentation by the long heat treatments may be beneficial (Porat et al. 2000).

Table 2. Means and standard deviations of IC, Juice% and DI from each Treatments in the stage SC.

Stage	Treatments	**IC**	**% Juice**	**DI**
SC	**T1**	2.9 ± 0.5 b	48.9 ± 1.6 a	0.57 ± 0.03 b
	T2	3.1 ± 0.7 b	47.9 ± 5.4 a	0.56 ± 0.09 b
	T3	2.9 ± 0.9 b	43.2 ± 6.0 b	0.57 ± 0.08 b
	T4	2.3 ± 0.7 c	47.5 ± 3.5 a	0.61 ± 0.06 ab
	T5	3.5 ± 1.0 a	47.9 ± 3.3 a	0.65 ± 0.08 a
	T6	3.7 ± 0.6 a	46.8 ± 1.8 a	0.62 ± 0.05 a

Means with different letters are significantly different ($p < 0.05$ LSMEANS).

4. CONCLUSION

In the present research, it was found that Ruby Red grapefruit did not develop chilling injury under the postharvest practices applied at the end of simulated marketing period. Cold treatments are an effective quarantine method to kill eggs and larvae in grapefruit and are commercially applied by various citrus-importing countries. The application of heat treatments before cold disinfestations may overcome the risk of potential fruit damage from chilling injury after quarantine treatment.

Based on these results, it can be concluded that cold quarantine treatment and temperature conditioning have an important commercial application for Ruby Red grapefruit (*Citrus paradise* Macf.) without adversely affecting their quality.

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Color changes in vaccum-packed squid mantle rings (*Illex argentinus*) induced by gamma radiation

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ABSTRACT

Color measurement has been widely used for determining food quality, since color changes have been associated with deteriorating reactions such as lipid oxidation (particularly in squid), among many others. In this study, four different gamma radiation doses (0, 1.8, 3.3 and 5.8 kGy) were used as a preservation technology on minimally processed vacuum-packed squid mantle rings (*Illex argentinus*). Radiation induced color changes were analyzed in order to understand how gamma radiation affects squid quality during refrigerated storage (4 ºC). CIELAB color parameters, a*, b* and L* were determined using a portable colorimeter (NR-3000, Nipon Denshoku Kogyo Co. Ltd.) and color difference (DE^*_{ab}) was calculated for each day of analysis (1, 5, 8, 12, 15, 19 and 22 d) with respect to day 1. Color parameters a*, b* and L* of squid rings were affected by gamma irradiation ($p < 0.05$). In general, radiated samples values did not changed during storage while in non-irradiated sample it was observed a b* values increase towards yellow and a decrease of a*. Color difference of radiated samples, with respect to day 1, did not significantly ($p < 0.05$) changed during the whole storage period (22 days) while DE^*_{ab} of non-irradiated sample significantly increased ($p < 0.05$) reaching a value of 14.667 at day 22. Independently form the dose, radiation decreased color changes of squid rings during vacuum-packed refrigerated storage. Gamma irradiation was effective in improving color quality of mantle squid rings stored at 4 ºC.

1. INTRODUCTION

Food irradiation has demonstrated to be not only an useful but an efficient technology to reduce microbial counts and to increase food shelf life (Kilcast 1995, Kodo 1990). Unfortunately, consumer acceptance seems to be affected by wrong concepts about ionizing radiation even if the WHO, FDA, USDA and FAO have approved its safety. Diffusion of science-based information and human health safety seems to be the key to achieve success of irradiated products in the market (Byun et al. 2009).

Seafood is known to be a highly perishable food, deteriorated mostly by Gram-Negative bacteria, and so, wide research has been done in order to preserve it by gamma irradiation. Shelf-life of *Sea bream* (Chouliara et al. 2004), *Merluccius Hubbsi* and whole anchovies (Lakshmann et al. 1999) was improved by gamma irradiation and shelf-stable ready-to-eat shrimps were developed using this technology by Kannat et al. (2006). Irradiation of squid has been studied by Byun et al. (2000) in fermented and salted *Todarodes pacificus* but more studies could be done in order to extend shelf-life of fresh minimally processed squid by gamma radiation.

Illex argentinus is a Neritic-Oceanic species belonging to the Ommasthrefidea family, frequently found between the 52 ºS and the 35 ºS over the argentinean continental platform and slope (Brunetti et al. 1998). It represents the most abundant squid species of the country. Its capture figures, second among marine captures, were more than one million tons in 2006, representing a 27.3% of the total. In 2006, about 180.000 tons of squid Illex were exported from Argentine, mainly to Spain, representing a 28% of the marine products exports.

Squid is processed for its consumption in many different ways, fried floured squid rings (*rabas)* are consumed in North America and northern Europe (Paarup et al. 2002a) and in Latin America.

Research has been done on quality of fresh and spoiling squid (Lapa-Guimaraes et al. 2002, Paarup et al. 2002a, 2002b,) and autolytic changes have been found to be an important reason of deteriorating quality (Lapa-Guimaraes et al. 2002, Paarup et al. 2002a). As squids are highly perishable products, their sensory quality decreases after capture, and this fact has been related to changes in squid skin color and muscle stain formation (Lapa-Guimaraes et al. 2002). Sensory, chemical and microorganism tests are used in assessing squid freshness, but assessments based on external color and texture are often used in market transactions (Sugiyama et al. 1989).

Color measurement is important to determine quality of foods. In some foods it is used as an index of ripeness and spoilage (Potter and Hotchkiss 1995). Color is usually considered the most important attribute of any food's appearance. The appearance of the product is the first impression a consumer has of food. Color has to be within an expected range for food acceptance and the degree of acceptability is judged within that range. If the color is unacceptable, the other two major quality factors, flavor and texture, are not likely to be judged at all (Francis 1995). Color directly influences consumers purchase choices and so it is important to understand how color changes during storage and also which is the effect of gamma radiation. The objective of this work was to analyse the effect of different gamma radiation doses on color changes of vacuum-packed squid rings (*Illex argeninus*) during storage at 4 ºC, for further studies on shelf-life extension.

2. MATERIALS AND METHODS

2.1 Raw material source, treatment and storage

Peeled squid mantle rings of *Illex argentinus* specimens pre-treated with commercial solutions (H_2O, H_2O_2, citric acid/sodium citrate, sodium polyphosphate and Na_2CO_3 / $NaHCO_3$) were acquired in the port of Mar del Plata (Argentina). They were transported to laboratory in polystyrene containers covered with ice flakes.

Samples of approximately 110 $\pm$ 2 g were vacuum packed in a vacuum pakaging machine Minimax 430M (Servivac, Argentine). Cryovac bags of LDPE and nylon were used (125 µm, OTR: 35 cc/m^2/day (23 ºC; 0% HR), MVTR: 7 g/m^2/day (38 ºC; 90% HR)). Samples were transported refrigerated (4 $\pm$ 3 ºC) to the semi-industrial Ezeiza Atomic Centre facility (National Atomic Energy Commission (CNEA) of Argentina; activity: 600,000 Ci). They were gamma irradiated with a ^{60}Cobalt source at 1.8 (D1), 3.3 (D2) and 5.8 (D3) kGy (minimum doses absorbed). Doses were determined with Amber Persex dosimeters. Irradiated and non-irradiated samples (control, C) were stored at 4 ºC for 22 days. Samples were analysed days 1, 5, 8, 12, 15, 19 and 22, T0, T1, T2, T3, T4, T5 and T6, respectively.

2.2 Colour analysis

In order to determine CIELAB color space system parameters (L* = lightness, a* = red colour intensity, and b* = yellow colour intensity) a portable colorimeter was used (NR-3000, Nipon Denshoku Kogyo Co. Ltd.) with Standard Illuminant D65 and 2º Standard observer. Measurements on both sides were made on five rings of each sample. Color difference (DE^*_{ab}) for each storage time analyzed with respect to reference (T0) were calculated according to:

$$\Delta E = \sqrt{\left(L^* - L_r^*\right)^2 + \left(a^* - a_r^*\right)^2 + \left(b^* - b_r^*\right)^2}$$

2.3 Statistical analysis

Results were analyzed by a two main factors completely aleatorized design. The effects considered were Radiation Dose (0, 1.8, 3.3 and 5.8 kGy) and Days of Storage (1, 3, 5, 9, 12, 15, 19 and 22 d) and also interaction between them was analyzed. A two-ways ANOVA test was used with a 5% significance level. In further analysis, Tukey tests were used to compare means ($\alpha = 0.05$). The experiment was repeated twice. The statistical analysis was carried out using the R-Project software (R Development Core Team 2008).

3. RESULTS AND DISCUSSION

Color changes were analyzed for being associated to spoilage reactions. Thanonkaew et. al. (2006) informed that yellow pigment formation has been associated with lipid oxidation and quality deterioration. In Figures 1, 2 and 3 it is shown the evolution of b*, L* and a* color parameters respectively, during storage of squid mantle rings at 4 ºC.

Values of b* are used as a measure of yellowness. They were analyzed by two ways ANOVA and results indicated that interaction between Dose and Days of storage was significative ($p < 0.05$). The b* values tended to increase in Control during storage time towards yellows, meanwhile irradiated samples were not significantly different in time ($p < 0.05$) (Figure 1), which indicates that b* is independent from the radiation dose applied. The same pattern was observed in L* values in terms of increase in Control L* values and significative interaction of Dose and days, although irradiated samples showed significative differences ($p < 0.05$) (Figure 2). There was no effect of interaction Dose-Storage days on a* values, but they were significantly lower ($p < 0.05$) for control with respect to samples irradiated at 1.8 and 3.3 kGy. The a* values of irradiated samples were practically constant during storage, while they decreased for control sample towards green (Figure 3).

In general, the observed behavior of color parameters indicated that gamma irradiation, independently from the dose used, permitted to keep color parameters almost unchanged during 22 days of storage at 4 ºC in squid rings. Meanwhile non-irradiated sample color parameters significantly changed during storage, with an increase in b* and L* and a decrease in a* values. Color parameters a*, b* and L* of squid rings were affected by irradiation ($p < 0.05$).

Results obtained for a*, b* and L* of unirradiated samples are in agreement with those found by Lapa-Guimaraes et al. (2002) in *Loligo plei* mantle with respect to b* and L* increase and a* decreasing patterns during storage at 4 ºC. They found differences on muscle color parameters whether squid was or was not in contact with ice. Yellow pigment formation in squid (b* value increase) has been associated to deterioration and lipid oxidation products reactions (Thanonkaew et al. 2006).

Studies indicate that autolytic deteriorating reactions are more predominant in squid than in fish (Lapa-Guimaraes et al. 2002; Paarup et al. 2002a) but according to Kodo (1990) radiation doses used in this study are not enough to stop enzymatic activity.

Discoloration is also due to bacterial spoilage and taking into account the lower Total viable and psychrotrophic counts found in radiated samples compared with control, this could explain the fact that color did not significantly changed in radiated samples. Microbiological tests carried out in this study showed a dose dependant reduction of mesophiles and psycrotrophic bacteria counts (data not shown).

Even if squid presents a low fat content of about 1-2 %, Thanonkaew et al. (2006) reported an increase of b* values in *Loligo peali*, due to aldehylic lipid oxidation products. He suggests that formation of off-color in squid mantle could be due to nonenzymatic browing reactions between aldehydic lipid oxidation products and the amines on phospholipids headgroups.

Radiated samples b* values were practically constant meanwhile b* increased in control during 22 days of storage. According to Tükenmez et al. (1997) radiation induced free radicals are known to favor lipid oxidation and so it could have been expected to find higher b* values in irradiated samples. In this work, this did not occur and it could be explained by the lack of oxygen due to vacuum-packaging. As it has been observed by Brewer (2009) the absence of oxygen affects aldehyds generation, decreasing lipid oxidation.

The yellowness increase in control sample, also vacuum-packed, could be explained by the freshness loss related to bacterial spoilage reactions, as described above, delayed by gamma radiation in treated samples. Sugiyama et al. (1989) informed that after capture the transparency is gradually lost and squid meat becomes tinged white.

Color difference was calculated and evaluated for each day of analysis with respect to the first storage day, using L*, a* and b* parameters. Results, standard errors and Tukey Test results ($p < 0.05$) are shown in Table 1.

Color difference of non-irradiated sample significantly increased ($p < 0.05$) during storage, reaching a value of 14.67 on day 22. After day 5, DE^*_{ab} of control was significantly higher than irradiated samples. For all treated samples, there were no significative differences ($p < 0.05$) of color difference with respect to day 1 during the 22 days of storage at 4 ºC. Values were practically constant ranging between 1.96 and 3.81 for D1, D2 and D3 during the whole storage period. Gamma irradiation, without concerning the dose applied, avoided color changes of squid rings during vacuum-packed refrigerated storage.

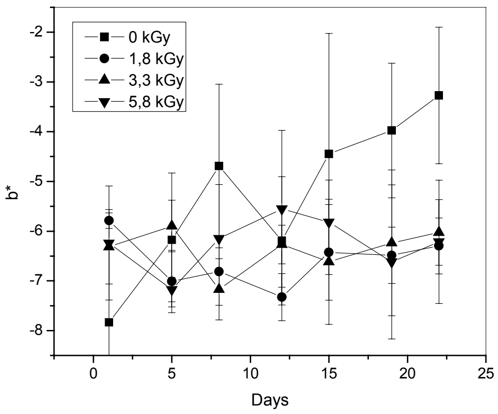

Figure 4. Evolution of b values of irradiated squid rings during storage at 4 ºC. Standard error represented by bars.*

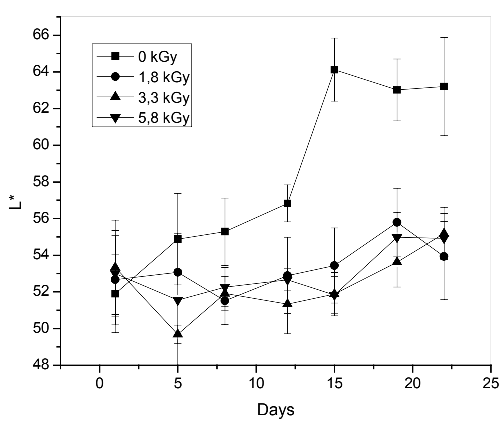

Figure 5. Squid rings L values evolution during storage at 4 ºC. Standard error represented by bars.*

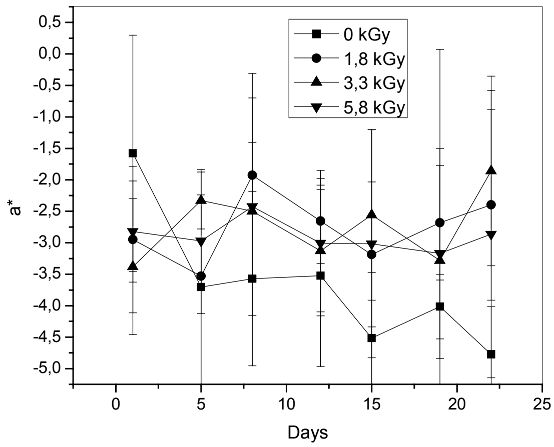

Figure 6. Vacuum-packed squid rings a values evolution during storage at 4 ºC. Standard error represented by bars.*

Table 1. Means, standard error and Tukey Test results for Color difference values of irradiated squid rings stored at 4 ºC.

	Dose											
Storage Time	**C**			**D1**			**D2**			**D3**		
	Mean	e.e.±	*	Mean	e.e.±	*	Mean	e.e.±	*	Mean	e.e.±	*
T0(d1)	0.000	0.000	c A	0.000	0.000	a A	0.000	0.000	a A	0.000	0.000	a A
T1(d5)	5.485	4.117	b A	2.720	0.412	a A	3.295	1.362	a A	3.656	1.853	a A
T2(d8)	5.982	3.604	b A	3.092	0.664	a AB	2.333	0.624	a B	3.103	0.780	a AB
T3(d12)	6.522	2.179	b A	2.897	0.239	a AB	2.194	0.570	a B	2.470	0.386	a B
T4(d15)	14.478	2.910	a A	1.960	1.688	a B	2.089	0.512	a B	3.303	2.137	a B
T5(d19)	13.402	1.937	a A	3.809	1.099	a B	2.623	0.673	a B	3.316	0.429	a B
T6(d22)	14.667	2.485	a A	2.881	0.633	a B	3.200	2.748	a B	2.137	0.913	a B

** Same letters (a, b, c) in the same column indicate non-significative differences of DE^*_{ab} with respect to day 1 in time for each dose applied. Means with the same capital letter in the same raw are not significantly different (Tukey Test, $p < 0.05$).*

4. CONCLUSIONS

Regardless the dose, radiation reduced yellow pigment formation (b* value increase) and avoided color changes with respect to day 1 during 22 days of storage at 4 ºC in vacuum-packed squid mantle rings. Color difference of non-irradiated squid rings increased during the storage period, which could be associated to bacterial spoilage reactions leading to quality loss. Gamma irradiation was useful for diminishing color associated deterioration reactions of minimally processed vacuum-packed mantle squid rings.

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Effect of washing-disinfection conditions on total anthocyanins retention and color of fresh-cut strawberries

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ABSTRACT

The aim of this work was to evaluate the total anthocyanins retention and color changes of fresh-cut strawberries after peracetic acid (PA) washing-disinfection at different times and temperatures. Response Surface Methodology was used with a Box-Benhken three-level, three-factor design (PA concentration: 0-100 ppm; time: 10-120 s; and temperature: 4-40 °C). The responses were: total anthocyanins retention and color parameters. Total anthocyanins content of the untreated strawberries were 24.8 mg P3G / 100 gfw. The peracetic acid concentration and time (linear terms), and temperature (interaction term with time) were significant for the total anthocyanin retention model. The anthocyanin retention decreased as both PA concentration and time increased. The only instrumental color parameters affected by process were L* and a*. PA concentration was significant ($p \leq 0.05$), for L* and a* parameters (linear and quadratic term, respectively). The parameter a* was significantly affected by temperature too (quadratic term). The a* values decreased as both PA concentration and temperature increased and L* values increased as PA concentration increased. The predictive models obtained were shown to be adequate and could be used as a way of improving the washing-disinfection operation.

1. INTRODUCTION

Strawberries are a good source of vitamin C and anthocyanins. The latter are responsible for strawberry appealing and bright red color. Another significant property is their antioxidant activity, which plays a vital role in the prevention of different illnesses. Disinfection of fresh-cut products by washing is an essential operation to eliminate foreign matter and cellular fluids produced by cutting (Pirovani et al. 2004). Some technological problems that may take place during washing operations of fresh-cut vegetables are the loss of pigments, vitamins, and bioactive compounds by oxidation and/or leaching, and other compounds by dissolution in the wash water. The color of a food product is an important fresh-like attribute for the consumer to evaluate the quality of the product. Several disinfections agents possess strong oxidizing properties related with deleterious effects on the color of vegetables. Compounds derived from chlorine are disinfectants widely used in the fresh-cut vegetables industry. However, reaction of chlorine with organic matter results in the formation of suspected carcinogenic by-products (Ölmez and Kretzschmar 2008). On the other hand, peracetic acid (PA) is a sanitizing agent which does not react with proteins to cause toxic or carcinogenic compounds and its only decomposition products which have been reported are oxygen and acetic acid (Silveira et al. 2008, Vandekinderen et al. 2009). In this study we propose to quantify and to model changes in the total anthocyanins and color parameters during washing-disinfection of fresh-cut strawberries using solutions of PA at different times and temperatures.

2. MATERIALS AND METHODS

2.1 Plant material and minimally processing

Strawberries fruits (*Fragaria ananassa* Duch), var. *Camarosa*, received directly from a local producer of Arroyo Leyes, Santa Fe, Argentina, were selected, eliminating those with signs of damage, as well as, parts of the plant. Calyx and peduncle were cut-off using a sharp knife. Then, strawberries were washed with tap water, drained on absorbent paper and cut with a stainless-steel sharp knife, longitudinally, into quarts. Cut fruits were washed in the conditions indicated by the experimental design, with a ratio of 3 L of washing solution per kg of fruit. Subsequently, quarts and control raw material (200 g) were stored at –80 °C until analysis.

2.2 Anthocyanin content

Five grams of crushed fruit were homogenized with 75 ml acetone / water (80:20) and sonicated in an ultrasonic Testlab bath, for 5 minutes. The mixture was centrifuged at 12.000 g for 30 minutes at 4 °C with a MSE-Mistral 4 L refrigerated centrifuge. The supernatant was separated and used for analysis. All samples were analyzed by duplicate.

The total anthocyanin content was determined on the extracts with the pH differential method according to Heo and Lee (2005). Sample absorbance in buffer solutions at pH 1 and 4.5 was measured at 510 and 700 nm with a Milton Roy spectrophotometer. Absorbance readings were converted to milligrams of pelargonidin-3-glucoside / 100 g fresh fruit (mg P3G / 100 g fresh fruit), using a molar extinction coefficient of 22400 L / (mol.cm), an optical path of 1 cm and an absorbance of:

$$A = \left[(A_{510} - A_{700})_{pH=1} - (A_{510} - A_{700})_{pH=4,5}\right]$$

2.3 Color determination

Colorimetric measurements of each crushed sample (about 50g per sample) were made placing samples in white plastic cells (40 mm diameter, 10 mm high), and using a Minolta CM-508d spectrophotometer, calibrated using the standard white tile. D65/10º was used as the illuminant/viewing geometry and specular component excluded (SCE). CIELAB values were evaluated. Chroma value ($C^*_{ab} = (a^{*2} + b^{*2})^{0.5}$), and hue angle ($h_{ab}$ = arctangent b^*/a^*) were also determined. Five measurements were performed on each sample. Results were also shown as color retention percentage of raw material.

2.4 Experimental design

Response surface methodology (RSM) using a Box-Behnken design (three factors at three levels) was used. It was assumed that there was a mathematical function for each of the responses (percentage of retention, compared with raw material, for total anthocyanins, and color), according to three independent factors of process: **Y = f (C, T, t)**; where Y = Response, C = concentration of PA (ppm), T = temperature of the wash solution (°C) and t = time of treatment (s). The 2nd order polynomial equation proposed as a model was:

$$Y_k = \beta_{ko} + \sum_{i=1}^{3}\beta_{ki}X_i + \sum_{i=1}^{3}\beta_{kii}X_i^2 + \sum_{i=1}^{2}\sum_{j=i+1}^{3}\beta_{kij}X_iX_j$$

Where: β_{ko}, β_{ki}, β_{kij} are the coefficients and *Xi* are the independent variables coded. The independent variables, the coded variables and their levels are presented in Table 1.

Table 1. Experimental design of Box-Benhken, variables and coded and uncoded levels.

Independent Variable	**Coded-variable**			
	Symbols	**Levels**		
		-1	**0**	**1**
Peracetic acid conc. (ppm)	X1	0	40	80
Temperature (°C)	X2	4	22	40
Time (s)	X3	10	35	60

2.5 Statistical analysis

Statgraphics® was used for data analysis through ANOVA and to test the suitability of the proposed models, as well as to adjust the 2nd polynomial equations in order to plot the experimental data and surface models for each response.

3. RESULTS AND DISCUSSION

The raw material had a total anthocyanin content of 24,8 ± 1,5 mg P3G / 100 gff. The CIELAB values and the derivate parameters were: **L***= 31.9 ± 0.6; a*=25.4 ± 0.7; b*=12.2 ± 0.6; $\mathbf{C^*_{ab}}$=28.2 ± 0.9 and $\mathbf{h_{ab}}$=25.7 ± 0.5.

In the case of total anthocyanins, the response surface model described the experimental data adequately (R^2 = 0.912), exhibiting no significant lack of fit ($p \geq 0.05$). The peracetic acid concentration and the washing-disinfection time, as described by the linear term, and the temperature, as described by the interaction term with time, were significative ($p \leq 0.05$) for the total anthocyanin retention model. The predictive model obtained by eliminating non significative terms, was:

$$Y = 59.877 - 0.216X_1 + 0.240X_3 - 0.006\,X_2X_3$$

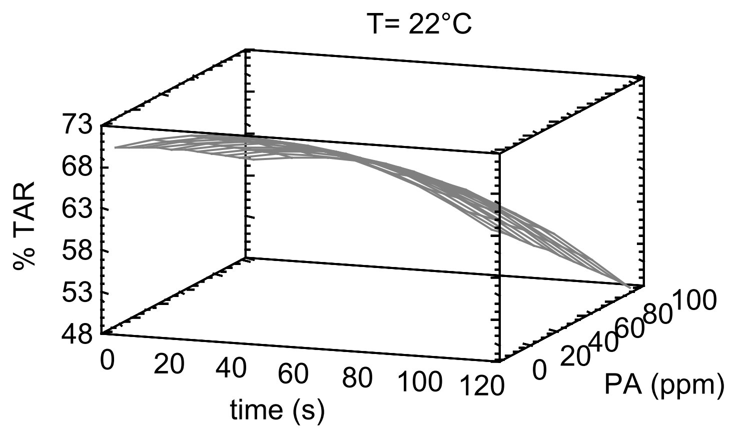

Figure 1. Response surface of total anthocyanins retention (% TAR).

As it is shown in Figure 1, the total anthocyanin retention decreases as both peracetic acid concentration and time increase. The only instrumental color parameters affected by process were L* and a*. PA concentration, described by a linear and quadratic term, was significative ($p \leq 0.05$), for a* and L*. The a* was also significantly affected by temperature, described by the quadratic term. The experimental data show that the a* values decreased (less red) as PA concentration and temperature increased; and L* values increased (lighter colors) as PA concentration increased.

Peracetic acid solution also contains H_2O_2 (300 and 600 ppm in 50 and 100 ppm PA concentration, respectively). We suppose an oxidizing degradation of anthocyanins as peracetic acid and, in the same way, H_2O_2 concentration increase. These results are in agreement with Özkan et al. (2002) that described the effect of decomposition and dissociation products of H_2O_2 as responsible for the oxidation and subsequent degradation of phenolic compounds.

The predictive models obtained were shown to be adequate and could be used as a way of improving the washing-disinfection operation.

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Effects of maturity stage and use of drying on sweet cherries *(Napolitan var.)*

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ABSTRACT

The effect of different treatments previous to drying on the color of mature and immature cherries (*Napolitana var.*) has been compared. The superficial color in colorimetric coordinates and pigments by spectrophotometry have been evaluated after pretreatments (blanching and/or immersion in saline acid solutions) and along the drying process. The Hunter L and a values were different for fruits in both states of ripeness and varied considerably by applying a thermal treatment. To the end of the process higher L values were observed in immature fruits than in the ripe ones. The a values decreased considerably in the first drying stages but they increased along the process in pretreated fruit recovering the red shades typical of the pigment present specially in mature cherries consistent with the absorbances measured. The combined treatments led to protect, to a greater extent, the anthocyanin pigments, which results of great importance in fruit varieties with relatively low quantity of pigments.

1. INTRODUCTION

Cherry is a non-climacteric fruit that must be harvested at physiological maturity stage determined by the following indices: soluble solids content (SSC), acidity and color. Napolitana cherry is bright light red, of small caliber and it has an intermediate firmness compared to other cultivars. Taste perception, related to a balance between SSC and acidity, is of 0.48 when the market demands values from 1.8 and 2.0 for the acceptance of fresh fruit (Salato 2006). These characteristics make industrialization as its only destiny. Although dehydration constitutes a traditional conservation method used to extend the shelf life of fruits, it has been infrequently applied to this type of raw material, probably due to reactions that take place during the process and lead mainly to an important damage in color.

In these fruits, the pigments responsible for the attractive red color are the anthocyanins, which are compounds relatively unstable to the variation of certain external factors, being the acid environment the factor where greatest stability is achieved. In this type of food, the antocyanins can exist in 4 structural forms, depending on pH: the blue quinonoidal base (pH near to 6.0), the red flavylium cation (pH $\approx$ 1.0) and the colorless forms (pseudocarbinol and chalcone; pH $\approx$ 4.5). As regards temperature, the structural characteristics that lead to an increase in pH stability also lead to thermal stability. By increasing the temperature, the equilibrium moves to the formation of chalcone. During the conservation of food enriched with organic acids these pigments are linked to with the acids (copigmentation), improving and stabilizing their color. This is evident by the hyperchromic effect and the bathochromic shift detected by spectrophotometry (Rein 2005). The aim of this work was to apply different treatments previous to cherry drying to achieve greater color retention during subsequent drying.

2. MATERIALS AND METHODS

Fresh cherries (*Prunus avium*, Napolitana *var.*) were selected in the High Valley of Río Negro, at different maturity degrees. The characterization of fruit was carried out by analyzing the following parameters according to AOAC (1979): moisture, pH, total acidity and soluble solids content by refractometry (SSC). The *pigments* were evaluated after extraction with a methanol and hydrochloric acid mixture (1%) and a subsequent spectrophotometric reading of absorbance at 530 nm (Ochoa et al. 2001). The *superficial color* was determined by measuring tristimulus parameters (Hunter Lab color space) with a Minolta CR 400 photocolorimeter, standardized with a white ceramic plate (L = 95.55, a= -0.10 y b = +2.69). *Hue angle* values were calculated to analyze the red color evolution. The *pretreatments* used were: 1) blanching with boiling water vapor during 1.5 min and subsequent water cooling at 4 ºC for 2 min (B), 2) combined blanching treatment and subsequent fruit immersion in a citric acid solution (10% p/v) for 5 min (B+Dip 1) and 3) combined blanching treatment and subsequent fruit immersion in a citric acid solution (10% p/v) and calcium lactate (2.5% p/v) for 5 min (B+Dip 1 + Dip 2). The *dehydration* was performed in a pilot drying chamber (70 ºC, 4m/s air speed and 10% relative humidity). A Statgraphic Plus 5 statistics software was used to evaluate by an ANOVA and a multiple comparisons test, the significant differences ($p < 0.05$) between the different experimental conditions.

3. RESULTS AND DISCUSSION

Comparing the parameters used in postharvest, it was observed that SSC fresh cherry values were of 22.5 ± 1.32°Brix (mature cherry) and 16.0 ± 1.73°Brix (immature cherry) with the same acidity values (0.56 ± 0.11 g citric acid / 100 g). Mature cherry showed a Hunter a value higher than in the immature in a 30% that coincided with the spectrophotometric reading of red pigments, whose values were higher in a 38% with respect to the immature ones. Fresh cherries in both states of maturity and subjected to pretreatments showed significant differences in superficial color. The Hunter L for ripe cherries increased with the pretreatments due to dilution of pigment colour and swelling of the fruit by the application of a thermal treatment and a subsequent immersion in water. This would lead to lower colour saturation and greater lightness of the product. For immature fruits (higher initial L and less initial pigments content) pretreatments led to a decrease in L and blanching affected this parameter slightly. The Hunter a, both in mature as in immature cherries, diminished in an abrupt way with pretreatments in all the cases. The blanching present in all pretreatments not only produced thermal pigments degradation but also it would have acted on them shifting the chemical balance to the colorless resonanting structure of anthocyanin.

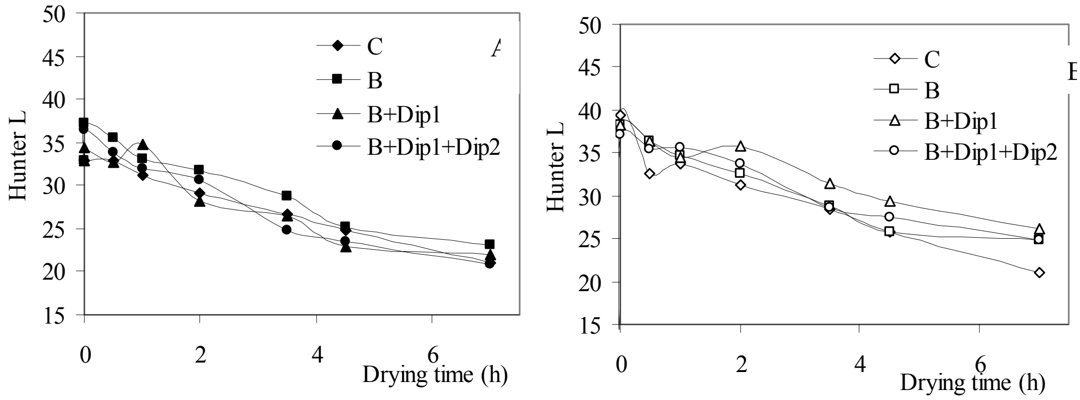

Figure 1. Evolution of Hunter L parameter along the drying process in mature (a) and immature cherries (b) with or without pre-treatment.

A decrease in cherries lightness along drying was observed in all cases (Figure 1.a. and b.). After 2h of drying, the decrease in mature cherries (calculated respect of fresh fruit) was of 10.9% for non-pretreated fruit (control), 14% for B+Dip1 and 3-7% for the rest of the conditions, whereas immature fruit did not present significant differences between the different pretreatments at this drying stage. At the end of the drying process immature cherries presented, in general, a greater Hunter L than mature ones, except from control cherries, which did not present significant differences ($p < 0.05$).

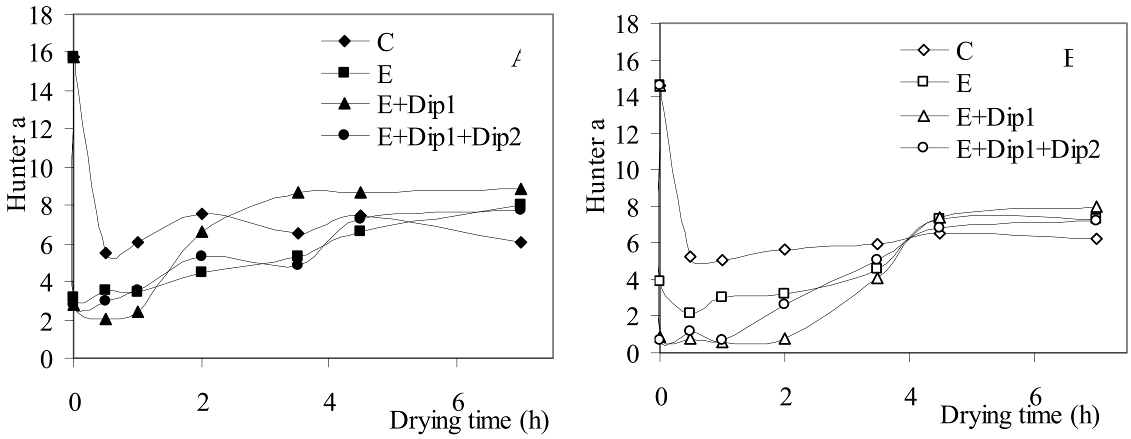

Figure 2. Hunter a parameter evolution during drying of mature (a) and immature (b) cherries with or without pretreatment.

In the first drying stages (0.5 h) the Hunter a diminished abruptly in all cases (Figure 2). In the control ripe cherry (Figure 2.a) the reduction was that of 65% with the appearance of brown shades characteristics of enzimatic browing that pigments suffer due to the high temperatures of the process, and then remained aproximately constant until the final stage of dehydration. In pretreated samples a greater decrease of the parameter (78 - 88% from 0.5 h) was produced. In all cases a significant recovery of the values after 2h of process was observed, reaching after 7h of drying approximately between 43.8 and 62.5% of the initial value measured when fresh. During heat exposure it would be not only inactivating part of polyphenoloxidases, enzymes that acts on anthocyanins, but also a concentration of the acids present would be allowing a greater pigments expression along the course of dehydration of the fruits. In cherries pretreated with immersion in an acid environment a greater protection of the anthocyanin pigments during drying would explain the highest rate of increase of Hunter a in the early hours of these curves (Figure 2.a).

Even though pretreated immature cherries (Figure 2.b) presented a greater variation in the Hunter a parameter in the first drying stages, similar values to mature cherries were reached to at the end of the process, independently of the pretreatment used. These results are coherent to the Hue values obtained, between 38.99 ± 7.01 and 48.05 ± 6.30 for ripe cherries and between 49.82 ± 5.48 and 57.48 ± 5.17 for the immature ones.

According to Figure 3 the absorbances measured in ripe cherries diminished between 68 – 74% in all cases, while in immature cherries the values did not present significant differences along drying. In mature fruits there was a gradual increase in absorbance, reaching values above the initial in pretreated samples. The most effective pretreatment was the B+Dip1 combination, in which the absorbance values overcame 40% of the initial value. Probably anthocyanin compounds, in an acid environment and by means of heat can present a hyperchromic effect (copigmentation phenomenon of these compounds). On the other hand, high sugar concentrations of mature fruits could stabilize the anthocyanins due to water activity decrease. In immature fruits the low concentration of the mentioned nutrients would accelerate the degradation of the pigments (Usenik et al. 2008).

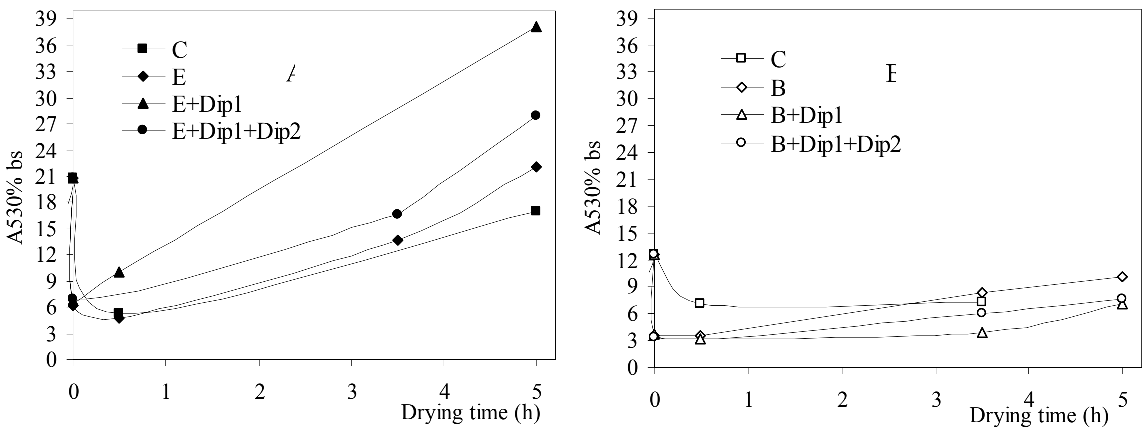

Figure 3. Red pigment evolution in mature (a) and immature (b) cherries along drying measured by spectrophotometry.

4. CONCLUSIONS

According to the evolution of the Hunter parameters during drying and the measurements of red pigments by spectrometry, combined treatments were effective in relation to color retention during the drying of both ripe and immature cherries. On one hand, the thermal treatment permitted to protect the anthocyanic compounds from the action of polyphenoloxidase. On the other hand, the acid environment allowed the anthocyanin resonating structures to move to the formation of flavylium cation, the only structure present and with greater stability than the other resonating forms. Preliminary sensorial analysis results showed that calcium salts decreased the blanching effects on the fruit structure, being this treatment the most favorable from the end-product sensorial characteristics point of view.

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Temperature, air speed and pre-treatments influence in dehydrated sour cherries color

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ABSTRACT

The aim of this work is to evaluate the color changes that occur during air dehydration of Montmorency sour cherry. They were subjected to dehydration by hot air at 40, 55 y 70 ºC and air speed of 0.1; 2,5; y 4.0 m/s. Besides, they were subjected to two pre-treatments: scalding and enzymatic treatment. The superficial color were measured on each curve of dehydration, on fresh and pre-treated fruit by Hunter parameters: "L", "a" and "b". The changes were evaluated from the parameters ΔE, Δa, hue and chroma. The results obtained allow indicate that: The drying at 70 ºC without pre-treatments produce the least variation in the superficial color of the sour cherries and a better preservation of the reds. The changes of the superficial color would not depend on the air speed when it is being worked on a range between 1.5 and 4 m/s. The scalding pre-treatment shows the greatest global color variation. Pre-treatments are not effective to preserve the red color at any of the tested temperatures. The enzymatic pre-treatment on the skin allow to reduce the time of dried without modifying very much the color

1. INTRODUCTION

Color is usually considered the most important characteristic in food appearance especially if it is associated to other aspects of quality, such as, fruit ripeness or the visible spoilage that takes place when food deteriorates. Almost all food products have an acceptability range color which depends on different factors that include variability among consumers, their age, ethnic origin and the physical conditions of the environment at the moment of judgement (Francis 1999). Food structure and pigments interact affecting color, transparency and/or dullness.

The sour cherry is a very attractive red fruit but of low consumption when it is fresh due to its high level of acidiy. The dehydration process would be a good way of preserving this kind of fruit to enhance its consumption but this causes important effects on the superficial color. Variables can be handled to minimize the negative effects on the color of the dehydrated product. In general, pretreatments decrease the dehydration time but bring about important changes at fruit microstructure level that are transferred to the final aspect of it.

2. MATERIALS AND METHODS

We worked with Montmorency sour cherries harvested on farms from El Bolsón, Río Negro and immediately sent to Villa Regina, stored at 2 ºC until dehydration.

Dehydration: Drying curves were carried out in a pilot drying chamber, putting the selected fruit on a drying tray in single layers and dehydrating them at controlled temperatures, moisture and air speed up to an average moisture content of 12%.

The effect of air speedy was evaluated making drying curves at 70 ºC and 11% of moisture obtained by passing air through a KOH saturated solution, changing only the air speed between 0.1, 1.5 and 4.0 m / seg. Samples were taken at different time intervals (different residual water content) and were stored at –20 ºC in sealed containers until they were analysed.

Pre-treatments: A Group of fruits were scalded (ES) in a Sharp R-210B microwave oven on maximun for 2 minutes and then fenolasa activity was tested (Tronk et al. 1997). An enzymatic treatment was done on a group of fruits (TE) immersing them in a pectinex™ (Novo Nordisk Ferment, Switzerland) solution at 0.8% for 8 minutes at 40 ºC. Pre-treated (ES and TE) and untreated fruits (UT) were then subjected to dehydration at constant moisture and air speed at different temperatures.

Color measures for tristimulus colorimetry: On each point of the dethydration curves, fresh and pre-treated fruit, the Hunter "L", "a" and "b" parameters were measured in a CR-300 Chroma Meters Minolta colorimeter; the instrument was standardized with a white ceramic plate . Hue angle (Hue = $\tan^{-1}(b/a)$), Chroma o Saturation Index (SI = $(a^2 + b^2)^{1/2}$), and total color difference ΔE ($\Delta E = \sqrt{(\Delta a^2 + \Delta b^2 + \Delta L^2)}$) were calculated. Two readings per fruit were performed in the equatorial zone. The results informed are average of twenty determinations for each condition.

Statistic analysis: The analysis of the results was examined by analysis of variance (ANOVA) and the mean values were compared by the LSD test with $\alpha = 0.05$, using the InfoStat 2008 statistical package.

3. RESULTS AND DISCUSSION

3.1 Drying temperature effect on superficial color

One of the parameters that is most modified by different processes in red fruits is the Hunter "a" parameter (Ochoa et al. 1999, García-Viguera et al. 1999, Cinquanta et al. 2002, Stojanovic and Silva 2007). By analyzing the variation of this parameter, it is seen in Fig. 1 that fruits dehydrated at 55 and 70 ºC at the end of dehydration have a greater Hunter "a" value than fresh fruit. There were significant differences between 40 and 55 ºC and between 40º and 70 ºC ($p < 0.05$) on the last point of the drying curve. The value of the hue angle at 40º is significantly higher than at 55 and at 70 ºC ($p < 0.05$); moreover at 70 ºC it evolves from 13.1º to 10.1º, i.e. the shade shifts to the purple zone. By observing Fig. 2 the chroma, hue and ΔE parameters are seen at the end of the drying process at the studied temperatures. The chroma parameter has the main values (most saturation) at 55 and 70 ºC and the hue angle reaches its least value at 70 ºC, whereas ΔE is very similar at the three temperatures.

3.2 The effect of drying speed on superficial color

In Figure 3 the evolution of the Hunter "a" parameter at the three air speeds is shown. In the last point of the drying curve it was seen that there are significant differences between rates 0.1 and 1.5 m /s and between 0.1 and 4.0 m /s, ($p < 0.05$). Both at 1.5 and at 4.0 m /s the highest value of this parameter is maintained.

In Figure 4 the chroma, hue and ΔE parameters are observed at the final stage of drying. The biggest change of the ΔE is produced in the dehydration process at 0.1 m /s ($p < 0.05$); it also achieves its least color saturation, chroma ($p < 0.05$), even though the shade value, hue, is similar to the one reached at higher rates ($p > 0.05$).

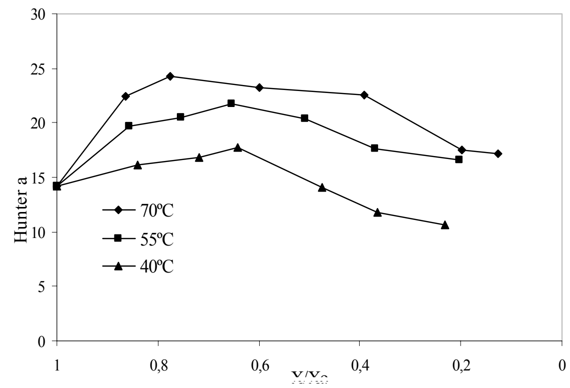

Fig. 1. Hunter "a" evolution during dehydration.

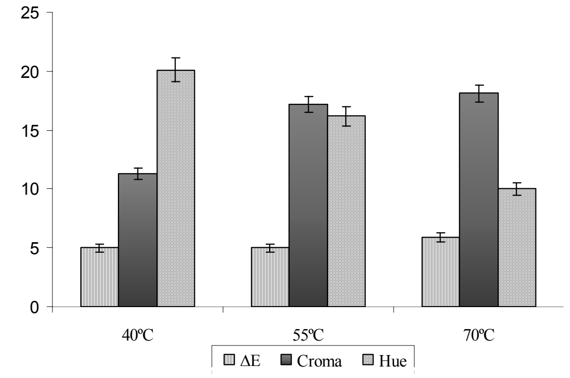

Fig. 2. Croma, ΔE y hue parameters at the end of drying process.

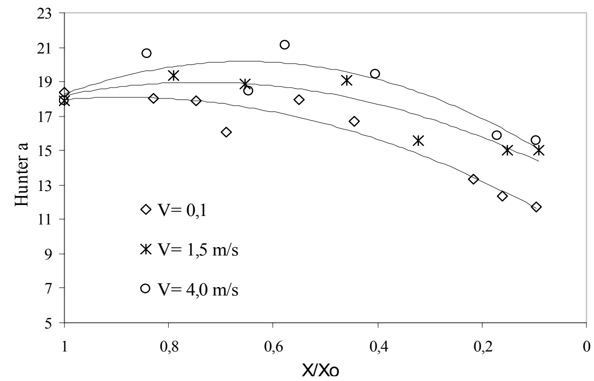

Fig. 3. Hunter "a" evolution at different air speeds.

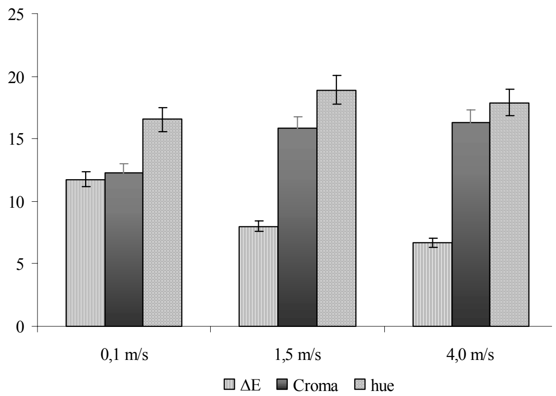

Fig. 4. Chroma, hue and ΔE parameters at the end of drying process.

3.3 Pre-treatment effects on superficial color

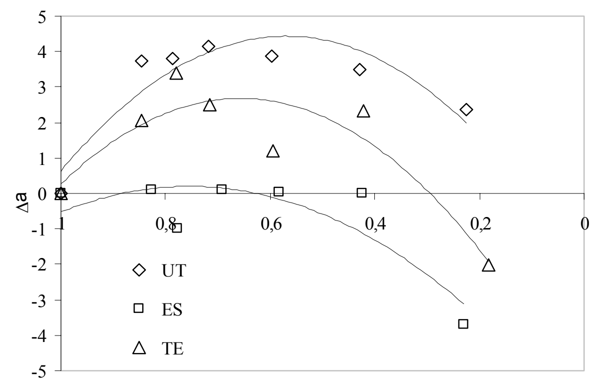

Fig. 5. Δa evolution in pre-treatment vs. control at 70 ºC.

When the initial results of the color readings were compared stadistically, it was found that in both the Hunter L parameter as well as in the chroma parameter, there are very significant differences ($p < 0.01$) between the control fruit (UT) and the scalded fruit (ES) On the other hand, there is not any difference between the control and the fruit with enzymatic pre-treatment (TE) (Test Dunett, $\alpha = 0.05$). It can be observed, at a glance, that the scalded fruit is clearer and pink that the fresh fruit. By looking at Fig. 5 it is noticed that at the most operating temperature the fruit that best preserves the reds (Δa positive) is the UT fruit and the one with the further degradation is the ES fruit, remaining at an intermediate level TE fruit. A double ANOVA was carried out to compare the pre-treatment and temperature effects on the Δa parameter: both temperature as well as pre-treatments significantly influence on this parameter.

There are very significant differences ($p < 0.01$) between the temperatures and also between the control and the two applied pre-treatments ($p < 0.01$) even though there are no interactions between the temperature and pre-treatment factors.

As a summary, on Table 1 data from the different Hunter parameters both in fresh fruit as well as in dehydrated fruit and in pre-treated and dehydrated fruit can be observed.

Table 1. Hunter color parameters in fresh dehydrated fruit and pre-treated dehydrated fruit.

Sample	L	a	b	hue	chroma	ΔE
Fresh UT	27.9 ± 2.4	14.5 ± 4.0	3.4 ± 1.4	14.3 ± 4.0	13.8 ± 3.5	-------
Deh. UT 40 ºC	24.4 ± 2.7	10.6 ± 2.3	3.9 ± 1.4	19.1 ± 4.9	11.4 ± 2.4	6.0 ± 1.6
Deh. UT 55 ºC	23.8 ± 2.1	16.5 ± 3.4	4.9 ± 1.6	16.4 ± 3.5	17.6 ±3.1	6.1 ± 1.8
Deh. UT 70 ºC	23.1 ± 1.9	17.5 ± 3.2	4.5 ± 1.3	14.2 ± 2.7	18.2 ± 3.5	6.8 ± 1.9
Deh. ES 70 ºC	17.4 ± 1.4	11.2 ± 2.0	2.4 ± 0.6	12.4 ± 1.7	11.5 ± 2.1	11.1 ± 1.4
Deh. TE 70 ºC	19.4 ± 2.0	13.0 ± 3.1	3.0 ± 1.2	14.2 ± 3.8	13.3 ± 3.8	10.0 ± 2.4

4. CONCLUSIONS

Drying in a drying chamber at 70 ºC produce the least variation of superficial color of sour cherries and a better preservation of the reds since at the end of the dehydration Δa is positive, Hue only changed 3º and chroma increases. The color difference (ΔE) was similar at the three temperatures, so this parameter itself would not be useful to evaluate color changes. The Hunter "L" evolution shows that dehydration process leads to a darker product independently of the temperature used. The results show that the changes in superficial color would not be dependent on air speed while working in a range between 1.5 and 4 m /seg.

The enzymatic pre-treatment on the skin allow to reduce the time of dried without modifying very much the color.

The hue angle varies 10º maximum in the studied conditions which would be too little so as to predict color stability of dehydrated sour cherries.

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Relationship between mineral content and color in honeys from two ecological regions in Argentina

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ABSTRACT

Mineral composition and ash content of honey depends mainly on botanical and geographical origin. Dark honeys usually show higher electrical conductivity than light ones and higher mineral content. In order to study the relationships among minerals and color, 30 representative honey samples, 15 from the "Pampeano Austral" and the "Caldén" districts (Argentina) were analyzed. Nine minerals were quantified: Ca, Mg, Na, K, Zn, Cu, Fe, P and S. Botanical origin of honey was confirmed by pollen analysis. In accordance with other authors, K was the most abundant mineral in all samples. Most of the dark honeys (> 50 mm Pfund) came from the Caldén region and contain over 75% of *Condalia microphylla* pollen. Two of them were over the conductivity threshold to differentiate honeydew honeys (> 8 mS cm^{-1}). The Principal Component Analysis showed a direct relationship between color, conductivity, K, Ca and Cu. Considering all samples the correlation coefficient between color and K was the highest ($r = 0.916$). Color and conductivity were also highly related ($r = 0.895$). If light honeys (< 50 mm Pfund) are studied separately, no correlations were found, suggesting that some components other than the total mineral content affect the color of light honeys.

1. INTRODUCTION

Mineral content of honeys is largely variable and several authors indicate that dark honeys contain higher mineral matter than light ones (Bianchi 1980, Crane 1990). The international market classifies honey according to the Pfund color scale being light honeys more valued than dark ones (Bogdanov et al. 2004). Pfund scale ranges from 0 to 140 mm, beginning with very the light-colored and increasing up to the most dark honeys. Characterization of unifloral honeys also takes into account the Pfund ranges (Piazza et al. 1991, Devillers et al. 2003).

Electrical conductivity depends on the ash and the acid content, and is frequently used to estimate honey mineral content (Bianchi 1980, Bogdanov et al. 2004). Minerals are transported by the sap to the nectaries. As a result the mineral composition of blossom honey depends on botanical and geographical origin. Some trace elements could come from environmental pollution (Bogdanov et al. 2007, Bogdanov et al. 2004, Terrab et al. 2004).

Raw honey color, according to Eva Crane (1990), is related to mineral content and many other components which are largely unknown. The presence of polyphenolic compounds and a high content of amino acids are also reported in dark honeys (Bertoncelj et al. 2007, Crane 1990).

The aim of this study was to relate the mineral composition and the physico-chemical characteristics, in particular color of honeys, from two nearby ecological regions in Argentina, the "Pampeano Austral" and the "Caldén" districts (Cabrera, 1976).

2. MATERIALS AND METHODS

A set of 30 representative honey samples, 15 from the "Pampeano Austral" district and 15 from the "Caldén" district (Argentina) were obtained from professional beekeepers during 1997-1999.

The color of honey samples was assessed by a Pfund grader and the electric conductivity was measured according to Louveaux et al. (1973). Moisture content (refractometric method), free acidity and hydroxymethylfurfural content (HMF) (White method) were determined according to AOAC (2000). Nine minerals (Ca, Mg, Na, K, Zn, Cu, Fe, P and S) were quantified by using inductively coupled plasma - atomic emission spectrometry (ICP-AES). The botanical origin of honeys was confirmed by pollen analysis, according to Louveaux et al. (1978).

Principal Component Analysis (PCA) was used to obtain a reduction of dimensionality of the 14 x 30 data matrix and determine the relationships between variables (physico-chemical characteristics and mineral content) and objects (honey samples) through optimal 2-D graphical display. The search for natural groups in the honey samples was performed by cluster analysis, using complete linkage and Euclidean distance. Cluster analysis also represents a multidimensional space by mapping in two dimensions.

The "extra light amber" upper limit in the Pfund grader scale (50 mm Pfund) was established as the limit between light and dark honeys. Within these two groups, the relationship between color and mineral content was studied by Person´s correlation and linear regressions.

3. RESULTS AND DISCUSSION

The analytical results are summarized in Table 1. Color presented a wide range, from 16 to 109 mm Pfund, while electrical conductivity ranged from 0.13 to 0.90 mS cm^{-1}.

The Principal Component Analysis shows a direct relationship between color, conductivity, K, Ca and Cu. Other physico-chemical properties (moisture, free acidity, HMF) and some minerals do not associate with color (Figure 1A). Sample grouping on the basis of similarities is shown in Figure 1B. Those samples from the Caldén district grouped with the Pampeano Austral district ones showed less than 50 mm Pfund.

In accordance with other authors (Hernández et al. 2005, Crane 1990), K was the most abundant mineral in all samples. Within the same color range (< 50 mm Pfund), the Caldén district samples contained higher levels of K (Figure 2).

Pollen analyses of the samples coming from the Pampeano Austral district (Southern Pampas) showed a representative combination of three pollen types: *Diplotaxis tenuifolia*, *Eucalyptus* sp. and *Centaurea solstitialis* (Valle et al. 2007). These were light-colored samples, excepting one of them. Most of the dark honeys (> 50 mm Pfund) belong to the Caldén district and contain over 75% of *Condalia microphylla* pollen. These dark-colored blossom honeys showed high conductivity values. Two of them were over the threshold established by the International Honey Commission to differentiate honeydew honeys (> 8 mS cm^{-1}) (Figure 2).

Considering all samples, the correlation between color and K content was the highest ($r = 0.916$) and it also was found a high correlation between color and conductivity ($r = 0.895$). However, if light honeys are studies separately, no correlation was found between K and color. Similar results were obtained between color and conductivity (Figure 2).

Table 1. Physico-chemical characteristics of the honey samples from "Pampeano Austral" and "Caldén" ecological regions, Argentina.

	Pampeano Austral district (n=15)				*Caldén district (n=15)*			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Color (mm Pfund)	36,47	10,88	16,50	59,20	65,93	28,00	21,50	109,00
Conductivity (mS cm^{-1})	2,02	0,40	1,30	2,80	5,36	1,93	3,20	9,00
Moisture (%)	16,03	1,32	12,50	18,00	15,77	1,33	13,20	18,80
Acidity (meq kg^{-1})	16,10	2,92	12,00	23,00	18,10	3,86	140	26,00
HMF (mg kg^{-1})	2,05	2,30	0,00	6,58	1,78	2,32	0,00	5,97
Minerals (mg kg^{-1})								
Ca	10,11	3,69	5,20	17,60	23,11	8,32	10,90	38,70
Mg	1,82	0,34	1,37	2,41	2,30	0,36	1,50	2,72
Na	12,02	5,40	5,90	23,40	11,29	6,23	3,70	26,30
K	45,49	14,19	21,10	77,90	199,25	108,39	97,00	422,00
Zn	0,38	0,15	0,19	0,64	0,24	0,09	0,11	0,45
Cu	0,01	0,01	0,01	0,03	0,05	0,04	0,01	0,15
Fe	0,09	0,08	0,01	0,31	0,18	0,10	0,05	0,44
P	6,93	2,35	4,88	13,30	8,45	4,66	2,86	16,10
S	9,30	5,01	3,74	24,00	11,77	5,63	3,88	21,70

SD = Standard deviation, Min = Minimum, Max = Maximum

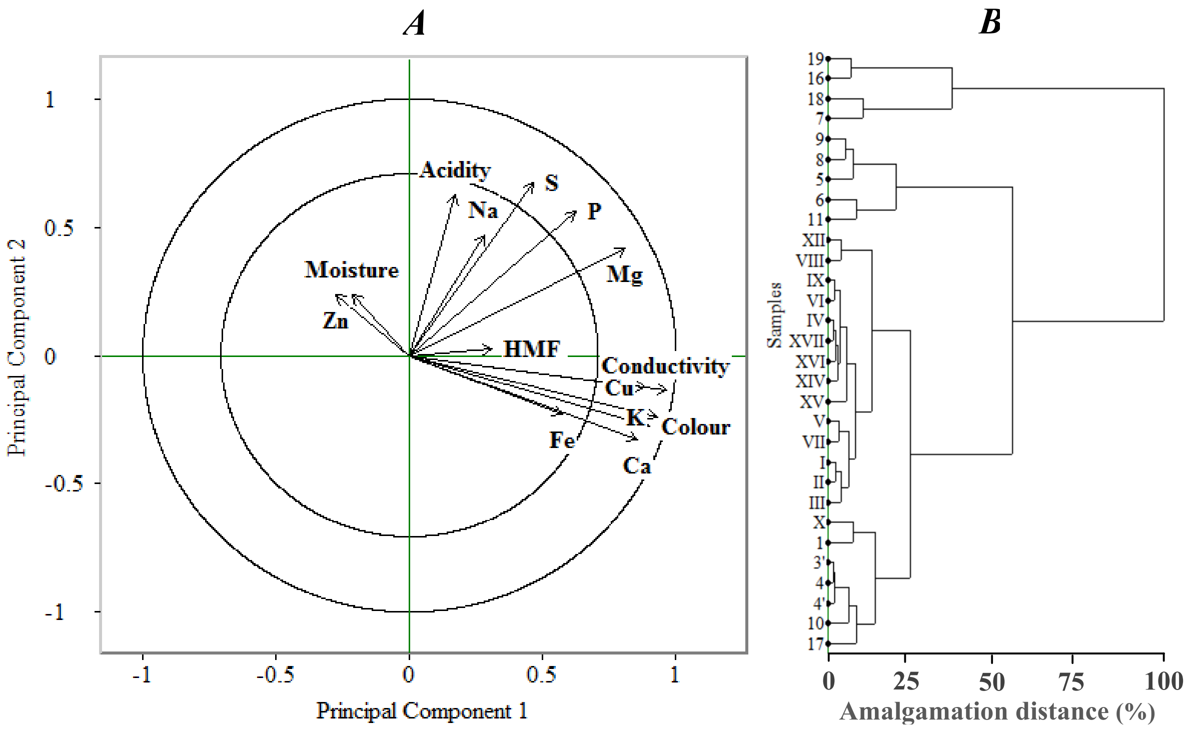

Figure 1. Relationship between mineral content and physico-chemical honey characteristics. (A) Principal Component Analysis; vectors between concentric circles have more than 70% representation. (B) Dendogram with complete linkage Euclidean distance: Arabic and Roman numbers belong to samples from Caldén and Pampeano Austral districts respectively.

It is remarkable that no correlation was found between minerals and color in light honeys, while dark ones showed a close relationship, suggesting that some components other than the total mineral content affect the color of light honeys.

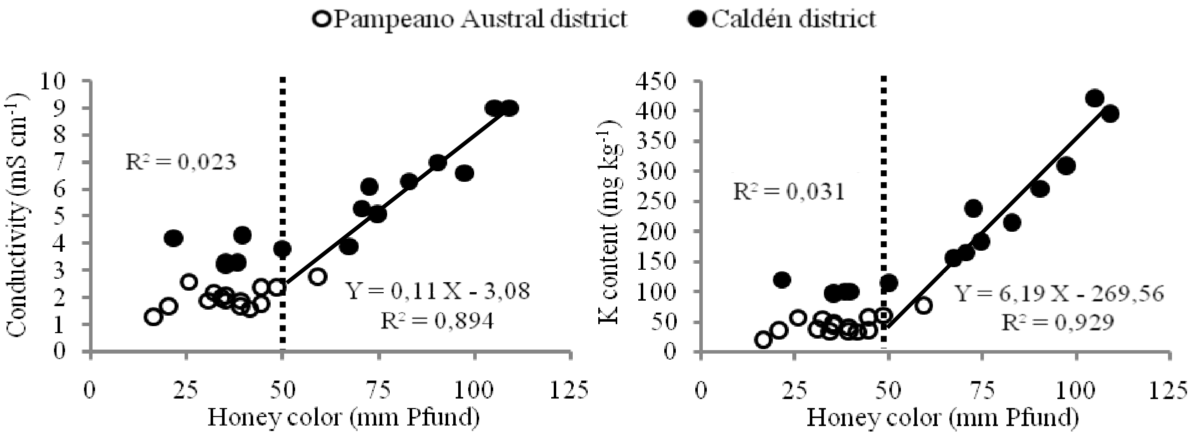

Figure 2. Relationships between conductivity and K content with honey color.

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Colour references for estimating actual conditions of food materials and cooked meat

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ABSTRACT

Colour information is critical for checking the freshness of vegetables and for knowing the degree to which meat has been cooked. However, food colour distributions have not been systematized quantitatively and there is no practical colour chart for cooking.

In this study, we conducted two measurements in order to clarify the actual conditions of the colour of food ingredients and cooked meat. First, we measured the luminance and chromaticity of 101 food ingredients and transformed the values of the chromaticity into Munsell values. Next, we measured the luminance and chromaticity of a hamburger steak during the cooking process and transformed high frequency values of the chromaticity into Munsell values.

According to the results of these measurements, we made two colour charts as an index to be used as reference in food preparation and cooking. These colour charts enable us to estimate the actual conditions of food ingredients and cooked meat both easily and quantitatively.

1. INTRODUCTION

Colour is one of the major factors along with gloss, visual texture and flavor influencing our food tasting perception. In previous studies, translucency of liquid foods, tomato, fresh meat and cured meat were measured, and colour appearance was also considered (MacDougall and Sansom 2007). In spite that food colour atlases may be useful for food professionals as well as general people, food colour distributions have not been systematized quantitatively. In addition, colour information is important for checking the freshness of vegetables and for knowing the degree to which meat has been cooked. Therefore, colour chart for cooking may be useful. However, there is no practical colour chart for cooking.

In this study, we conducted two measurements in order to clarify the actual conditions of the colour of food ingredients and cooked meat and in order to make colour charts as an index to be used as a reference in food preparation or cooking.

2. METHODS

2.1 Measurement of the food ingredients

We measured the luminance and chromaticity of food ingredients; 54 vegetables, 7 kinds of fruit, 16 kinds of fish, 11 kinds of meat, 5 kinds of cheese, and 8 others as shown in Table 1, which were used in four Cooking classes of the Department of Food Science and Nutrition, at DWCLA. We measured each of them at 15 points with a colour luminance meter (Konica Minolta CS-100A) under the lighting condition of 400-500 lx on a work table with 6500 K fluorescent lamps.

Table 1. Food ingredients measured.

Vegetables		Fish	Meats
Japanese honeywort	Green yuzu	Inkfish	Boneless chicken leg
Bamboo shoot	Japanese-mushroom	Shrimp	Pork loin
Japanese-pepper	Carrot	Trachurus japonicus	Bacon
Spinach	Burdock	Tilefish	Graund pork and beaf
Pea	Yuzu	Sillago	Ham
Fuki	Beansprout	Chicken grunt	Chicken breast
Parsley	Onion	Japanese Spanish mackerel	Round of beef
Green asparagus	Chinese chive	Japanese seabass	Pork belly
Red bell pepper	Bell pepper	Sardine	Beef hind shank
Green welsh onion	Taro root	Sphyraena japonica	Trussed chicken
Snow pea	White welsh onion	Crab	Liver
Cabbage	Green pea	Common Japanese conger	**Cheese**
Cucumber	Chicory	Japanese tiger prawn	Parmigiano Reggiano
Shiso	Potato	Sea eel	Pecorino
Ginger	Garlic	River eel	Gorgonzola
Udo	Broccoli	**Fruit**	Edam
Pumpkin	Tomato	Kiwi	**Others**
Common bean	Crown daisy	Lemon	Konjac
Small turnip	Lettuce	Banana	Roll
Celery	Shimeji-mushroom	Pineapple	Bread
Sweet potato	King trumpet mushroom	Japanese persimmon	Freeze-dried bean curd
Green capsicum	Hen of the woods	Apple	Dried mushroom
Japanese-radish	Turnip	Sweet chestnut	Dried kelp
Winter melon	Kintoki-carrot		Raisin
Eggplant	Lotus root		Walnut
Radish			

2.2 Measurement of the cooked meat

We baked hamburger steaks in an electric oven (Panasonic NE-DB801P) for 3, 6, 9, 12, 15, 18 and 21 minutes at 230 °C. The hamburger steaks were made of minced pork, minced beef, onion, eggs and bread crumbs. Their size was 10 cm in diameter and 1.5 cm in thickness. We measured the luminance and chromaticity of the hamburger steaks at 8 stages, raw and at the 7 above mentioned cooking stages, with a two-dimensional luminance colorimeter (Konica Minolta CA-2000) under the lighting condition of 1000 lx on the work table with D_{65} lamps.

3. RESULTS

3.1 Measurement results of the colour of the food ingredients

Figure 1 shows the chromaticity values of the 101 food ingredients and the name of the food ingredients often used in cooking classes. The chromaticity values were distributed from x = 0.30 to x = 0.50, and from y = 0.30 to y = 0.55. Figure 2 shows the frequency of each chromaticity value using a 0.01 unit resolution, indicating that there are some high frequency values of the chromaticity of food ingredients.

Next, we transformed the chromaticity values into Munsell values and made a colour chart of 9 colour chips, 5GY7/4, 10Y4/3, 7.5GY4/4, 5Y6/4, 7.5YR6/8, 7.5R4/9, 2.5R4/4, 2.5Y8/12 and 5GY5/6, to be used as reference in food preparation. 5GY7/4 (corresponding to parsley) and 10Y4/3 (corresponding to Japanese-mushrooms) were chosen from high frequency values of the chromaticity as shown in Figure 2. 7.5GY4/4 (corresponding to celery), 5Y6/4 (corresponding to potatoes) and 7.5YR6/8 (corresponding to carrots) were selected on the colour of the food ingredients used very often in cooking classes. Finally, 7.5R4/9 (corresponding to apples), 2.5R4/4 (corresponding to sweet potatoes), 2.5Y8/12 (corresponding to pumpkin) and 5GY5/6 (corresponding to spinach) were selected by considering that the hue of each colour chip on the colour chart is different.

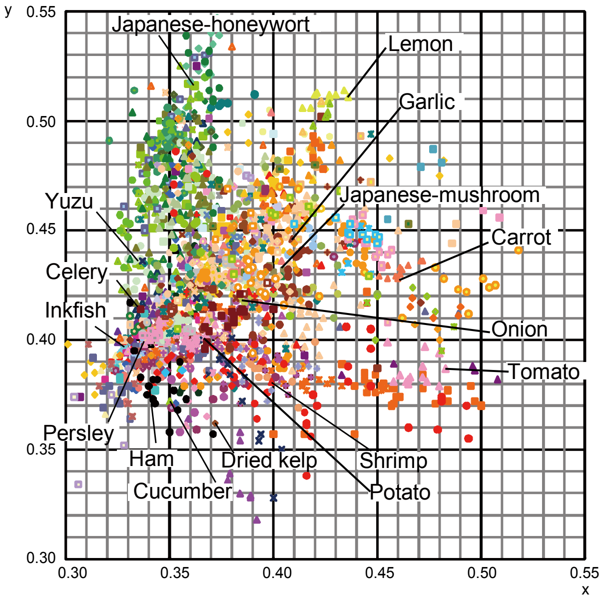

Figure 1. The chromaticity values of food ingredients.

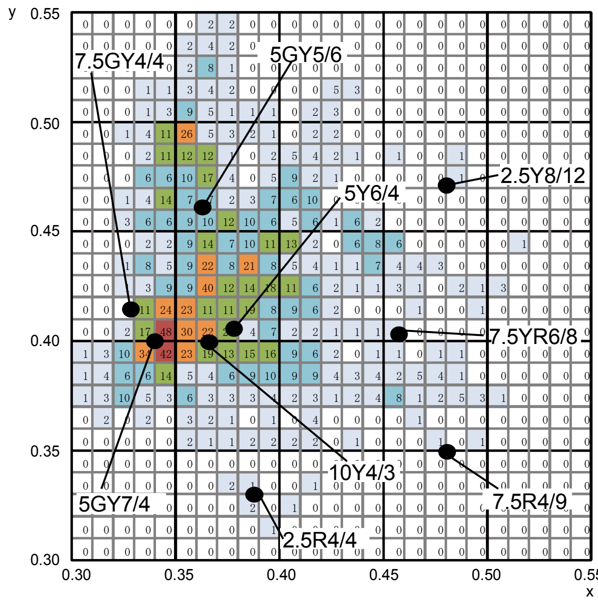

Figure 2. Frequency of each chromaticity values of food ingredients.

3.2 Measurement results of the colour of the cooked meat

Figure 3 shows the chromaticity values of the hamburger steaks at 4 stages during the cooking process, raw, baked for 6, 12 and 18 minutes. In the raw stage, the chromaticity values were distributed from x = 0.35 to x = 0.47, and from y = 0.32 to y = 0.39. The range of the chromaticity values of baked hamburger steaks is wider than that of the chromaticity values of raw hamburger steak.

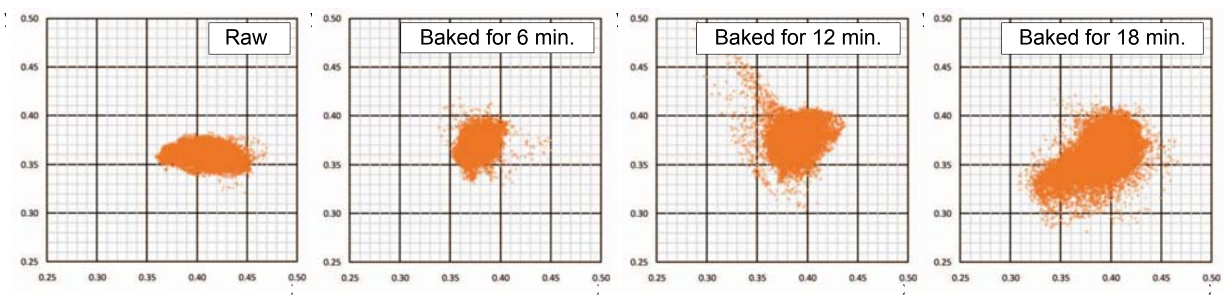

Figure 3. The values of the chromaticity of cooked meat.

Figure 4 shows the frequency of each chromaticity value using a 0.01 unit resolution, indicating that the frequency of the chromaticity values is high in the range from x = 0.37 to x = 0.43, and from y = 0.35 to y = 0.39.

We transformed the chromaticity values into Munsell values and made a colour chart of 9 colour chips, 7.5YR5/4, 10YR6/4, 5YR4/4, 10YR5/4, 7.5YR4/3, 7.5YR4/4, 5YR3/4, 7.5YR4/5 and 7.5YR5/6, to be used as a reference in cooking. 7.5YR5/4, 10YR6/4, 5YR4/4, 10YR5/4, 7.5YR4/3 and 7.5YR4/4 were chosen from high frequency values of the chromaticity as shown in Figure 4. 5YR3/4, 7.5YR4/5 and 7.5YR5/6 were determined using the results of previous measurement (see Table 2), as the Munsell values of a hamburger steak cooked with an IH cooking heater for 60, 120 and 180 seconds, on the availability of the colour chips.

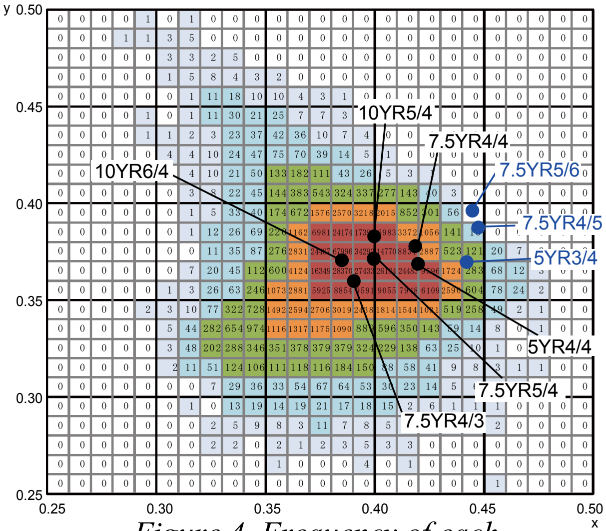

Figure 4. Frequency of each chromaticity value of hamburger steak.

Table 2. Color data of hamburger cooking (Okuda et al. 2009).

Cooking Time (s)	1st Measurement				2nd Measurement			
	Munsell	Y	x	y	Munsell	Y	x	y
10	10YR6/4	36.4	0.447	0.404	10YR6/4	38.0	0.441	0.400
20	10YR5/4	36.0	0.448	0.400	10YR6/4	41.8	0.437	0.409
40	10YR5/4	35.4	0.442	0.399	10YR6/5	38.2	0.443	0.410
60	7.5YR5/6	32.5	0.448	0.399	7.5YR5/6	36.2	0.444	0.416
120	7.5YR4/6	27.6	0.462	0.401	7.5YR5/6	32.7	0.451	0.410
180	5YR3/6	25.4	0.458	0.395	7.5YR4/3	20.7	0.456	0.402

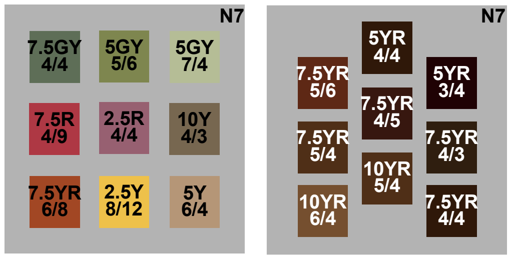

Figure 5. Colour chart for the food ingredients (left) and cooked meat (right).

4. CONCLUSION

We measured the chromaticity values of food ingredients and cooked meat, and transformed the values into Munsell values. Finally, we made 2 colour charts of 9 colour chips to be used as references in food preparation and cooking as shown in Figure 5.

These colour charts enable us to evaluate visibility of food ingredients and cooked meat under the lighting conditions in food preparation and cooking.

ACKNOWLEDGMENTS

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Importance of anthocyanic copigmentation on the colour behaviour of red wine obtained by prefermentative cold maceration

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ABSTRACT

The objective of this study was to assess the influence of copigmentation evolution on the colour changes of red wines, specifically elaborated in warm climate from grapes with different maturity grade by prefermentative cold maceration. The phenolic profile and relative contribution of each group of pigments to the total colour of wines was different according the maturity grade of grape, which determined particular colorimetric changes of the wines studied. In general, wines made from more matured grape had darker and more vivid colours with reddish hues.

1. INTRODUCTION

The phenolic compounds, mainly anthocyanins and their polymeric products are responsible for the colour of red wine; but colour expression of anthocyanic pigments also relies on copigmentation phenomena. Copigmentation reactions consist of non covalent molecular association between anthocyanins and other organic compounds (flavonoids, amino acids, organic acids, polysaccharides, metals and anthocyanins themselves) generating changes or increments in the colour intensity. In the next few months of ageing, the copigmentation complexes trend to disappear due to the transformation into polymeric pigments by covalent links (Bakker and Timberlake 1997). This conversion yields to the evolution and stabilization of wine colour, which shows red-orange hues and less colour intensities. Therefore, to produce high quality red wines is necessary to select grapes with special characteristics, which include, not only adequate amounts of sugars and acids at the moment of harvest, but also appropriate levels of copigments (mainly phenolic compounds) (Pérez-Magariño and Gonzalez-San José 2006). In this work, the phenolic composition and copigmentation evolution of red wines elaborated from grapes with different maturity grade by prefermentative cold maceration in Andalucía (warm climate) have been compared.

2. MATERIAL AND METHODS

Red wines were elaborated in duplicate from *Vitis vinifera* cv. Syrah grapes in 2008 from two vineyards with different ripeness grade: SyA (12.5º Bé, 6.10 g/l titratable acidity and a pH 3.58) and SyB (14.0º Bé and 6.53 g/l of titratable acidity and a pH 3.48). Prefermentative cold-maceration process was applied to elaborate the wines. The whole process consisted of two stages: 10 days of prefermentative cold maceration (5-8 ºC), followed by 14 days of fermentative maceration (20-25 ºC). Wine samples were taken at 1, 3 and 6 months during stabilization period in stainless tanks.

Anthocyanic composition was analyzed by high performance liquid chromatography (HPLC-DAD) (Heredia et al. 2010). Total Polyphenols (TP) was determined by Folin-

Ciocalteau method. Colour changes as well as the contribution of free anthocyanins (%FA), copigmented anthocyanins (%CA) and polymeric pigments (%PP) to the total wine colour have been studied by tristimulus colorimetry (Gómez-Míguez et al. 2006). Statistical analyses were carried out using the software Statistica® v 8.0.

3. RESULTS AND DISCUSSION

Quantitatively, an important influence of the maturity grade of the grape on the pigment content of the wines was observed. SyA wine, which was elaborated from less matured grapes, showed a significant lower anthocyanic and phenolic content than SyB wines, made from more matured grapes (total anthocyanins: 149 vs. 204 mg/L; total polyphenols: 1850 vs. 1900 mg/L) (Figure 1). Several factors influence the developments of ripeness, which are responsible for the quality of grapes at the moment of harvesting. In general, the phenolic content and the extractability index of grape increases throughout ripening process, which explain the results obtained. However, the final concentrations and stability of wine anthocyanins can be also affected by the vinification technique, especially in red wines elaborated in warm climate (Gordillo et al. 2010). In this sense, the intensive maceration conditions applied during prefermentative phase favoured the SyA wine presented a correct phenolic potential and pigment stability. The evolution pattern of phenols during the stabilization period was similar in the two wines. An expected loss of both types of compounds was experimented by all the wines. The loss was especially remarkable in the first 3 months. The degradation reactions as well as the formation of new pigments with high degree of polymerization from the initial copigmentación complexes largely is responsible of the pigment loss in advanced stages of winemaking (Monagas et al. 2005).

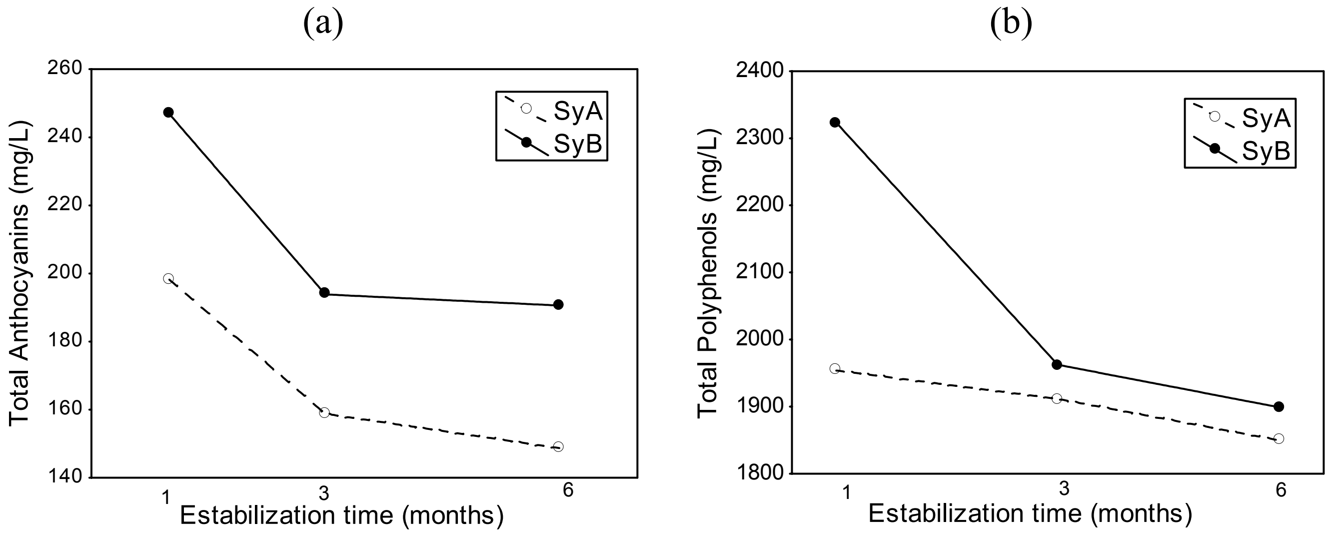


Figure 1. Total Anthocyanins (a) and Total Polyphenols (b) evolution during vinification in SyA and SyB wines.

It was confirmed that the ripeness grade of the grape also influenced qualitatively the anthocyanic profile (Figure 2), since significant differences ($p < 0.05$) was found for the most individual anthocyanins between the two Syrah wines elaborated (except to peonidin acetate and petunidin coumarate). An accurate differentiation and classification of the wines into each of their respective groups was obtained by applying a discriminant analysis, being petunidin, petunidin acetate and total polyphenols the variables which make possible the differentiation according the ripeness grade of grape. Considering only these variables, a 100% correct classification was achieved.

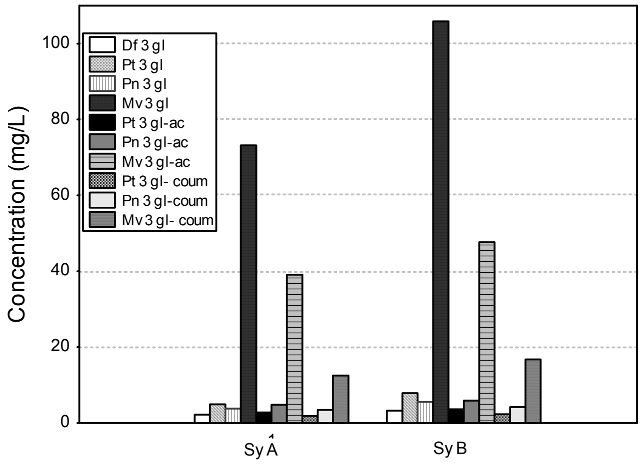


Figure 2. Anthocyanic profile of SyA and SyB wine, corresponding to 6 months of stabilization.

The relative contribution of each group of pigments (%CA, %FA, %PP) to the total colour of wines was different (Figure 3), which determined particular colorimetric changes of the wines studied. During the storage period (6 months), the contribution of the polymeric pigments increased in all wines; however, the contribution of copigmented anthocyanins was quite variable. Despite of the pigment degradation, SyB wine reached the highest polymerization grade values (49% vs. 37% in SyA wine), indicating a higher proportion of more stable pigment in this wine. Moreover, the increase of the percent of copigmentation experimented in SyB wine (aprox. 20%) favoured a more intense development of the polymerization process, which evidence a better cofactor/pigment ratio than SyA wines.

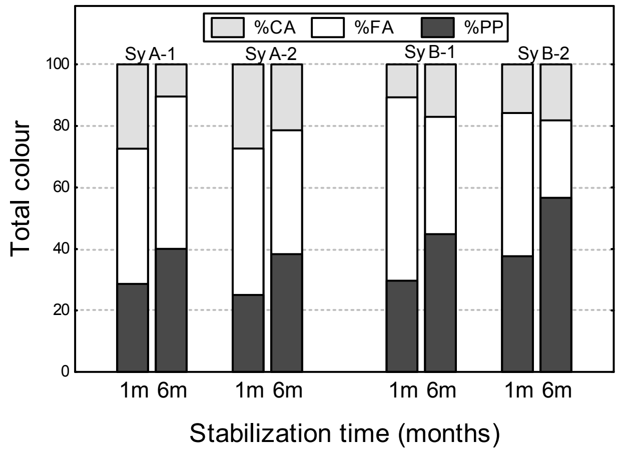
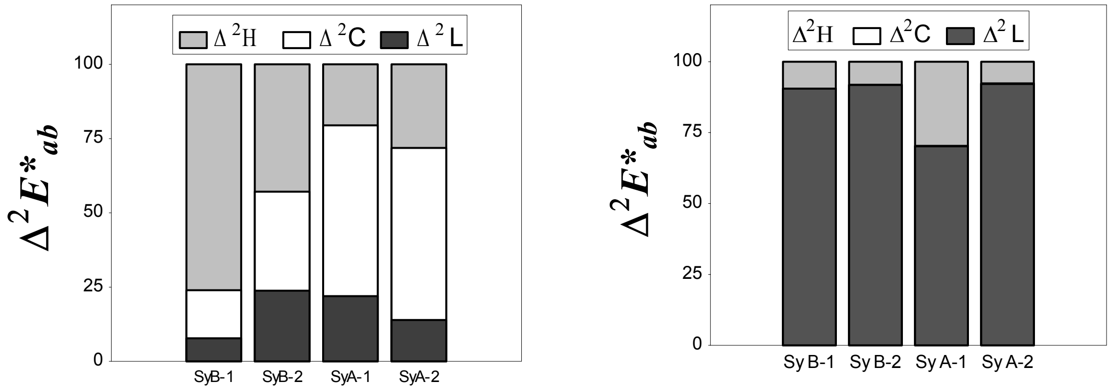


Figure 3. Evolution of the copigmented anthocyanins (%CA), free anthocyanins (% FA), and polymeric pigment (PP) during the vinification.

For a more comprehensive analysis of the colorimetric implication of copigmentation process, the colour differences (ΔE^*_{ab}) between the wines with and without copigmentation was calculated for each wine. It was observed that the effect of this phenomenon on the colour of wines was always evident, showing ΔE^*_{ab} values upper than 3 CIELAB units (ΔE^*_{ab} = 7-14 CIELAB units). However, the colour of wines is not always influenced in the same way, varying according to the time of storage (Figure 4). At first stage of vinification, the contribution of copigmentation to the total colour of wines affected notably both the chroma and the hue. Specifically, hue modification was more marked in SyB wine. In contrast, at the end of the storage period, the copigmentation influenced mainly the lightness, being the modification similar for both of wines.



(a) (b)

Figure 4. Quadratic components of the colour differences: Lightness (Δ^2L) chroma (Δ^2C) and hue (Δ^2H) modifications due to copigmentation phenomena in SyA and SyB wines, corresponding to (a) 1 month and (b) 6 months of stabilization.

As a consequence of a better phenolic potential, SyB wines experimented an optimum development of copigmentation simultaneously to an intensive polymerization process; so finally, red wines elaborated with more matured grapes exhibited darker, more vivid colour with a redness hue (Table 1). However, the application of low maceration temperatures prior to fermentation confirmed to be an interesting strategy to improve and protect the phenolic potential as well as colour of red wines made from less matured grapes.

Table 1. Colorimetric parameters of SyA and SyB wines during vinification.

	SyA-1		**SyA-2**		**SyB-1**		**syB-2**	
	1 month	6 months	1 month	6 months	1 month	6 months	1 month	6 months
L*	74.14	78.42	76.96	81.32	68.84	72.51	65.32	70.77
C^*_{ab}	32.45	24.24	29.07	20.91	34.89	31.16	37.23	33.50
h_{ab}	-6.35	-3.82	-6.61	-3.31	-5.86	-2.45	-2.43	2.43
s^*_{uv}	0.63	0.45	0.54	0.38	0.76	0.64	0.79	0.73

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Color characteristics of raw milk from silage and alfalfa-fed cows

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ABSTRACT

Carotenoids pigments are related to the yellowness of milk, being this characteristic associated with b* parameter. Forage diets improved the content of carotenoids and vitamins in milk when compared to grain-based diets. The experiment was conducted during spring (October to December) at the National Institute of Agricultural Technology in Rafaela (Argentina). During a first four-week pre-experimental period, ten Holstein cows were fed on a silage-only diet with at least 50% of forage; this diet also contained soy expeller and sunflower pellets (3.5 and 1.1 kg/day per cow, respectively) and hay (1.5 kg/day per cow). Thereafter, five cows were randomly assigned to an alfalfa diet (at least 60% alfalfa of dry matter on dietary basis) while another group remained as control, during 60 experimental days. At each measure time, CIELAB parameters were recorded using a reflectance spectrophotometer (BYK Gardner Color View model 9000), with large port area (5 cm diameter) and D65 artificial daylight. As regards of b* component, raw milk corresponding to the alfalfa-based diet showed significant differences at 60 days after implementing the diet. These samples presented higher b* values, which indicates a more yellow color. No significant differences were observed for L* parameter.

1. INTRODUCTION

Food color is the result of natural products associated with the raw material from which it is processed and/or colored compounds generated as a result of processing (Morales and von Boekel 1998). It is influenced by how the food matrix interacts with light, regarding as its reflecting, absorbing or transmitting characteristics, which in turn is related to its physical structure and chemical nature (Kaya 2002).

Appearance of dairy products is related to different factors associated to both primary and industrial processing. Several dietary factors have been identified as being responsible for the characteristics of the raw milk obtained. Milk contains different amounts of carotenoids that contribute to the nutritional and sensory properties of dairy products. Therefore, carotenoids are relevant in determining the color of dairy products.

In grazing systems, a change in carotenoids in milk in the course of time may depend on both the amount of carotenoid intake and milk yield (Calderón et al. 2006).

2. MATERIALS AND METHODS

Assay

The experiment was conducted during spring (October-December) at the National Institute of Agricultural Technology in Rafaela (province of Santa Fe, Argentina) throughout 60 days.

During a first four-week pre-experimental period, ten Holstein cows were fed on a silage-only diet with at least 50% of forage (SS diet). This diet also contained soy expeller and sunflower pellets (3.5 and 1.1 kg/day per cow, respectively) and hay (1.5 kg/day per cow). Thereafter, five cows were randomly assigned to an alfalfa diet (ALF diet) with at least 60% alfalfa of dry matter on dietary basis; while the other group remained as control in SS diet.

Diets were isoenergetic and showed different profiles for fat-soluble vitamins: ALF was higher in α-tocopherol, β-carotene, and retinol than SS diet. In contrast, silage diet was higher in the gamma and delta isomers of tocopherol due to the soy expeller contribution in these isomers (Rossetti et al. 2010).

Color assessment

Color measurements were carried out using a reflectance spectrophotometer (BYK Gardner Color View model 9000) according to CIELAB scale, with a 5 cm port area and D65 illuminant.

The methodology used was based on that described by Celestino et al. (1997). At any experimental point (20, 40 and 60 days, after the initial switch to ALF or SS diet) and for each cow, an aliquot of 30 ml of raw milk was collected and storage for 24 h at 4 ± 1 °C in the dark until analysis. Each milk sample was measured in triplicate. In order to avoid possible interference of ambient light, milk sample was covered with an opaque white cube during color measurement.

3. RESULTS AND DISCUSSION

In Table 1 color parameters are presented. As regards to b* color component, raw milk corresponding to the alfalfa-based diet showed significant differences only 60 days after implementing the diet. These samples presented higher b* values, which indicates a more yellow color.

No significant different ($p > 0.05$) were observed for L* parameter. As a tendency, samples corresponded to ALF diet exhibited lower values at 20 and 40 days compare to the beginning and end of the assay.

In the case of a*, no significant differences ($p > 0.05$) were observed for SS diet. Even tough, samples of ALF diet showed an increase (in absolute value) until 40 days, and after that decreased at 60 days.

The white appearance of milk is the result of its physical structure. The casein micelles and fat globules disperse the incident light and, consequently, milk exhibit a high value of parameter L*. The other color components (parameters a* and b*) are influenced by factors related to natural pigment concentration of milk.

The increment observed for b* for ALF diet is related to the carotenoids content. This pigments are found in higher concentrations in milk produced through grass-based diets, specially pasture (Rossetti et al. 2010).

As stated by Priolo et al. (2003), one of the major challenges is to develop a method to trace grass feeding in ruminant products in order to satisfy the demands of farmers, consumers and certifications. Priolo et al. (2003), and Langam et al. (2009) demonstrated that reflectance spectrum pattern in the range of 450 nm to 510 nm could be a representative index of the feeding system in raw milk of cows.

In this context, b* values had been proposed to trace grass feeding in sheep or cow milk. Even tough, this parameter could only discriminate between diets up to 60 days of feeding under the trial conditions described in this study.

Table 1. L, b* and a* values in raw milk samples of Holstein cows fed on a silage (SS diet) and alfalfa (ALF diet) diets. Means plus standard deviations.*

Feeding time (days)	Diets					
	SS	ALF	SS	ALF	SS	ALF
	L*		b*		a*	
0	89.4 ± 0.7	89.6 ± 0.6	8.46 ± 0.7 b	7.99 ± 0.5 b	-1.9 ± 0.3 ab	-1.7 ± 0.3 bc
20	89.3 ± 0.7	88.8 ± 0.8	8.63 ± 0.4 b	9.09 ± 0.8 b	-2.2 ± 0.3 ab	-2.1 ± 0.3 ab
40	89.6 ± 0.4	88.9 ± 1.0	8.55 ± 0.5 b	9.08 ± 0.9 b	-2.0 ± 0.2 ab	-2.4 ± 0.1 a
60	89.4 ± 0.2	89.1 ± 0.5	8.70 ± 0.5 b	10.61 ± 0.3a	-2.0 ± 0.2 ab	-1.2 ± 0.2 c

*Different letters show significance differences ($p < 0.05$) in diet*feeding effect for each variable.*

4. CONCLUSION

In dairy products, color assessment being an important part of the product quality and process management. Several authors proposed indexes that involve the study of the main pigments of milk, in order to trace grass feeding characteristic. In this context, more research is needed in the application of b* parameter to comprehend its response under different feeding conditions.

ACKNOWLEDGEMENTS

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Color as an indicator for the Maillard reaction at mild temperatures. The effect of reducing sugars

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ABSTRACT

The effect of heat treatment at mild temperatures (37 and 50 ºC) in milk protein-sugar models on nonenzymatic browning was studied. The type of protein and reducing sugar on the extent of Maillard reaction was compared at the initial and final stages by measuring lysine loss and the color attribute lightness (L*) respectively. The reaction occurred at a considerably faster rate in the system with glucose, and kinetic constants for lysine loss and color development were higher in the systems containing whey proteins than in those containing casein. In most systems analyzed, color was detected only at prolonged storage times, when lysine losses were higher than 50%. The glucose-whey protein system was the only where color was detected when losses of lysine were lower than 40%. At mild temperatures, parameters related to the early stage of the reaction could be better indicators of heat treatment than color.

1. INTRODUCTION

Maillard browning is one of the main chemical reactions occurring during the processing and storage of foods containing reducing sugars and proteins. This reaction affects milk protein quality and gives rise to compounds responsible for color and flavor changes.

It is useful to consider three stages in the Maillard reaction: initial, advanced and final stages. In the early stage, the reducing sugar condenses with free amino group of amino acids or proteins, lysine being the most affected amino acid due to the blockage of its free ε-amino group (Hurrell 1990). Therefore, the estimation of available lysine loss can be used as an indicator of the extent of the reaction. Milk proteins are one of the best sources of lysine for human nutrition. However, the presence of sugars in dairy foods makes them very vulnerable to protein damage by Maillard reaction, lessening the availability of this aminoacid (van Boekel 1998). In the final stage most of the color is produced due to the formation of brown polymers and co-polymers called melanoidins. These compounds have significant effect on the quality of food, since color is an important food attribute and a key factor in consumer acceptance (Mauron 1990).

The rate of the reaction is strongly dependent on concentration, ratio and chemical nature of reactants, temperature, time of heating, water activity and pH (Labuza and Baisier 1992). The regulation of these factors is one of the means to control the Maillard reaction progress.

The purpose of this work was to study the effect of heat treatment at mild temperatures in milk protein-sugar models on the development of color by nonenzymatic browning. The kinetic behavior of the Maillard reaction of casein was compared to that of whey proteins and the influence of the nature of reducing sugar on the extent of the reaction was compared at the initial and final stages.

2. MATERIALS AND METHODS

2.1. Preparation of samples

Four model systems containing casein or whey proteins and glucose or lactose as reducing sugars were prepared. The initial sugar: available lysine molar ratio was the same of milk (9:1). Potassium sorbate was added as an antimicrobial agent. Each system was equilibrated at water activity (a_w) 0.52, sealed in glass flasks and stored at 37 and 50 ºC. A pair of duplicate flasks was periodically removed and held at –18 ºC until analysis.

2.2. Analytical methods

The water activity of the milk systems were measured using an AquaLab Water Activity Meter Series 3TE with internal temperature control (Decagon Devices, Inc., Pullman, WA, USA).

The kinetic of the initial stage in the nonenzymatic browning reaction was studied by measuring the extent of lysine loss over time using the o-phthalaldehyde / N-acetyl-L-cysteine spectrophotometric method reported by Medina Hernández and García Alvarez-Coque (1992). For analysis, samples were dissolved in 5% w/v sodium dodecylsulfate solution. To 10 mL of the OPA-NAC reagent (25 mL of a 0.05 M ethanolic OPA solution, 25 mL of a 0.05 M aqueous NAC solution and 200 mL of pH 9.5 boric acid-borate buffer solution (0.02 M), in 1 L of water), 2.0 mL of the sample solution were added and diluted to 25 mL with water. Absorbance was measured at 335 nm with a Hewlett Packard spectrophotometer HP 8453 (Hewlett Packard, Palo Alto, CA, USA). Three replicates of each sample were analyzed. The coefficient of variation for this assay was < 3%. The available lysine content was obtained from a standard curve plotted using casein or whey proteins as was previously reported by Malec et al. (2002).

Total nitrogen content was determined in duplicate by the Kjeldahl method with a digestor Bloc Digest 6 P-Selecta (J. P. Selecta SA, Spain) and a nitrogen distillation unit Pro-Nitro M P-Selecta (J. P. Selecta SA, Spain).

The degree of browning (final stage) was determined by reflectance measurements of the color attribute lightness (L*) with a white background of reflectance. A handheld tristimulus reflectance spectrocolorimeter with an integrating sphere (Minolta CM-508-d, Minolta Corp., Ramsey, NJ, USA) was employed. Color functions were calculated for illuminant D65 at 2º standard observer and in the CIELAB uniform color space. The color function Lo* - L* was found to be an adequate parameter to evaluate the non-enzymatic browning reactions being Lo* and L* the sample color attribute before and after heat treatment, respectively. Two replicates were analyzed for each storage time.

3. RESULTS AND DISCUSSION

The first order rate constants (k) for lysine loss at 37 and 50 ºC are listed in Table 1. At both temperatures analyzed, the loss of lysine was approximately two fold higher in the systems containing whey proteins than in those containing casein. In concordance with previous reports (Chevalier et al. 2001, Naranjo et al. 1998, van Boekel 1996), the reaction occurred at a considerably faster rate in the systems with glucose, being the rate constants of the monosaccharide one order higher in all systems analyzed.

Table 1. First order rate constants (k) with 95% confidence limits for available lysine loss from model systems with casein (C) and whey proteins (WP) stored at 37 and 50 ºC.

Model systems	k x 10^3 (hs^{-1})	
	37ºC	50ºC
C-lactose	0.911 ± 0.050	7.13 ± 0.,60
WP-lactose	2.14 ± 0,08	11.23 ± 0.41
C-glucose	9.45 ± 0.49	55.1 ± 2.3
WP-glucose	20.5 ± 1.0	145.8 ± 3.5

At 37 ºC, in the systems containing lactose, no color was detected along the experiment, and in those with glucose a slight color was noticeable only at prolonged times of storage, when the loss of lysine was higher than 50%.

Figure 1 shows lysine loss and color development in systems stored at 50 ºC. As can be seen, in the systems with glucose, browning developed faster than in those with lactose. However, in most systems analyzed, color was detected only at prolonged storage times, when lysine losses were higher than 50%. The glucose-whey protein system was the only where color was detected when losses of lysine were lower than 40%.

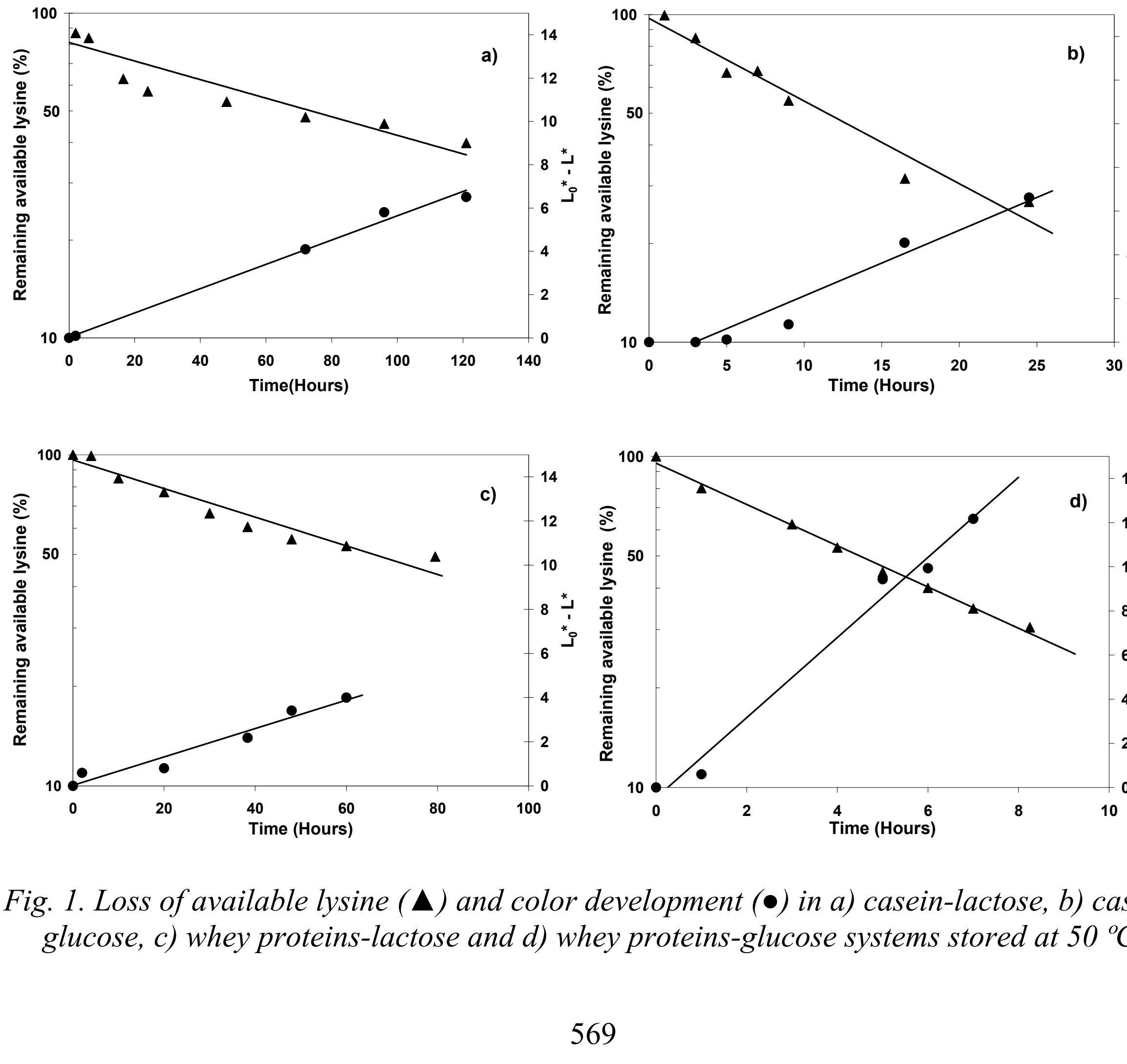

Fig. 1. Loss of available lysine (▲) and color development (●) in a) casein-lactose, b) casein-glucose, c) whey proteins-lactose and d) whey proteins-glucose systems stored at 50 ºC.

It can be concluded that the influence of temperature and of the nature of the reactants was stronger on the first stage of the reaction than when color was analyzed. Hence, at mild temperatures, parameters related to the early stage of the reaction, such as lysine loss, could be better indicators of heat treatment than color.

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Colour-composition relationships of seeds from two red grape varieties

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ABSTRACT

Grape seeds are waste products of the winery and grape juice industry. Grape seed extract is known a powerful antioxidant that protects the body from premature aging, disease and decay. In this study, seeds samples from two red grape varieties (*Vitis vinifera*) were screened for their polyphenolic composition and, the tristimulus colorimetry was applied to evaluate the colour of the seed extracts. The identified compounds were mainly benzoic acids (gallic and protocatechic acids) and flavonoids (catechin, epicatechin and quercetin). The phenolics compounds quantified by spectrophotometric method were related to chroma (C^*_{ab}) and lightness (L^*). The differences with respect to the results reported by other authors in relation to polyphenol profile were attributable to climatic differences, in our case very hot summers with very high environmental temperatures.

1. INTRODUCTION

Agricultural and industrial residues are attractive sources of natural antioxidants. By-products, which remain alter processing of fruit and vegetables in food processing industry still contain a huge amount of phenolic compounds. Some studies have already been done on by-products, which could be potential sources of antioxidants (Lapornik et al. 2005). Phenolics compounds make up a class of phytochemicals that play an important role in the nutritional and sensory properties of various fruits and vegetables. The past two decades these compounds have been the subject of investigations with different aspects such as health, isolation from plants and determination of polyphenolic profiles in different cultivars and their antioxidant activity (Bujic-Kojic et al. 2009). Extraction of phenolic compounds from plant materials is influenced by several factors: solvent, temperature, solid-liquid ratio and time of extraction, etc. Resides, plant polyphenols are structurally much diversified, so practically it is impossible to develop extraction method suitable for all plant phenolics (Nawaz et al. 2006).

2. MATERIALS AND METHODS

2.1 Plant materials

Seeds from two widely cultivated wine grape varieties were chosen: two red varieties used in many countries (Tempranillo and Syrah). All samples used were obtained from vineyards located in “Condado de Huelva” in Andalusia to the south western Spain, with the typical climatological conditions of warm climate regions. The seeds were sampled twice a week from July 20 until the harvest.

2.2 Analytical methods

Seeds were lyophilized and milled to a fine powder and stored at -20 ºC before extraction. The polyphenols were analyzed by high performance liquid chromatography. Extraction procedure was carried out according to a slight modification of the method described by Nawaz et al. (2006). The total phenol content (TPC) in the extracts was determined spectrophotometrically according to the Folin-Ciocalteu method.

The spectral transmittances of the extract were measured. The CIELAB parameters (L*, a*, b*, C^*_{ab}, and h_{ab}) were determined by using the original software CromaLab® (Heredia et al. 2004), following the *Commission Internationale de L'Eclariage's* recommendations (CIE 2004): the 10° Standard Observer and the Standard Illuminant D65.

2.3 Statistical analysis

Appropriate statistical techniques were applied in order to evaluate the existence of significant differences among seed varieties and/or abstract degree of ripeness and to discriminate between different samples. The Statistica© v.8.0 (Statsoft 2007) software was used for all the statistical treatments.

3. RESULTS AND DISCUSSION

Figure 1 shows the distribution of the seeds grouped according to the grape varieties (Tempranillo and Syrah) in the (a*b*) colour plane, in which the colour points are represented regarding the axes green-red (-a* +a*) and blue-yellow (-b* +b*). It can be observed that most of the samples are located inside a defined area between 80° and 110° of hue angle (h_{ab}). The seed extracts from Tempranillo tend to be located in the first quadrant of (a*b*) diagram (80°-90°). On the other hand, the samples from Syrah tend to be located between the first and the second quadrant (80°-100°). Certain differences were observed for the colour extracts from different varieties, although these differences were not significant ($p < 0.05$). However, there was significant difference for L* when it was consider the ripeness evolution time.

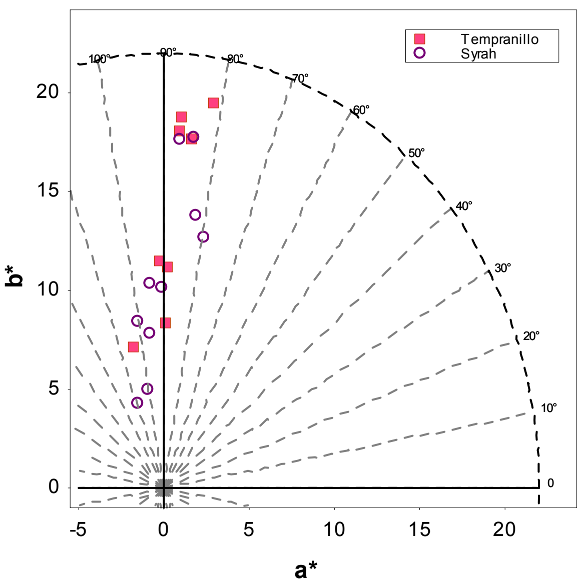

*Figure 1. (a*b*) diagram of seed extracts from two red grape varieties.*

In the analysis of individual phenolic compounds, gallic acid, catechin and epicatechin were identified before the 30 min of retention time by HPLC. Catechin was found at the highest levels; its concentration decreased with the degree of ripeness from 1.10 mg/g to 0.39 mg/g and from 4.79 mg/g to 0.65 mg/g in Tempranillo and Syrah seeds, respectively. This result is in agreement with previous findings of monomeric phenols in grape extracts (Burns et al. 2000, Shui and Pneg-Leong 2000).

To assess the existence or not of statistically significant differences among the varieties regarding their phenolic compounds ANOVA were applied. For this purpose, the phenolics are grouped in benzoic acids and flavonoids (considering the sum of all the individual phenolic compounds). The data from the phenolic compounds for each variety were taken into account a significant differences ($p < 0.05$) among flavonoids content were found. When two-way ANOVA analysis was applied, significant interactions between varieties and degree of ripeness were observed for flavonoids content.

Degree of ripeness does not affect phenolic content significantly, although the content decreases during degree of ripeness, this decrease occurred mainly in flavonoids content (Figure 2).

Whit regard to the evolution of the TPC, also a decrease is detected during the degree of ripeness (Figure 3). The content of TPC varied from 43.9 to 20.7 mg/g of dry seeds, although this decrease is not significant.

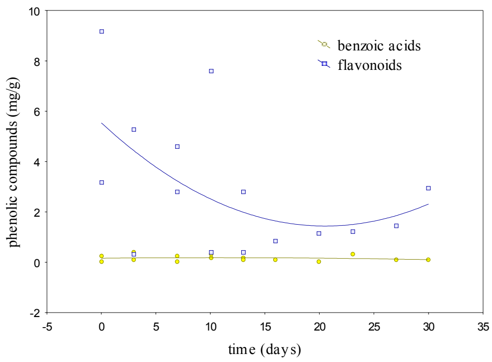

Figure 2. Evolution of flavonoids and benzoic acids.

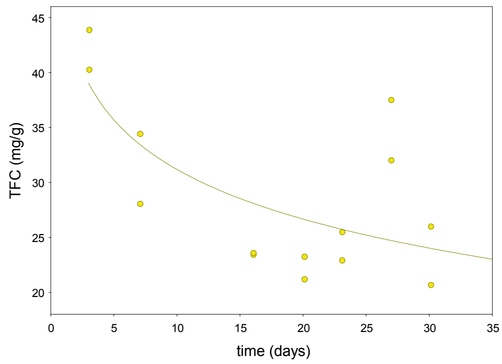

Figure 3. Evolution of TPC.

The relations between the color parameters and the phenolics compounds were explored by means of simple correlations. Significant correlations ($p < 0.05$) were found between b* and the gallic acid levels ($r = 0.53$) and between C_{ab}* and gallic acid ($r = 0.60$).

In order to observe the contribution of colour parameters to the differentiation between the varieties, the results are subjected to a discriminant analysis. Forward stepwise method selected b* and L* as the variables of highest discriminant capacity (according Fisher's test). The calculated discriminant function allows discriminate between Tempranillo and Syrah as observed in Figure 4.

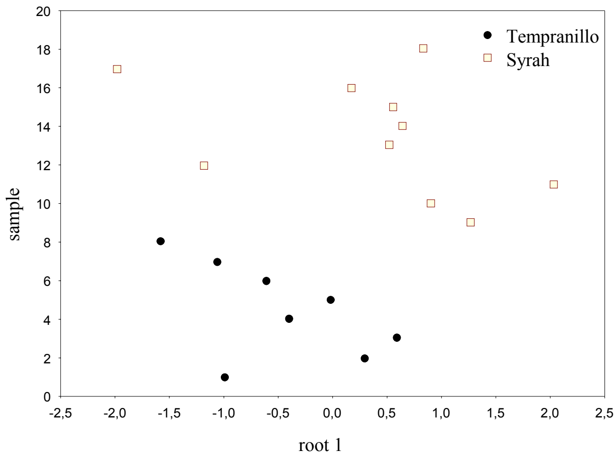

Figure 4. LDA Scatterplot of the canonical functions.

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Statistical relationships between soil colour and some factors of soil formation

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ABSTRACT

In this paper we used a combination of colour variables together with geographical and edaphic variables in order to find out relationships between soil colour and several soil formation factors. The study area is located in the municipality of Sax, province of Alicante (southeastern Spain). We collected 130 samples over an area of 2925 ha using standard methods (Soil Survey Division Staff 1993). Existing soil orders include *aridisols* and *entisols*, which are the most common in semiarid environments.

1. INTRODUCTION

The classical theory of Soil Science establishes the following equation of soil formation:

$$s = f(cl, o, r, p, t)$$

The formation factors are climate (cl), organisms (o), topography (r), parent material (p), and time (t). The outcome of the equation is what we know as soil. It seems clear that the combined action of the previous factors results in very complex processes.

There is not a generally accepted definition for the term *Soil*. Jenny (1941), provides a number of definitions given by different authors. In the context of Agriculture and Soil Science, the soil is the body where plants find foothold, nourishment, and other conditions of growth.

Soil has a main feature called anisotropy which makes it different from other geological formations. The direction of maximum anisotropy is the vertical or z-axis. Direct observation allows one to differentiate layers which differ in texture, colour, and other characteristics. The detailed description of the different soil layers is known as *soil profile*.

The variable of interest in this paper will be soil colour. In particular, we will try to obtain significant statistical relationships between soil colour and other Agricultural variables which are related to formation factors in some way.

2. PREPARATION AND PROCESSING OF DATA

The tool used to collect the whole data set was a Geographical Information System (GIS), which can be seen as a system of hardware, software and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially-referenced data for solving complex planning and management problems (NCGIA 1990).

In this study, the geographic locations of samples were collected with GPS receivers, whereas other geomorphologic variables were collected from existing maps. The two data sets have different coordinate systems. Therefore, a first step was to transform all of the geographical coordinates to a common system.

Once the spatial data sets are stored in the same coordinate system, sample locations can be plotted over existing maps or images to capture spatially distributed variables directly from digital maps (Figure 1). Spatially distributed variables include elevation, slope, aspect, and parent material, amongst others.

Figure 1. Overlay of the map point over an orthoimage of the study area.

A number of variables, including soil colour, were measured in the laboratory from soil samples. The numerical values of these variables were arranged in tables, which were joined to the point map by means of a key identifier.

The resulting data set can be divided into four groups of variables:

- Geomorphologic variables. The values of elevation above sea level, slope, and aspect were collected from the digital terrain model of the study area.
- Edaphic variables. This group includes carbonate content, pH, electrical conductivity, texture, and stoniness. They were obtained by using specific laboratory procedures in all cases except in the particular case of stoniness, whose values were obtained by direct photographic interpretation.
- Management variables. These variables include crop and irrigation system, and were collected during field visits.
- Colour variables. Chromaticity coordinates were collected using a colorimeter under standard conditions. We used illuminant D65 as the light source and 45/0 geometry. The measurements were performed with a field of view of 2º.

This data set is suitable for statistical processing. There are different statistical techniques available to process multivariate data (McGarigal et al. 2000). In this study we used the method of stepwise regression. This method is suitable in situations with collinearity between independent variables, which is common in data sets that do not come from experiment designs.

3. ELEMENTS OF COLORIMETRY

In the context of Soil Science, colour has always been one of the basic properties reported in soil profile descriptions (Bigham and Coilkosz 1993). The common approach is based on the use of specific Munsell charts under natural illumination (Munsell Color Co. 1980, Soil Survey Division Staff 1993). According to the Munsell Soil Color Chart, colour is reported in terms of the so-called hue, chroma, and value. However, we used a different laboratory procedure based on CIE standards and colorimeter measurements.

Laboratory measurements provided chromaticity coordinates *Yxy* of both soil samples and the white reference target. Chromaticity coordinates were then transformed into tristimulus values *XYZ* using well-known formulas given by Westland and Ripamonti (2004).

Next, we converted tristimulus values into CIELAB coordinates, and finally, CIELAB coordinates were transformed into the CIE L*C*h cylindrical representation, which is more easily understandable from the human perception standpoint.

4. RESULTS AND DISCUSSION

The procedures described so far provide a number of relationships which are summarized in this section. It is necessary to note that the results presented here are not based on experiment designs, but on the sample values themselves. Therefore, we cannot establish true cause effect relationships and the results should be considered as a first approach to the problem.

4.1 Luminance (L*)

There are seven significant variables related to L*, five of them were positively correlated, and two were negatively correlated (Table 1). In this context, positively correlated means that L* has greater values, i.e. soil colour is lighter, and negatively correlated means that soil colour is darker. The value of the determination coefficient (R^2) was 39%.

There are some relationships which were expected beforehand. For instance, high *Carbonate content* and parent material no. 28 (white marl) should produce lighter soils. The result about *Aspect*, which determines the amount of solar radiation that falls on the terrain surface, is not so obvious. The most surprising results are those of *pH* and *EC* (electrical conductivity). They are very difficult to explain because their values can be effectively affected by tillage practices, or irrigation water quality, which were not taken into account in this study.

Table 1. Regression analysis of Luminance (L).*

Parameter	Estimate	p-Value
Constant	19.543	0.2865
Aspect	0.033	0.0194
GEO28:marl	5.093	0.0237
Sand	-0.124	0.0178

Parameter	Estimate	p-Value
Clay	-0.137	0.0637
Carbonate	0.092	0.0586
pH	4.207	0.0456
EC	0.002	0.0185

4.2 Hue (h_{ab})

There are three significant variables related to *Hue* (Table 2). The value of R^2 is 34%.

Slope is positively correlated to Hue. This suggests that soils located on higher slopes tend to be less red. On the other hand, *Sand* and *Clay* are negatively correlated, which suggests that high contents of sand and clay produce lower values of hue (in this context this means that soil colour approaches to red).

Table 2. Regression analysis of Hue (h_{ab}).

Parameter	Estimate	p–Value
Constant	82.384	0.0000
Slope	0.324	0.0621
Sand	-0.199	0.0000
Clay	-0.193	0.0010

4.3 Chroma (C^*_{ab})

There are four significant variables related to Chroma. *Parent material no. 28*, and *Stoniness* are negatively correlated, whereas *Sand*, and *pH* are positively correlated (Table 3). The value of R^2 is 39%.

It seems that the colour of samples located on white marls is less saturated than other soils, which is in agreement with the expected result. The influence of *Stoniness* (that is the percentage of soil surface covered by stones or rocks), *Sand*, and *pH* on Chroma is harder to explain. There would be necessary additional analyses in order to obtain reliable information.

Table 3. Regression analysis of Chroma (C).*

Parameter	Estimate	p–Value
Constant	-7.776	0.3496
GEO28	-2.352	0.0279
Sand	0.102	0.0000
Stoniness	-0.023	0.0282
pH	4.428	0.0217

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Color of Pedro Ximenez sweet wine: From grape to raisin and wine

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ABSTRACT

Changes in CIELAB color during the raisining of grapes *cv.* Pedro Ximenez, as well as throughout the aging of sweet wine made from them in Montilla-Moriles D. O. (Andalusia, southern Spain) have been studied. Drying process of grapes was carried out in two ways: by means of the traditional sun-drying method and an alternative chamber-drying method at 50 ºC. During raisining grape musts decreased in h_{ab} and increased in C^*_{ab}. In comparative terms, hue final values were virtually identical in both types of drying, although differences were found in the final values of chromaticity, being lower in the chamber-drying method. Changes in the color parameters during aging were compared in commercial wines with different aging systems and without aging. Likewise, as a reference of traditional system wine aging, were also studied the color changes in wines with four aging degrees. Regarding to the commercial wines studied, it can be pointed out that the aged for 4 years without blends significantly differed in the values of h_{ab} and C^*_{ab} of the remainder wines, these showing more similar values among them and ranging into the data obtained for the wines aged by traditional aging system.

1. INTRODUCTION

Among the European sweet wines, the Pedro Ximenez sweet wine (PX) is increasingly recognized worldwide, it causing that its annual production is virtually sold in advance. PX are obtained from grapes of the same name that are subjected to a traditional sun-drying process in order to raisin the berries. Grapes are harvested with approximately 14 °Baume and the bunches spread onto long stripes of a plastic material placed on grounds with mild slopes facing south in order to facilitate slow raisining by effect of moisture losses. Depending on the particular climatic conditions of the year, the raisining process takes 5–7 days, but it can be as long as 10 days under especially unfavorable circumstances.

The resulting raisins are crushed and pressed at high pressure in a vertical hydraulic press in order to ensure a yield of must at least 30% (w/v). The musts thus obtained are extremely sweet (they can easily contain reducing sugar concentrations above 450 g/L), with a strong flavor of raisins and a very dark brown color. These musts can be partially fermented to ethanol content below 5% (v/v), and subsequently fortified up to 12-17 %. The young sweet wines thus obtained can be directly marketed or subjected to static or traditional dynamic oxidative aging (with blend of younger with older wines) by means of the so-called *criaderas and solera* system (Casas Lucas 1985).

Insect attacks, intense solar radiation, occasional rains and fungi producing toxins, such as ochratoxin A (OTA), can deteriorate grapes during sun-drying. Thereby, the replacement of the traditional sun-drying process of Pedro Ximenez grapes by drying in chamber under controlled conditions must be advantageous because of its no dependency on the climatic conditions of each year. This method with controlled temperature is reliable, fast and easy to use, but it requires high efficiency to be profitable.

The brown color of raisins is the combined result of pigments formed by effect of the enzymatic and non-enzymatic reactions (Grncarevic and Hawker 1971), taking place during grape dehydration (Karadeniz, Durst and Wrolstad 2000). Oxidative enzymes such as polyphenoloxidase (PPO) (Gunata, Pineau and Cordonnier 1987) catalyze the oxidation of phenolic compounds to quinones in the presence of molecular oxygen, which subsequently evolve to brown pigments (melanins). Also, exposure of berries to high temperatures (above 50 °C) can result in the formation of melanoidins, which are brown polymers typically appearing at the latest stages of the Maillard reaction (Rivero-Perez, Perez-Magariño and Gonzalez-San Jose 2002). In addition, oxidative aging in wood induces major oxidation reactions of phenolic compounds in wine (Singleton 1987), particularly those involving the flavan-3-ol derivatives, which have proved to be effective substrates for several browning reactions (Es-Safi et al. 1999, Lopez-Toledano et al. 2002).

2. MATERIAL AND METHODS

Drying experiments: Pedro Ximenez grapes were collected in the Montilla-Moriles D. O. (Andalusia, southern Spain). The traditional sun-drying samples were obtained from grapes extended to sun in 10 drying mats about 20 m long each. The grapes were randomly collected in triplicate at 8.30 a.m. each day from the start of the raisining process (day 0) to its end (day 7). In the chamber-drying method fresh grapes were distributed uniformly (14 kg/m^2) in a single layer and dried in chamber at air temperature of 50 ºC. Samples were periodically collected and the weight loss of the grapes was measured. The reducing sugar content (measured as ºBrix) was used as tracking criteria of the grape dehydration process. The drying was concluded when the sugar concentration was around of 450 g/L. In the laboratory, the grapes of both drying processes were crushed and subsequently pressed in a vertical press similar to those used at the industrial level. The highest pressure reached in each pressing cycle was 300 bar, and each grape batch was pressed in three cycles. The musts thus obtained were centrifuged at 3000 rpm and subjected to the different determinations.

Traditional aging: samples of each aging degree from the *criaderas* and *solera* system were collected in triplicate in a Montilla-Moriles winery. The aging degrees, so-called *escalas,* were in increased order of wine age 3rd *criadera* (3C), 2nd *criadera* (2C), 1st *criadera* (1C) and *solera* (S).

Commercial wines: 6 samples of commercial PX from the Montilla–Moriles D. O. winery were subjected to triplicate analyses. Their aging times were: 2 samples without aging (0Ya and 0Yb), 1 sample aged by 4 months (4M), 1 sample with 4 years aging without blends (4SA) and 2 samples aged 4 years in the traditional aging system with blends (4DAa and 4DAb).

Color analyses: the determinations were carried out following CIE recommendations (standard observer 10º visual field and the CIE standard illuminant D65) (CIE 2004), and measured by spectrophotometry (Perkin Elmer Lambda 25 model). The following CIELAB uniform space colorimetric parameters were considered: rectangular coordinates a^* (red-green component), b^* (yellow-blue component) and L^* (black-white component, lightness) and cylindrical coordinates h_{ab} (hue angle) and C^*_{ab} (chroma).

3. RESULTS

Figure 1 shows the changes of the CIELAB cylindrical coordinates in the musts obtained from grapes during sun-drying and chamber-drying processes. As can be seen, traditional sun-drying took 7 days, during which the grape musts decreased in h_{ab} and increased in C^*_{ab}. As a result, they showed a progressive redness and higher color intensity. Chamber-drying grapes reached their final point in only 4 days, showing during this time similar changes in h_{ab} and C^*_{ab}. In comparative terms, hue final values were virtually identical in both types of drying, although differences were found in the final values of chromaticity, being lower in the chamber-drying method.

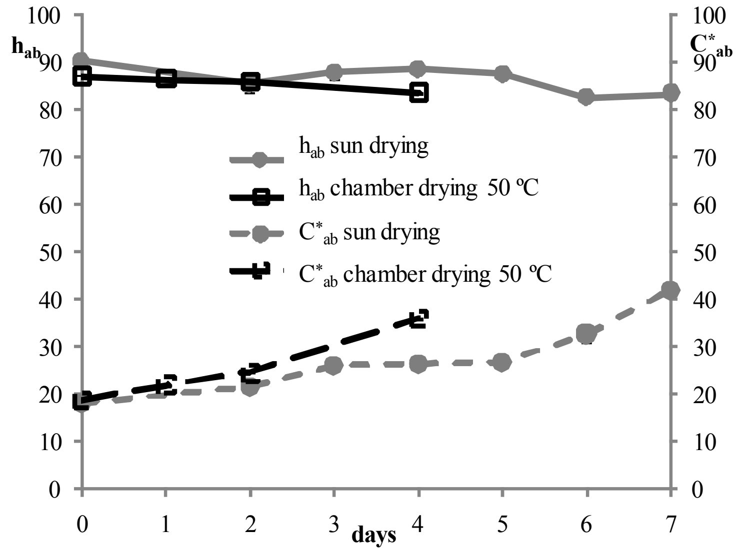

Figure 1. Changes of the cylindrical coordinates in the grapes during drying processes.

Table 1 lists the values of C^*_{ab} and h_{ab} of the wines during dynamic oak aging and commercial bottled. During the traditional wine aging (dynamic) can be observed a progressive redness, it reaching a value in h_{ab} of 66.9 in the *solera* (highest level of aging), against the value of 79.7 corresponding to 3rd *criadera* (lowest level of aging). The chromaticity C^*_{ab} showed a strong increase from the 3rd to the 2nd *criadera*, then decreasing slightly in the 1st *criadera* and *solera*, showing in this last aging level a final value of 80.8. Regarding to the commercial wines studied, it can be pointed out that those aged for 4 years without blends significantly differed in the values of h_{ab} and C^*_{ab} of the remainder wines, these last showing more similar values among them and ranging into the data obtained for the wines aged by the *criaderas* and *solera* system.

Table 1. C^*_{ab} and h_{ab} of the wines during dynamic oak aging and the commercial bottled.

		Dynamic oak aging				Commercial bottled					
		3C	2C	1C	S	0Ya	0Yb	4M	4DAa	4DAb	4SA
C^*_{ab}	$\bar{x}$	69.4	82.4	82.0	80.8	76.0	85.4	82.1	77.7	78.1	32.8
	sd	0.066	0.232	0.117	0.290	0.405	1.17	0.176	0.351	0.904	0.078
h_{ab}	$\bar{x}$	79.7	69.8	69.9	66.9	75.5	72.4	74.3	62.1	63.2	24.0
	sd	0.000	0.000	0.062	0.066	0.379	0.154	0.046	0.062	0.100	0.177

Figure 2 shows a^*b^* plane and lightness of all the samples studied in this work. L^* decreased in proportion to raisining and aging. Likewise, in both drying processes a^* and b^* components increased with time drying. In relation to the traditional aging, wines shifted to the right in the color plane as the aging process developed. The commercial wines placed in a^* b^* plane near their equivalent aging degree in the *escalas* system. However, sample 4SA showed very different chromatic characteristics, it moving away from the usual color of typical PX already accepted by the consumers.

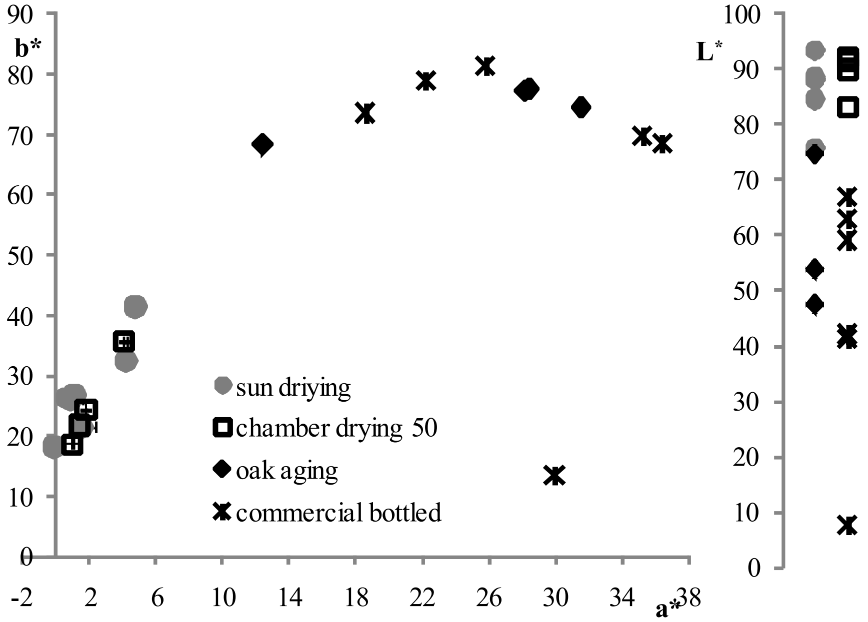

Figure 2.CIELAB space of all the samples studied.

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Food colouring and liquids - basic and natural colours

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ABSTRACT

Humans constantly apply a bilateral system of colour interpretation: that of light and pigment. The objective of these experiments / installations was to verify *White's illusion* (White 1979) in a comparison between three natural liquid colour contrasts and three basic colour food colouring in water contrasts. The illusion involves changes in the lightness of a colour test element that interrupts a dark or a light- bar of a dark-light square wave grating (White 2009). In Experiment 1 we used three different basic colours of food colouring in water compared with Experiment 2, where we used natural food liquids. We proposed a three dimensional structure, composed of glass jars containing the coloured liquids. The transparency of the container allows for a complex pigment light interaction. Typically illusion experiments have been visualized with pigments on paper. The use of coloured liquids in a three dimensional structure created the same effect as the *Munker White illusion*; lightness or colour assimilation occurred in these multidimensional versions.

1. INTRODUCTION BACKGROUND

Humans constantly apply a bilateral system of colour interpretation: that of light and pigment. Sandford&Gosti (2009) create installations and art works based on basic colour primaries (RGB and RYB), observing the use of colour pigments suspended in water and the duo refraction and reflection of light. The meeting theme *Colour and Food: From the Farm to the Table* is illustrated in this comparison of naturally coloured food liquids and industrially produced food colourings in water. The objective of these experiments / installations was to verify *White's illusion* –also known as the *Munker White Illusion*– in a comparison between three natural liquid colour contrasts and three basic colour food colouring in water contrasts.

The name *Munker White Illusion* –Munker's coloured version (1970) White's Illusion (1979)– best identifies both the colour and the black and white versions. The *groundal dotted illusion* (White 1981), or the *dungeon illusion* (Bressan and Kramer 2008), creates the same type of assimilation in both colour and black and white versions, but the geometrics of the pattern are different from the *Munker White Illusion* and therefore seem to have different theoretical explanations. White's explanatory approach is a mixture, from the most direct idea of *assimilation theory* he specifies three types of lightness assimilation. He also points out that Gilchrist's *anchoring theory* (2005) or Anderson's *scission theory* "may provide a more satisfactory explanation" (White 2009: 2). Other researchers have been working on a theoretical explanation of this illusion and similar ideas.[1]

The *Munker White illusion* involves changes in the lightness of a colour test element that interrupts a dark or a light bar of a dark-light square wave grating (White 1979, 2009). This illusion seems to contradict simultaneous contrast, where the gray 'square' should look lighter when surrounded in black, and the opposite, it should seem darker when surrounded by white.

[1] See White (2009) for a summary of early illusion research, and Andelson (2000), Gilchrist (2005), and Bressan and Kramer (2008).

But instead, when the gray elements line up with the white bars and are surrounded by black they seem darker than when the gray elements line up with the black bars and are surrounded by white.

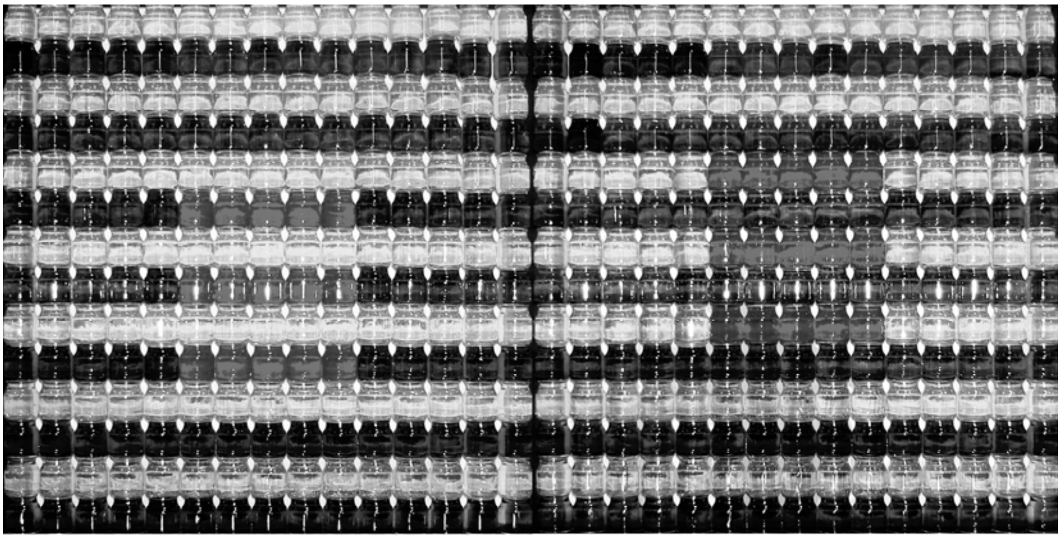
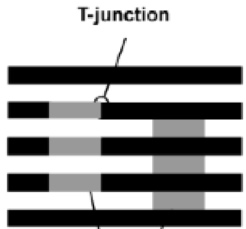


Figure 1. "Anchoring between three colour liquids". Red test elements on yellow and blue grating, white backdrop; 210 in-line jars, 95 × 95 cm, each half; water, red, blue, and yellow food colouring; photomontage of the two settings, image taken at 3 meter distance.

In Adelson's example, illustrated here (2000), he points out that "the T-junctions give evidence that the rectangle should be grouped with the region touching its shorter sides, thus, if the gray rectangle is being compared to the black strips flanking it left and right, it should be seen as lighter, in accord with the illusion". Some researchers, including Adelson, have indicated that a mechanism called 'perceptual transparency' could be part of the illusion, where we see the lighter test element as being transparent and in front of the bars, making the dark bar seem lighter, and the darker test element as being behind the bars. This would be in keeping with the concept of LIGHT IS NEAR and DARK IS FAR, the implicit conceptual metaphor that guides our gestaltic visual and linguistic interpretations of light and distance (Sandford 2009). Howe (2005), refers to a "circular variant of White's effect in which all the junctions have been removed without significantly affecting the strength of the illusion, suggesting that junctions are not an important consideration in all versions of White's effect". Corney and Beau Lotto have simulated illusions of lightness by "training synthetic neural networks to recognize surfaces under different lights. [...] These data suggest that "illusions" arise in humans because (i) natural stimuli are ambiguous, and (ii) this ambiguity is resolved empirically by encoding the statistical relationship between images and scenes in past visual experience" (Corney and Beau Lotto 2007: 1790). Bressan (2006) more recently expresses a different double anchoring theory, which seems particularly relevant.



2. METHOD AND RESULTS

In Experiment 1 (Figure 1) we used three tones of food colouring in water in two combinations (*Red, Yellow, Blue* and *Red, Green, Blue)* in comparison with, Experiment 2 (Figure 2), three combinations of three different colours of natural food liquids. For

Experiment 2, we chose between different tea combinations (*black, green, camomile; green, camomile, hibiscus;* and *hibiscus, camomile, green,*). The best five combinations were tested in a full installation. We experimented with the jars inline and off-set; we noted no visual difference in assimilation.

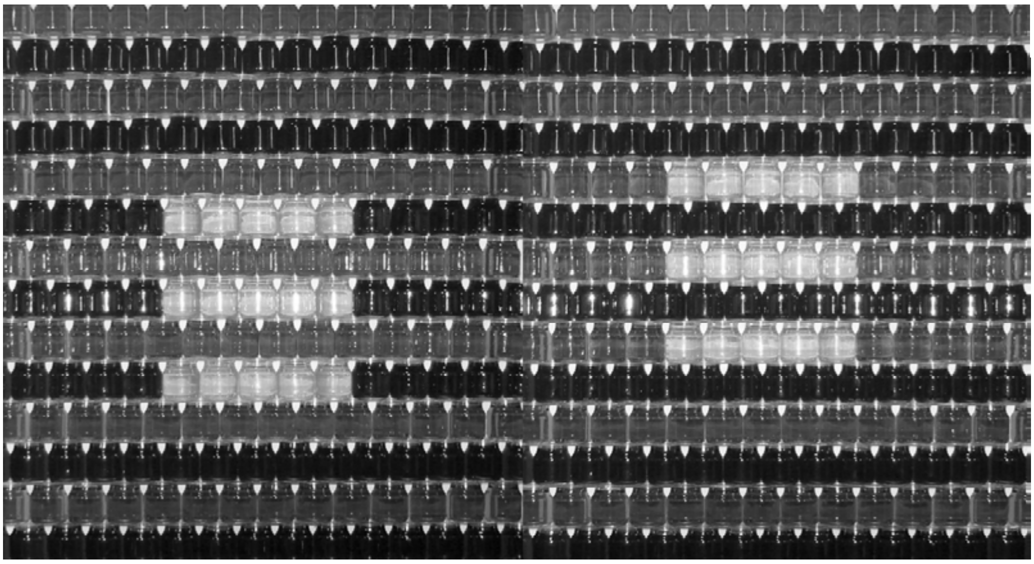


Figure 2. Yellow (camomile tea) test elements on dark brown (black tea) and light brown (green tea) grating, white backdrop; 203 off-set jars, 95 × 95 cm, each half; photomontage of the two settings, image taken at 3 meter distance.

To make sure that the colour in each jar (7 × 6 cm) was the same we measured the food-colouring for each container in Experiment 1, and used one batch of each tea in Experiment 2. Every jar was filled with as much liquid as possible (150 ml) to facilitate the illusion. The glass jars containing the three coloured liquids were piled and placed in a dark gray frame that we constructed for a square installation of the jars.

The anchoring effect, colour and lightness assimilation, was immediately apparent. The photographic images[2] shown here were taken with cross lighting of two incandescent lamps at a distance of three meters. Transparency did not hinder the effect. Each set of colours were photographed with a white backdrop and a black backdrop. The difference in backdrop colour changed the image completely, which made the complex reflected and refracted light interaction more evident. Munker's colour combination revealed the most robust assimilation illusion, as could be expected by the distinctness of the colour combination. The warm natural tea colours, which we expected to react in a similar way to grays, made the illusion less evident, lower saturation and luminance seemed to stimulate a weaker illusion.

3. DISCUSSION

The transparency of the containers allowed for a complex pigment light interaction. Typically illusion experiments have been visualized with pigments on paper, or illustrations viewed on monitors. The use of coloured liquids in a three dimensional structure created the same effect. When the coloured liquid is seen in a clear glass jar all four colour aspects are activated: adaption, constancy, reflection and refraction. The *Munker White illusion*; lightness or colour assimilation, activates clear contextual effects on colour appearance. Perceptual transparency and the interaction of past experience seem to further influence visual interpretation of colour.

[2] Sony 4.1 mega pixel, DSC-S60, JPEG, 2304 × 1728 pixel, 1.7 MB image, Zeiss lens.

Contemporary art operates between the conceptual symbol and the predominant sign. In architecture deconstruction represents the ongoing realignment of the relationship between art, nature and science. In the ecology of foods today they must be natural, organic, zero mile, 'slow' cooked, or even considered on a molecular basis. Colour emphasis in the visual arts, culinary arts, and architecture always produces feelings of wonder, curiosity, harmony and well-being. Colour research and understanding is therefore able to give a sense of identity and belonging through experiments and artistic technology. The proposed installation experiment illustrates a perceptual 'medium' variation that engages and communicates with the public. It also represents contemporary scientific endeavor, as it is involved in the processing of multiple dimensions and relationships with space, time, and the viewer.

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Evaluation of compressed images displayed on LCD monitor (V): Introducing a coefficient for maximum color difference used in the formula of underestimating edge color difference

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ABSTRACT

We developed a new measure based on the color differences between corresponding pixels of original and compressed images displayed on a liquid crystal display (LCD) monitor. The new measure is a mean of modified color differences, $\Delta E_{00}/(1+m)$, where color difference ΔE_{00} between corresponding pixels of the original and compressed images is utilized, and m is the maximum color difference between the pixel and its neighbors in the original image. Compressed images are produced from four SCID images using JPEG and HPK software products. Evaluation values of the new measure were calculated from the modified color difference. Subjective evaluations of similarity values were scored by comparing the original and compressed images. Using this method, a correlation coefficient between the objective evaluation values and subjective evaluation values was 0.74. A coefficient c for maximum color difference m used in the formula was introduced for improvement of the formula, $\Delta E_{00}/(1+cm)$. Correlation coefficients were obtained for variations of c values from 1/16 to 16 with step of 2. The highest correlation coefficient 0.94 was obtained for c = 1/8. Consequently a good measure for evaluation of compressed image, $\Delta E_{00}/(1+m/8)$, was developed.

1. INTRODUCTION

In recent years, with the spread of PC, digital camera, and the internet, graphical data compression is performed briskly and it is often observed on the display. Although the signal-to-noise ratio (SNR) is well used for evaluating the image quality of a compressed image as an object evaluation value, it is well known that impressions of images are different for images of same SNR. The relationship between subjective evaluation value and PSNR for SCID images is shown in Figure 1 (Yamada et al. 2005, Machida et al. 2005). The SCID images are shown in Figure 2 later (ISO). The plots for four images are separated in this figure, i.e. PSNR depend on the images. We tried to develop a new measure for evaluating image quality of compressed images which shows good correlation to subjective evaluation value, which is independent on images, and preferably which shows a straight line. We developed some measures considering color difference and/or MTF of human visual system, like S-CIELAB, for this purpose. The best result were obtained for mean color difference of spots (4 × 4 pixels) based on characteristic of human visual system (Machida et al. 2005). In this study, we developed a new measure considering underestimation of color difference at edge.

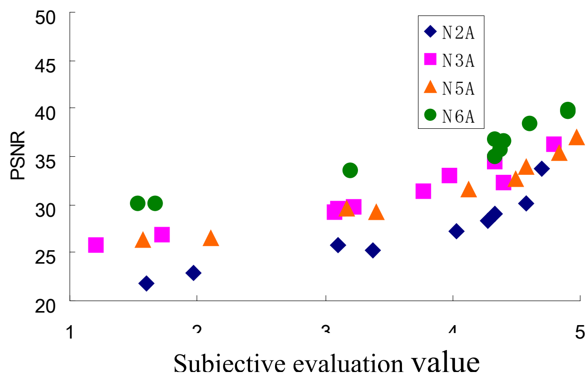

Figure 1. Relationship between PSNR and subjective evaluation value on color similarity.

2. SUBJECTIVE EVALUATION

Four images of SCID, shown in Figure 2, are used in this study (ISO). Four compression levels JPEG images were compressed by Photoshop, and six compression levels HPK images were also compressed by HPK codec software (Yamada et al. 2005, Machida et al. 2005, ISCT). The ten compressed images were compared to the original image, and subjective evaluation values on color similarity were obtained. The images were presented at LCD monitor EIZO CG 211. Thirty students of our university observed and evaluated the compressed images for the following five steps.

A (5 point) unchanged
B (4 point) little different, but not annoying
C (3 point) slightly different
D (2 point) different
E (1 point) completely different

In addition, the compressed images were shown at random and observation distance was about 50 cm. The thirty students evaluation values were averaged for a subjective evaluation value.

(a) N2A (b) N3A (c) N5A (b) N6A

Figure 2. SCID images used in this study (ISO).

3. NEW MEASURE OF EVALUATING IMAGE QUALITY OF COMPRESSED IMAGES

3.1 Underestimating edge color difference

Colorimetric values of the original and the ten compressed images were calculated by using sRGB formula. Then CIE 2000 color differences were calculated from colors of the original and the compressed images at same position, $P_{i,j}$ and $Q_{i,j}$, i.e.

$$\Delta E_{00} = \delta(P_{i,j}, Q_{i,j})$$

where, δ is a function calculating CIE 2000 color difference (CIE). Mean values of the color difference of all pixels were

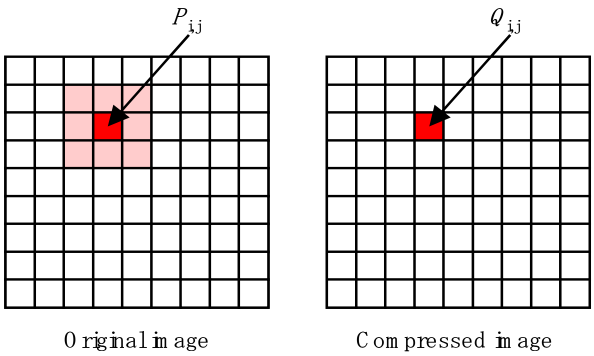

Figure 3. Colors of original and compressed image, $P_{i,j}$ and $Q_{i,j}$ respectively. These colors are used calculating color difference ΔE_{00}. The color of a pixel $P_{i,j}$ and those of the neighbors are used for determining the maximum color difference m.

calculated for objective evaluation value.

Although change of color between original and compressed images is noticeable in smooth region, but is unnoticeable in the region where color changes steeply such as edge. As color difference is not conspicuous at the edge, a value of color difference should be underestimated at the edge. We introduce a maximum color difference, m, between the interested pixel, P_{ij} and the surrounding pixels $P_{i-1,j-1}$ - $P_{i+1,+-1}$, in the original image to the color difference ΔE_{00} between pixels of original and compressed images P_{ij} and Q_{ij} shown in Figure 3 (Inui et al. 2009).

$$m = \max\left(\delta(P_{i,j}, P_{i-1,j-1}), \cdots, \delta(P_{i,j}, P_{i+1,j+1})\right)$$

Thus we developed a modified color difference $\Delta E_{00}/(1+m)$. The more color change steeply, the larger value of m is. At a perfectly flat area, where color difference between the interested pixel and the surrounding pixels, value of maximum color difference m is zero. For escaping zero divide, value 1 is added in the denominator of the new measure. At the perfectly flat area value of $\Delta E_{00}/(1+m)$ are equal to one of ΔE_{00}.

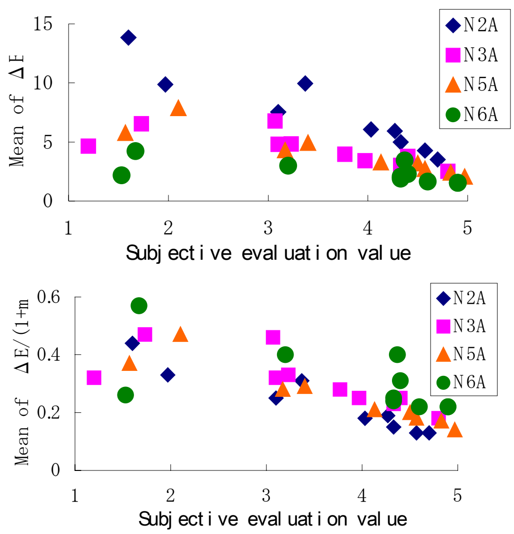

Figure 4. Relationship between mean of modified color difference $\Delta E_{00}/(1+m)$ and subjective evaluation value on color similarity.

Although we explained the method by using the word "pixel" for simplicity, we use the "spot" (4 × 4 pixels) for real computation (Machida et al. 2005). We use a mean value of modified color differences $\Delta E_{00}/(1+m)$ of spots as a new measure of evaluating image quality of compressed image displayed on LCD monitor.

Resultant relationships between subjective and objective evaluation values for ΔE_{00} and $\Delta E_{00}/(1+m)$ are shown in Figures 3 and 4, respectively. In Figure 3, the plots of N2A are differ from those of other images. And in Figure 4, the plots of N6A are differ from those of other images in high subjective evaluation value region. Correlation coefficients are 0.59 for mean of ΔE in Figure 3 and 0.74 for mean of $\Delta E_{00}/(1+m)$ in Figure 4, respectively. Higher correlation coefficient value was obtained for the new measure for objective evaluation value.

Recently a new paper on the image quality of motion picture has been published (Matsumoto et al. 2008). Color difference at the edge region is not calculated in the paper. There is ambiguity for determining edge area in the paper. However, there is no ambiguity for the new measure developed in our study.

3.2 Introducing a coefficient for maximum color difference

When observed carefully, it was found that plots of N2A were put on higher positions than those of N6A in Figure 3, on the other hand plots of N2A were put on lower positions than those of N6A in Figure 4. There must be better relationship between Figures 3 and 4, i.e. between ΔE_{00} and $\Delta E_{00}/(1+m)$. We introduced a coefficient c to reduce the effect of maximum color difference m, and a newly modified color difference $\Delta E_{00}/(1+cm)$ was derived. Means of the newly modified color difference and correlation coefficients to the subjective evaluation values were calculated for variations of c values. The values of c were increased every 2 times from 1/16 up to 2. As shown in Figure 5, the highest correlation coefficient 0.94 was obtained for c = 1/8. Consequently a good measure for evaluation of compressed image, $\Delta E_{00}/(1+m/8)$, was developed. The resultant relationship is shown in Figure 6.

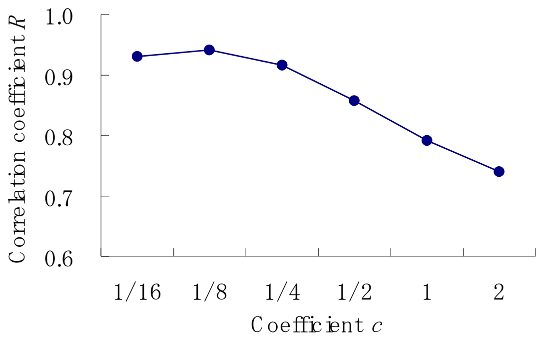

Figure 5. Correlation coefficient for variation of coefficient c used in the newly modified color difference $\Delta E_{00}/(1+cm)$.

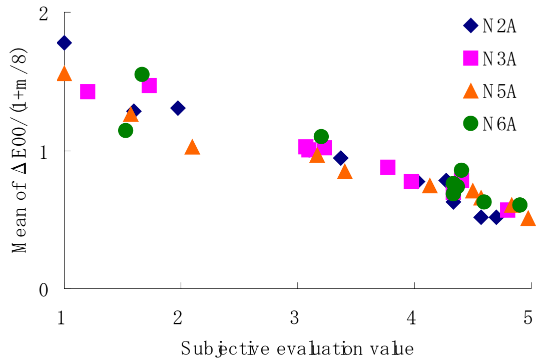

Figure 6. Relationship between mean of newly modified color difference $\Delta E_{00}/(1+m/8)$ *and subjective evaluation value on color similarity.*

4. SUMMARY

We developed the new objective measure for evaluation of compressed image displayed on LCD monitor. The correlation coefficient between values calculated by the new measure and subjective evaluation values was 0.94.

ACKNOWLEDGMENTS

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Applying machine vision for quality control of fruits in human based color space

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ABSTRACT

In recent years, the use of machine vision has been substituted for manual inspection for quality control in food and agricultural industries. The present study was an attempt for defect detection and sorting of some kinds of fruits such as banana. The fruits' images were captured using a digital camera with a capturing degree of zero and under illuminant D_{65}. Several methods such as color image clustering in RGB, HSV and, etc. and quantization of the images in single channels such as H, S and V as well as gray scale image was employed. The results showed that there was an identical threshold in the histogram of the S (saturation) channel of the image which can be applied to separate the object from its background. Moreover, the color change via the defect and time aging is more distinguishable in Hue channel. The effect of illumination and shadow of 3D imaging is less noticeable in comparison to Saturation and Value. The data of H channel was quantized to four groups based on the difference between each pixel value and the value of a healthy object. The percentage of different degree of defects is computed and used for grading the fruits.

1. INTRODUCTION

Quality control of food and agricultural products has been traditionally carried out by human assessment. Because of increasing the awareness and expectations of consumers, it needs to improve and be more speedy [1]. In addition, human inspection is heavily dependent on the human mood and easily changes based on physiological characteristics; also this technique is expensive, boring and laborious. Recent developments in computer hardware and software have introduced objective methods for quality control in different industries.

Color plays an important role for quality assessments in agricultural and the food industry and is extensively used for grading of products. It is clear that the color correlates well with other physical, chemical and sensorial properties and can be used to estimate ripeness, degree of defects, safety, storage time, nutrition, type and etc. Common color measuring devices, such as spectrophotometers, are expensive and have major limitations in terms of their ability to measure food and fruits' color with sufficient speed and accuracy [9]. Recently, digital color imaging provides an alternative for color measurement, quality inspection and classification of food and agricultural products, and can yield significant savings in terms of labor costs together with an increase in product quality; it has been feasibly applied for color grading of several kind of agricultural and food products [1-12].

The aim of the present study is to apply computer vision methods for feasibly defect detection and grading of some single color fruits such as banana.

2. EXPERIMENTAL

A machine vision system is employed for defect detection and grading of some single-color fresh fruits such as banana. For this purpose; the following procedure was implemented.

2.1 Image acquisition

2.1.1 Illumination: One of the most important factors which influence the quality of captured images and the performance of image processing is the illumination condition. In this research, D_{65} standard illuminant which is a simulation of daylight source was applied. A kind of diffuse illumination was preferred instead of direct illuminating.

2.1.2 Capturing device: A Cannon EOS 500D digital color camera was used for image capturing. The camera was set on autofocus and an acceptable white paper was placed in the scene for white balancing. The camera was set over the sample with almost 50cm distance. The angle between the sample and the camera was zero. A matte black surface was taken as background. The images were stored in JPEG format and the camera was connected to the USB port of a computer provided with a Remote Capture Software to monitoring and acquiring the images.

2.2 The proposed method

2.2.1 Color Space: The color space of the used camera is sRGB and also Adobe RGB. It is well known that other color space such as CIEL*a*b* and HSV are more correlated with human visual system and might be resulted better. If camera storage set as sRGB, L*a*b* and HSV measures can be estimated by standard equations. Applying these color space showed that HSV color space is an appropriate for the goal of this research.

2.2.2 Background removal: At first it was necessary to remove the background from the object. It was found that because of implementing a black background, the histogram of the image in saturation cannel shows a distinct threshold between the object and background which can be precisely used for background detection. Figure 1 shows a S channel histogram of a captured image. As illustrated, the first part of the histogram which is related to the background can be feasibly separated from the object.

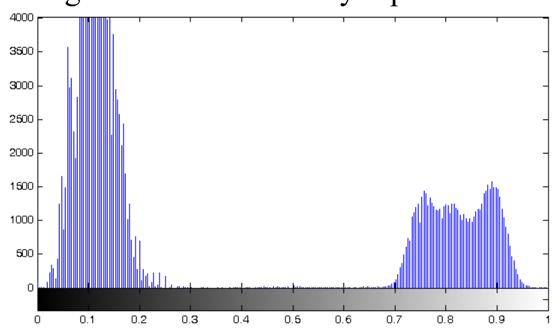

Figure 1. The histogram of the S channel of a captured image.

2.2.3 Defect detection and grading: Considering that defect existence and time aging is usually appeared in the color of the object, it can be useful to segment the object based on its color.

At the first trial, segmentation of the images in 3D color space was tested by applying FCM clustering methods. The obtained results were not acceptable which was mainly because of the lighting and gloss effect. After evaluating the image of each channel included H, S and V it was found that the color change via the defect and aging could be classified in H cannel properly. Using the H channel data, the effect of lighting condition, camera position and irregularity of the object (which is the most important one) on the captured image is almost disappeared. It is because of that the most effect of these factors is on the lightness of the sample which is more observed, in the S and V channels.

By this description, at first the images were converted to HSV color space and then the images of the H channel were assessed. To be able to grading the object based on H values it is necessary to access a standard value and compare the other measures with it. It was found out that this can be easily done by a calibration step in which the standard value for each kind of fruit can be obtained by a preliminary experiment. To do that, a healthy and completely acceptable fruit is selected. The image of the sample is captured and converted to HSV space. The mean of pixel values in H channel is applied as the standard value. It should be noted that this standard value can be also achieved by applying a set of healthy samples and averaging their obtained results.

As an example Figure 2 shows a healthy sample which is segmented from its background (the background is black), together with the H channel image and the histogram of it. It can be seen that as expected the H histogram of the sample has a sharp Gaussian shape and its mean can be used as the dominant H value of this type of banana.

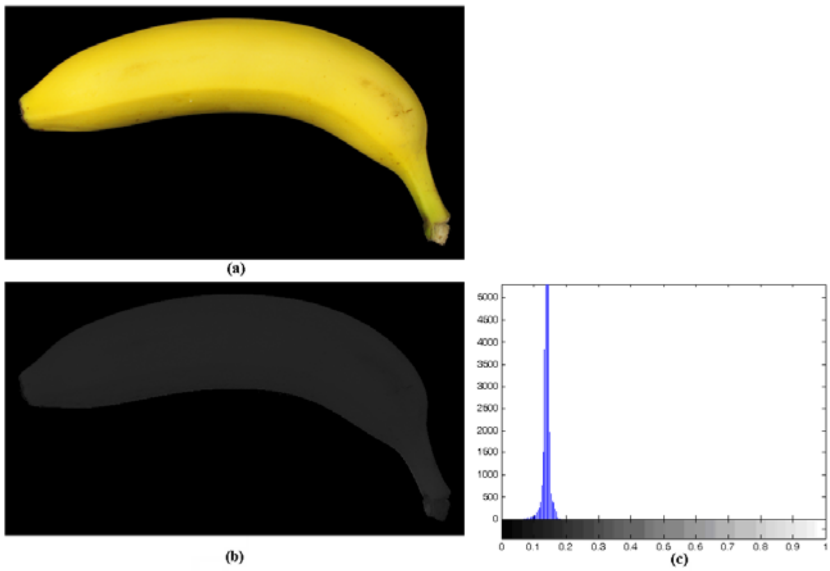

Figure 2. (a) The image of a banana which is separated from its background; (b) the hue channel of (a); (c) the histogram plot of hue channel.

Then the sample image should be segmented considering the standard value which was obtained from the last step. It is feasibly possible to segment the images by thresholding the histogram of H channel. To do that, the standard value is set as the center, and then the H value difference between each pixel value and the center is computed. The quantization process is applied considering the computed difference values.

3. RESULTS AND DISCUSSION

Figure 3 shows the captured images of a banana from day 2 to day 4 after applying the proposed background removal method. The image of the first day is similar to Figure 1, so it does not show again. As illustrated from Figure 3, time aging and defect growing would change the color of the samples. Figure 4 shows the images in H channel together with their corresponding histograms. As explained the dominant H value of this type of banana can be find from the healthy sample and then color clustering and quantization would be applied. Figure 5 shows the segmented images. Comparing Figure 5 and Figure 3 shows that the suggested method can feasibly and accurately shows the defected parts based on the degree of decay. Table 1 indicates the percentage of each segment for the samples which can be used for grading them.

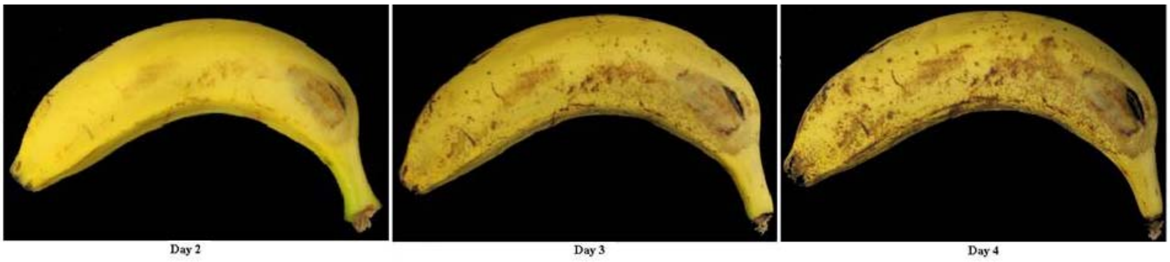

Figure 3. The image of a healthy banana on the second, third and fourth days.

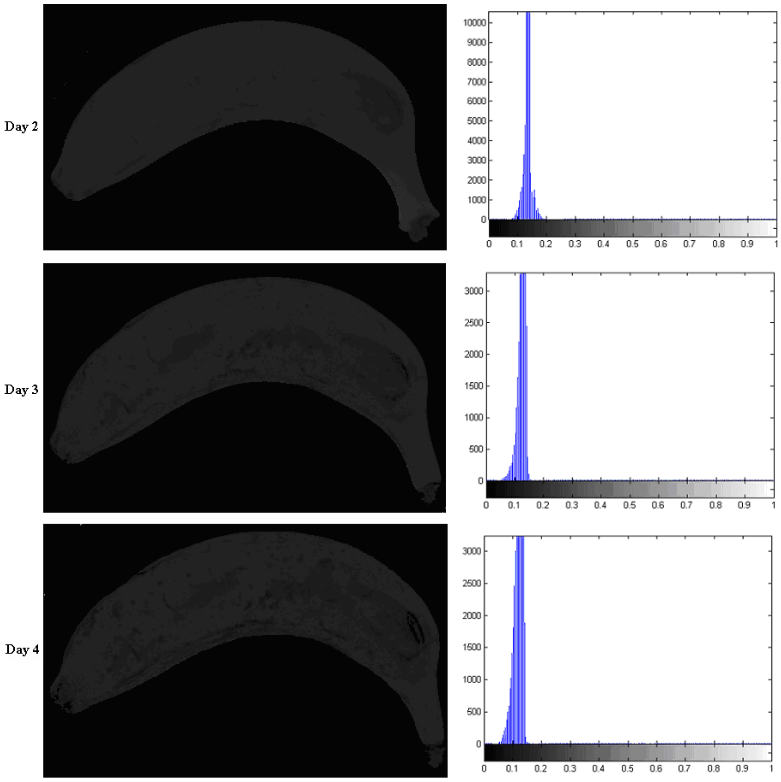

Figure 4. The hue channel of images of Figure3 together with the corresponded histograms.

Figure 5. The segmented images of figure 3 applying the proposed method.

Table 1. The percentage of each segmented parts for the images of Figure 5.

	white	**grey 1**	**grey 2**	**grey 3**	**black**
Day 2	85.53	8.64	3.31	1.59	0.93
Day 3	58.66	22.26	10.86	4.47	3.75
Day 4	46.48	22.29	14.19	8.61	8.43

4. CONCLUSION

Color is an important feature for defect detection and grading of most of the fresh fruits. The development of digital color imaging gives the possibility to on-line quality control of agricultural and food products. In the present study, color image processing was established for grading of some fruits. For this purpose, the images were captured with a RGB digital camera under diffuse illumination. It was found that the best capturing angle was zero. HSV color space was found to be able to give superior result. It was shown that it is simply possible to remove the background using the S channel information. A histogram-based theresholding in Hue channel was employed for quantization and segmentation of the images. It was found that the color change due to defect and time aging is suitably distinguishable in H channel due to eliminating the undesirable illuminating effects. Consequently the fruit image is segmented based on the degree of defect and can be graded according to the percentage of each segment.

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A multi-spectral approach of cross-media HDR imaging technique for food store scenes under multi-illuminants using a locally optimized automatic white balancing method

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ABSTRACT

In this research, a multispectral approach of cross-media HDR imaging technique, for realistic color reproduction of mixed multi-illuminants food-store scenes, was developed. Three HDR modules used tone-mapping algorithms (TMAs) of photoreceptive adaptation algorithm (PAA), fast bilateral filtering (FBF), and fast Fourier transform plus highpass filtering (FFTpHF), respectively. In addition to TMA, each module also carried out multi-illuminants whit-point estimation, white-point conversion using gray balancing look-up-table via CIECAM02 color appearance modeling, color gamut mapping, and device characterization. The gamut mapping algorithm (GMA) was derived using a multiple-conversing-points approach, and locally incorporated with each tone-mapping module to locally (or globally) carry out the adaptive white-balancing rendition of food images. Finally, each of HDR imaging modules could be further integrated with an ideal type of simulated CIEXYZ camera model,which was derived previously to mitigate metamerism problems often happened in cross-media imaging systems. Based on the standard reference color space of AdobeRGB, the ideal camera model derived simulated responses of CIE 1931 color matching functions. The illuminants-independent type of scene-referred food store images produced could be, hence, further transformed into multi-spectrally original HDR image data in cross-media high-rendition imaging for virtual food stores or E-table restaurants.

1. INTRODUCTION

Multiple illuminants with different color temperatures within a scene, especially of food store, provide a complicated situation for color constancy and automatic white balance algorithms in digital photography. This problem gets even worse in high-dynamic-range (HDR) imaging of such scenes of food stores, considered illuminating using various color-temperatures light sources to sensationally shine different types of food. It is due to a large scale of luminance information captured from the influence of different illuminants. Human eyes are very good at locally adapting to distinct illuminants in the same food-store scene by saccadic eye movement. However, digital cameras often have great difficulties in auto white-balancing in this mixed multi-illuminants situation. Therefore, the approach of a single global adjustment of food colors in a complex food-store image, captured under such mixing lighting by a camera, may not yield pleasingly acceptable results. Often it tends to exaggerate or mess up the color appearance of foods in most cases. For this reason, different color temperature lighting has to be considered in rendering of food-store HDR images. As a part of cross-media HDR color image processing and rendering procedure, three sets of tone mapping algorithms, with local illuminant estimation and auto white balancing (AWB), were thus proposed here and evaluated in this paper.

2. COMPUTATION FRAMEWORK OF MODEL

The HDR tone-mapping technique, with the incorporation of a locally adaptive white/gray balancing method (white-point conversion), was the main focus of this research. It took account of cross-media color transformation of scene-referred images on food stores, under mixed multi-illuminants. Figure 1 provides a flow chart of each major step in computation framework of model. Three sets of cross-media HDR imaging modules were proposed and evaluated. HDR modules developed here were only different in the use of tone-mapping algorithms. Three tone-mapping operators implemented included photoreceptive adaptation algorithm (PAA), fast bilateral filtering (FBF), and fast Fourier transform plus highpass filtering (FFTpHF) respectively. Each of modules integrated automatic approaches of multi-illuminants whit-point estimation, locally adaptive white-point conversion using gray balancing LUT (look-up-table) method via CIECAM02 color appearance modeling, tone and color-gamut mappings (Lo et al. 2003), and finally multi-spectral type of CIEXYZ camera characterization.

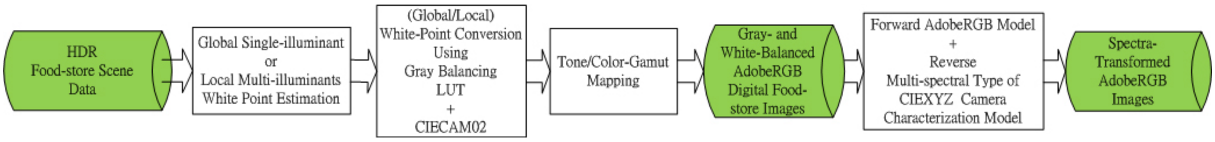

Figure 1. Working flow of HDR imaging computation framework model across media.

3. EXPERIMENT AND IMPLEMENTATION

***White-point conversion**:* To correct white-points mismatch problems, the transformation of white points, based on a defined appearance connection space reference viewing condition, was adopted in this study. The adopted white point was the standard illuminant D_{65} (i.e. $X_w = 95.02$, $Y_w = 100$, and $Z_w = 108.81$); $Y_b = 20$, $L_A = 63.6619$; Surround = Average. However, to perform white-point transform (or conversion) for complex food images, camera calibration and characterization using a gray-balancing LUT method were preliminarily conducted. The analysis was based on measurements of color appearance under each of three view conditions, considered in A, D50, and D65 illuminants (or simulators).

In the context of color-appearance matching, the link between camera/RGB and illuminants-independent) representation was established for each illuminant of interest. The illuminants-independent representation was appearance-correlates data, such as red-green and yellow-blue opponent dimension (a and b), lightness (J), chroma (C), hue quadrature (H), colorfulness (M), and brightness (Q). A GretagMacbeth Digital ColorChecker SG target was used as a training and test data set. The preliminarily experimental procedure of camera calibration and characterization for each tested illuminant is outlined as follows:

1. Generate 3D LUT from all combination of R, G, and B levels for a total of 11^3 lattice points in the source RGB space.
2. Calculate the CIEXYZ and CIELAB values with the Adobe RGB (1998) color image encoding, and then the corresponding color-appearance correlates (i.e. J, a, b, C, H, M, Q, and S) under the defined appearance connection space reference viewing condition.

3. Measure the spectral reflectance data of the SG target, and then calculate the CIEXYZ, CIELAB, and also corresponding color-appearance correlates under the defined reference viewing condition.
4. Correlate the Adobe/RGB with the lightness J which was calculated under the reference viewing condition, by using results from gray patches of the SG target, to build gray-balancing LUT.
5. Convert the Adobe/RGB to grayBalanced/RGB for all color patches in both the 3D LUT and the digital SG target, using the gray-balancing LUT.
6. Derive a transfer matrix that matches grayBalanced/RGB of color patches to their measured CIE color-appearance correlates, *J*, *a* and *b* using the 3rd-order polynomial regression.
7. Obtain the camera/RGB responses of the SG target which was illuminated under each illuminant or simulator considered.
8. Measure the spectral power distributions of the illuminant tested.
9. Calculate the CIEXYZ, CIELAB, and also corresponding color-appearance correlates for all test patches under each illuminant tested. Then scatter plot of all a and b data from each illuminant tested, into a and b opponent color space (later used in the estimation of illumination lights).
10. Build gray-balancing LUT for white-point conversion, by correlating the camera/RGB with the lightness J which was calculated under the reference viewing condition (also by using results from gray patches of the SG test target).

After the locally (or global) auto white-point estimation, the camera/RGB could be converted to grayBalanced/RGB for all color pixels in food images tested via the white-conversion gray-balancing LUT, and then further transformed into CIE illuminants-independent color space (i.e. J, a and b) via the derived matrix.

Therefore, in this study, the camera white-point conversion was a two-step process of gray-balancing and matrix transformation. The derived matrix could be used for all digital cameras which capture images in the AdobeRGB format. Only the gray balancing was needed to update according to the schedule of the camera calibration for illuminants considered used in food stores.

Tone-mapping models*:*The PAA was based on a multi-scale representation of the human visual system (Pattanaik et al. 1998), whereas the FBF carried out a two-scale decomposition of the image into a base layer and a detail layer (Durand and Dorsey 2002). As for the fast Fourier transform of FFTpHF, transfer functions of the Butterworth high pass filters of order *n* was applied to avoid ringing-like effect.

4. RESULTS AND CONCLUSIONS

Figures 2 and 3 represent two typical original food images and their resulting images by three HDR tone-mapping related imaging modules. The watermelons and grapes in original scene (Fig. 2(a) was the original captured image by camera used) were respectively lit by light sources similar to A and illuminant D_{50}. As for another image shown in the original captured image of Fig. 2(a), the watermelons and the other foods were respectively lit by red bulb and a light source with color temperature near D_{50} in their original food store.

(a)Original (b) PAA (c)FBF (d) FFTpHF

Figure 2. Resulting images for watermelons and grapes respectively lit by light source similar to A and lit D_{65} illuminants.

(a)Original (b)PAA (c)FBF (d)FFTpHF

Figure 3. Resulting images for watermelons and other foods respectively lit by red bulb and D_{50} simulator.

The results, obtained from most of food-store scene, showed that the PAA always gave out the best performance. Apparently, it seems that the PAA outperformed the other two models. As shown in Figs. 2(b) and 3(b), two resulting images of the PAA sensationally kept better renditions in color-appearance, details and tone range than those of the other two models. Also, three proposed modules all gave satisfactory rendition qualities on color appearance when the illuminant chromaticities of light sources fall on a long “thin-band” around the Planckian locus in chromaticity space. However, both the FBF and the FFTpHF didn’t perform pleasingly as the PAA did, on those images captured from food store lit by chromatic light sources (such as the red bulb in Fig. 3). The analysis from results strongly suggested that, to prove the performance of the proposed approach, the local white-point estimation and conversion algorithm applied in the multi-illuminants HDR imaging modules needs to further take those “chromatic” illuminants, into account. Finally, via the ideal CIEXYZ camera model, which was developed previously to mitigate metamerism problems often practically happened in cross-media imaging systems (Lo et al. 2010), the multi-spectrally illuminant-independent type of HDR food images could be further produced and used as representation of originals in cross-media HDR food-store imaging applications.

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Feature extraction of painter-specific color distribution from real paintings

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ABSTRACT

This paper proposes an analysis method for extracting the color features of painter-specific color distribution from real paintings. We photographed directly famous paintings with a white calibration plate in museums by using a calibrated digital camera, and constructed a real painting database. The captured camera image is transformed into the RGB image of a standard display device under CIE Illuminant D65 using the calibration data. We show that the color features of paintings belonging to each painter can be effectively represented by the mean vector and a small number of principal component vectors in the RGB space.

1. INTRODUCTION

Color analysis of art paintings is an important issue in the fields of color image reproduction, computer vision, image processing, art history, etc. The color analysis is often based on digital image data which were taken by scanning the printed matter in a picture collection book or obtained by retrieving the data file through internet. However, it should be noted that the reproduced colors from the image data are not generally equal to the original colors of the original painting observed under a certain museum lighting environment. This fact is a great stumbling block in the precise color analysis.

This paper proposes an analysis method for extracting the color features of painter-specific color distribution from the image data captured from real paintings. We photographed directly famous paintings with a white calibration plate in two museums in Paris by using a calibrated digital camera. The captured camera image is transformed into a standard image representing the appearance under CIE Illuminant D65 using a light source information recorded on the white plate. This image is further transformed into the RGB image of a standard display device. Then, we analyze the color distribution in the RGB color space for individual painters based on principal component vectors.

2. CONSTRUCTION OF IMAGE DATABASE

We photographed directly famous oil paintings in the Orsay museum and the Orangerie museum in where photography was permitted, and constructed a large database collecting high resolution digital images of paintings for each painter. We used a calibrated digital RGB camera (Canon EOS 1Ds) with an image size of 4992 × 3883 pixels and a quantization level of 12 bits. The camera sensitivity function is shown in Fig. 1. The illumination of each painting depended on the exhibition room. Therefore, in the image capturing, the light source information was also recorded for each painting by using a white calibration plate as shown in Fig. 2. From the database, in our analysis, we selected art works by eight painters of Jean-

Baptiste Camilla Corot with 5 works, Jean-Francois Millet with 5 works, Gustave Courbet with 6 works, Edouard Manet with 7 works, Paul Cezanne with 8 works, Claude Monet with 9 works, Pierre-Auguste Renoir with 13 works, and Vincent van Gogh with 7 works.

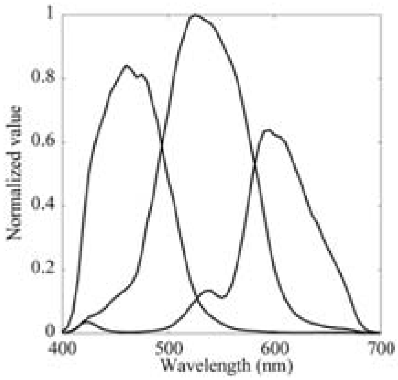


Figure 1. Camera sensitivity function.

Figure 2. Capturing with a calibration plate.

3. IMAGE TRANSFORMATION AND FEATURE EXTRACTION

A captured RGB camera image in the real painting database can be transformed into CIE-XYZ tristimulus values by multiplying a 3 × 3 matrix which is constructed by approximating CIE 1931 (2 deg) color matching function using the total camera sensitivity function in Fig. 1. Lighting condition of each painting was different. Therefore, the XYZ image is transformed into a standard image representing the appearance under the Illuminant D65.

In order to estimate the illuminant condition for each painting, we use the average of the tristimulus values on the white calibration plate. Then von Kries chromatic adaptation (Ives 1912) is used for the transformation. The tristimulus values are transformed into LMS cone coordinates as follows:

$$\begin{bmatrix} L \\ M \\ S \end{bmatrix} = \mathbf{M} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}, \quad \mathbf{M} = \begin{bmatrix} 0.40024 & 0.70760 & -0.08081 \\ -0.22630 & 1.16532 & 0.04570 \\ 0 & 0 & 0.91822 \end{bmatrix}, \tag{1}$$

where, the matrix **M** represents Esteven's data. Then the diagonal matrix **W** for the cone response ratio is determined as

$$\mathbf{W} = diag(L_{D65}/L_W, M_{D65}/M_W, S_{D65}/S_W), \tag{2}$$

where (L_w, M_w, S_w) and (L_{D65}, M_{D65}, S_{D65}) represent the LMS stimulus of the white calibration plate and the one of Illuminant D65, respectively. By using the matrices **W** and **M**, the original tristimulus values are transformed into the tristimulus values under Illuminant D65 as follows:

$$\begin{bmatrix} X_{D65} \\ Y_{D65} \\ Z_{D65} \end{bmatrix} = \mathbf{M}^{-1}\mathbf{W}\mathbf{M} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}. \tag{3}$$

Finally, the tristimulus values under D65 are further converted into the RGB values of a standard display device (EIZO ColorEdge CG221). The operation is done by a linear transformation with a 3 × 3 matrix and a nonlinear mapping by a gamma operator.

By mapping the real image data into the above standard RGB color space, we found that the color distribution for individual painters could be roughly represented by the principal component analysis (PCA). Therefore, in this study, we used the principal component vectors of the distribution of painting color which are inherent to the individual painter as color features. First, we add up the RGB image data of all real paintings by the same painter. Second, the mean color vector is calculated as center of gravity of the data set. Third, the principal components are obtained by calculating the eigen values and the eigen vectors of the covariance matrix. These principal component vectors represent the features of the color distribution of image data set.

4. EXPERIMENT

4.1 Color reproduction

We verified the color reproduction accuracy of our measurement system. We displayed Renoir's "Female Nude in the Sunlight", Manet's "The Fife Player", and Andre Derain's "Harlequin and Pierrot" in our real painting database on the standard display device, and measured the displayed white calibration plate by a spectroradiometer (Photo Research Inc., PR-650). The measured CIE-xy chromaticity coordinates are shown on the blackbody locus in Figure 3. Since each chromaticity value on the white plate was almost equivalent to the illuminant in the actual exhibition room, we confirmed that the color reproduction of the photographic image in the real painting database was appropriate. Figure 4 shows a captured image "The Fife Player" (left) and transformed image into the D65 environment (right).

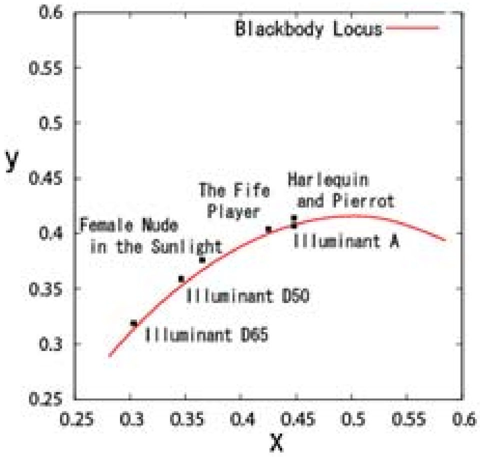
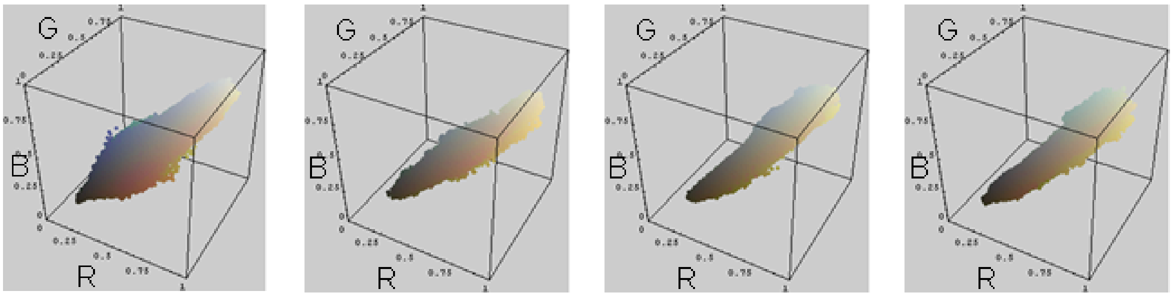


Figure 3. CIE-xy values of white plates. *Figure 4. Captured image and estimated D65 image.*

4.2 Color feature extraction for individual painters

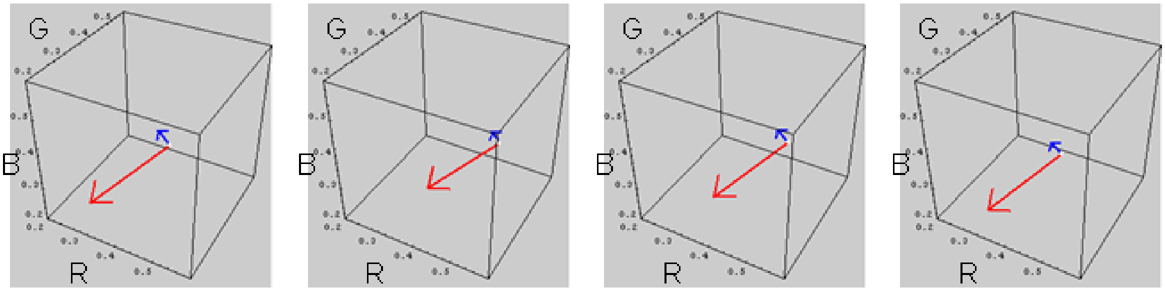
We analyzed the color distribution for individual painters based on the PCA. We added up the RGB image data of all paintings by the same painter. Figures 5 shows the RGB color distribution by 4 painters of all 8 painters. Figure 6 shows the color features represented by the mean coordinates and two principal component vectors. As a result, the mean vector represents the average color feature of a painter from the global point of view, which is the center of gravity of color distribution. We found that the mean value is high for Monet, and low for Manet and Courbet.

We analyzed the percent variance of principal component for all painters. The first principal component represents lightness that means the directional vector combining the center point and the origin of the space. The contribution of the first component was more than 95% for Corot, Millet, Courbet, and Manet. The percent variance of the second component was less than 3% for these painters. The percent variance of the principal components corresponded to the variance of color distribution. The color distributions of Corot, Millet, Courbet, and Manet formed a linear cluster (thin ellipsoid). The color distribution of van Gogh formed a wide cluster (broad ellipsoid). The color feature for the latter case meant wide color variation.



a. Manet *b. Millet* *c. Corot* *d. Courbet*

Figure 5. Color distribution for image sets of 4 painters.



a. Manet *b. Millet* *c. Corot* *d. Courbet*

Figure 6. Principal components for image sets of 4 painters.

5. CONCLUSION

This paper has proposed an analysis method for extracting the color features of painter-specific color distribution from real paintings. The color features of paintings belonging to famous painters were represented by the mean vector and several principal component vectors in the standard RGB space. We will apply the color features to color correction of the digital image data obtained from arbitrary image media as a future work.

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Color reproduction of 3D printer

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ABSTRACT

3D printer is a new device that can produce 3D objects. Inkjet type 3D printer can put color on 3D objects. This printer has four-color binders (clear, cyan, magenta, and yellow), and can make fully-colored 3D objects with the four-color binders. To evaluate the color gamut, 24 samples of square tiles with colors of Macbeth color checker were made by the 3D printer. The side of the tile is 40mm, and the thickness is 3mm. Additional samples processed by transparent resin were made.

1. INTRODUCTION

3D printer can produce three-dimensional objects based on 3D model data made by 3D CAD or 3D modeling software. There are different types of 3D printer: stereolithography, sintering powder method, inkjet printing method, and so on. Stereolithography was the first one to be in practical use. This method makes an arbitrary three-dimensional shape using a vat of liquid UV-curable photopolymer and a UV laser. Sintering powder method makes a three dimensional shape by fusing small particles of plastic, metal, ceramic, or glass powders using a high power laser. Recently 3D printers are used not only for the rapid prototyping in the development of products but also for the fields of medical purposes (Yamazawa et al. 2008), hobbies, food samples, and so on.

In these methods, the inkjet printing method is the only one method that can make fully colored 3D objects. This method creates 3D objects based on layers of a fine powder by printing an adhesive and color inks in a shape of each cross-section as determined by the 3D CAD data.

This paper reports a color reproduction utilizing the inkjet printing method (Z Corporation, ZPrinter450 2009).

2. 3D PRINTER USING INKJET PRINTING METHOD

3D printer with inkjet-printing method (inkjet type 3D printer) can put color on the 3D object. This printer has four-color binders (clear, cyan, magenta, and yellow), and can make full color 3D objects with these four-color binders.

The following process makes a 3D object: At first, 3D CAD data made by 3D CAD software or 3D CG modeler is sliced to digital cross sections each of which thickness is 0.1 mm. For each section, the 3D printer puts a fine powder of plaster of the same thickness. The adhesive and color ink is printed to each cross-section by the inkjet printer-head. The processes above are repeated until completing the entire model. Construction of 3D models completes after the model is left to dry, and the unused plaster powder is removed. Moreover by post-processing with transparent resin, the durability of object increases and the color becomes clearer because the transparent resin coats the surface by filling the microscopic interstices of the model.

Figure 1 shows 3D objects made by the inkjet type 3D printer. Figure 1.a is a picture of two roses with different color, and the right one is cut in half. The inside is white to indicate that the model is made by plaster powder. Figure 1.b is a picture of replicas of a nine-story tower that was built in the 7th century. The tower no longer exists. The left one is the reproduction model of the original tower, and the right one is the model with estimated aged deterioration. The roofing tiles of the right tower were manually painted pearl over the original black and then post-processed. To make a desired 3D object, it is still important to know the characteristics of color reproduction of the 3D printer.

1.a Roses (Right object is cut in the half).

1.b Replicas of nine-story tower.

Figure 1. Products of 3D object by inkjet type 3D printer.

3. EXPERIMENTS

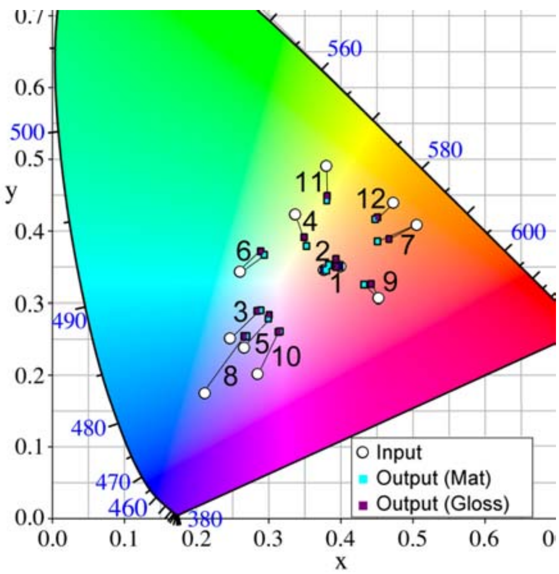
To evaluate the color gamut of 3D printer, 2 sample sets were made. Each set has 24 square tiles that were made by the 3D printer and painted with colors of Macbeth color checker. The side of the tile is 40 mm, and the thickness is 3 mm. One set was not post-processed (Figure 2.a), whereas the other set was post-processed by transparent resin (Figure 2.b). The colors of sample were determined based on Digital GretagMacbeth ColorChecker Data Tables (WallkillColor 2006). The samples in Figure 2.a are mat surface, and the colors become faded. On the other hand, the samples in Figure 2.b are glossy surface, and the colors are clearer than the mat samples.

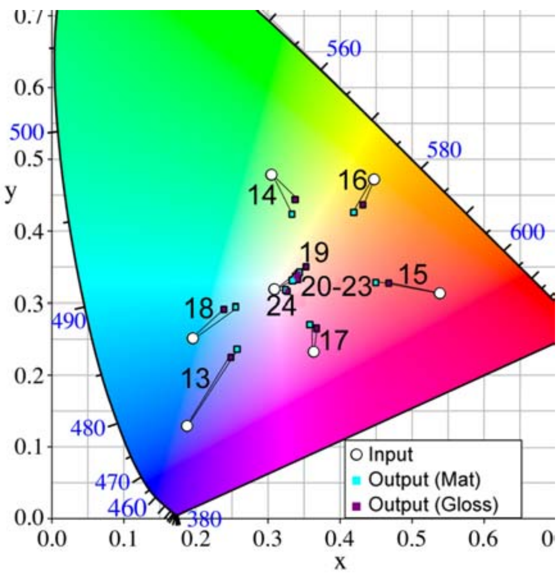
The individual color of samples was measured by Chromameter (Konica Minolta, CS-200). Figure 3 shows their plotted values on xy chromaticity diagram. Figure 3.a shows data of samples 1-12 (upper-side of tile array in Figure 2), and Figure 3.b shows data of samples 13-24 (bottom-side). These xy diagrams show that the chromaticity of samples appears to be closer to white than the original chromaticity of Macbeth color checker is. Moreover the chromaticity of the resined sample became closer to the original chromaticity than the chromaticity of samples without post-processing by transparent resin did. These results are useful to utilize the 3D printer to put desired color.

Table 1 shows the values of achromatic colors. The ranges of lightness L* in mat and glossy samples are narrower than of the input value. The table also indicates that the lightness L* is improved by the post-processing. On the other hand, a* and b* become slightly larger in both mat samples and glossy samples than those in input, and their values in glossy samples are larger than in mat samples. The possible reason is that the color of plaster powder and resin affects the color of samples.

2.a Samples without post-processing. *2.b Samples with post-processing.*

Figure 2. Samples made by 3D printer.





3.a Data of samples (1-12). *3.b Data of samples (13-24).*

Figure 3. Measurement results on xy chromaticity diagram.

Table 1. Results for achromatic color.

Color	Name	Hue Value/ Chroma	Input Values			Mat Samples			Glossy Samples		
			L*	a*	b*	L*	a*	b*	L*	a*	b*
19	white	N9.5	96.00	-0.06	0.06	81.25	3.22	15.99	81.42	3.94	17.28
20	light grey	N8	81.35	-0.05	0.06	74.10	2.41	9.40	73.77	3.44	10.34
21	light-medium grey	N6.5	66.67	-0.04	0.05	68.67	2.83	9.24	67.51	2.95	10.62
22	medium grey	N5	51.57	-0.03	0.04	61.53	2.15	9.41	59.63	3.00	9.64
23	dark grey	N3.5	35.99	-0.03	0.03	52.29	2.85	5.69	47.71	4.29	6.54
24	black	N2	20.54	-0.02	0.02	41.14	3.58	0.27	35.47	4.04	1.24

4. CONCLUSION

This paper describes about color reproduction of 3D printer with inkjet-printing method in order to make a 3D object with desired color. In the experiment, from the color of Macbeth color checker as input, the output color of 3D object samples was analyzed. The chromaticity of samples appears closer to white from the original chromaticity of Macbeth color checker, and the range of lightness became narrower than of the input value. Moreover post-processing using transparent resin was proven to enhance color gamut of 3D printer.

The information obtained from this experiment is useful to utilize the inkjet-type 3D printer to reproduce 3D objects.

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Color optimization of different fruits and vegetables for computer displays

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ABSTRACT

The aim of the research was to apply the spectral reflection distributions of color stimuli of different vegetables and fruits onto computer displays with the help of the color management methods. At the first stage of the research we measured the spectral reflection distributions of color stimuli of several different vegetables and fruits with a spectrophotometer and we calculated the color coordinates in the CIELAB color space. Based on the measured values we created each color on a calibrated LCD monitor by using the four "rendering intents" of the Color Management System. The displayed color stimuli were then remeasured by means of spectrophotometer and the results were compared to the original values. The final results of the calculations shall give recommendation on the method providing the lowest color difference when visualizing color stimuli of fruits and vegetables on computer displays.

1. INTRODUCTION

With the spreading of modern CAD applications, printing technologies and the conquest of the internet the appropriate display of colors has become very important in several applications. One example from the marketing point of view is that today when observing a product catalogue photo not only the shape and resolution is important but the picture also should reflect original colors. The common experience is that the colors of the products do not appear the same on the monitor or in the catalogue as in reality (Fairchild 2005). Although color sensation is a subjective perception it can be measured in objective ways (De Cusatis 1997). Moreover it can be communicated and controlled when displayed on digital screens.

The color management system (Fraser, Murphy and Bunting 2005) gives solutions to represent colors on the computer monitor close to their real appearance. With the application of adequate color management methods we can ensure that color information on a given object will not become distorted to great extent while it migrates from one device to another. On the other hand we have to take into account that human vision can perceive much more colors than the color gamut of the monitor or printer can realize, therefore device parameters also have to be considered.

2. COLOR RENDERING INTENTS

There are four different methods in the color management system (Cambridge in Color) that provide ways of calculation when transforming colors outside the color gamut of a specific device:

- **Relative colorimetric:** Any colors that fall outside the device color gamut area are replaced by one specific color within the target gamut while hue and brightness are being preserved. For most images this intent retains best the overall color quality of an image as it is transformed from one device color profile to another.
- **Perceptual:** When the color conversion or remapping is applied some colors may be shifted, but the relations between colors are retained to match human perception.
- **Absolute colorimetric:** Colors located outside of the device color gamut area are simply clipped or removed.
- **Saturation:** The color saturation is retained for the original color at the expense of hue and brightness.

The aim of our paper is to present the different color rendering intents' performance for the digital display of fruits and vegetables and to select the best method providing the lowest color difference.

3. MEASURING THE DIFFERENT FRUITS AND VEGETABLE COLORS

3.1 Color measurement

When observing fruits and vegetables, color is the first sensation that the consumer perceives and uses as a primary tool to accept or reject the food (Mendoza, Dejmek and Aguilera 2006, Nunes 2008).

To maintain adequate quantities and quality, we carried out the different vegetable and fruit color measurements in one of the largest hypermarkets in Budapest, Hungary where numerous fruits and vegetables were available at first-rate quality. Nearly 40 different kinds of vegetables and fruits were measured considering data acquisition on at least five pieces from each kind. The spectral reflection distributions of the different vegetables and fruits were measured with a CM2600d type Konica Minolta spectrophotometer. From the measurement results we calculated the color coordinates of each color stimuli in the CIELAB color space (De Cusatis 1997). The measuring range was between 380 and 730 nm with 10 nm spectral resolution.

3.2 The calculation of CIELAB color coordinates

The sequence of calculation from spectral reflection distributions to CIELAB space coordinates was the following (Fairchild 2005):

- **Spectral data to XYZ tristimulus values:** The spectral power distribution of the reference illuminant is *I(λ)*, the spectral power distribution of the sample is *P(λ)*; the $\bar{x}$, $\bar{y}$ and $\bar{z}$ are the CIE standard observer functions (for 2°). The integrals are computed over the visible spectrum (from 380 to 730 nm).

$$X = K\int_{380}^{730} I(\lambda)\,\bar{x}(\lambda)P(\lambda)d\lambda;\; Y = K\int_{380}^{730} I(\lambda)\,\bar{y}(\lambda)P(\lambda)d\lambda;\; Z = K\int_{380}^{730} I(\lambda)\,\bar{z}(\lambda)P(\lambda)d\lambda$$

where 'K' is the normalizing constant between radiometric and photometric values.

- **XYZ tristimulus values to CIELAB:** This conversion required a reference white, which in our case was ($X_w = 96.40$; $Y_w = 100$; $Z_w = 82.5$).

$$L = 116\left(\frac{Y}{Y_W}\right)^{\frac{1}{3}} - 16\ ;\ a = 500\left[\left(\left(\frac{X}{X_W}\right)^{\frac{1}{3}}\right) - \left(\left(\frac{Y}{Y_W}\right)^{\frac{1}{3}}\right)\right]\ ;\ b = 200\left[\left(\left(\frac{Y}{Y_W}\right)^{\frac{1}{3}}\right) - \left(\left(\frac{Z}{Z_W}\right)^{\frac{1}{3}}\right)\right]$$

4. CALCULATING THE COLOR RENDERING INTENTS

The next step was to display the calculated CIELAB coordinates on the calibrated LCD monitor (Samsung SyncMaster931BF) with the help of the Photoshop software and the specific ICC profile (Adobe Creative Team 2007).Using the color rendering intents of the Color management system, we created all the colors and remeasured them on the display. The measuring instrument was a Gretag-Macbeth X-Rite i1-Pro spectroradiometer. We have used all four color management system methods to display color stimuli and measured their spectral power distribution, calculated the XYZ tristimulus values and the CIELAB coordinates (Figure 1).

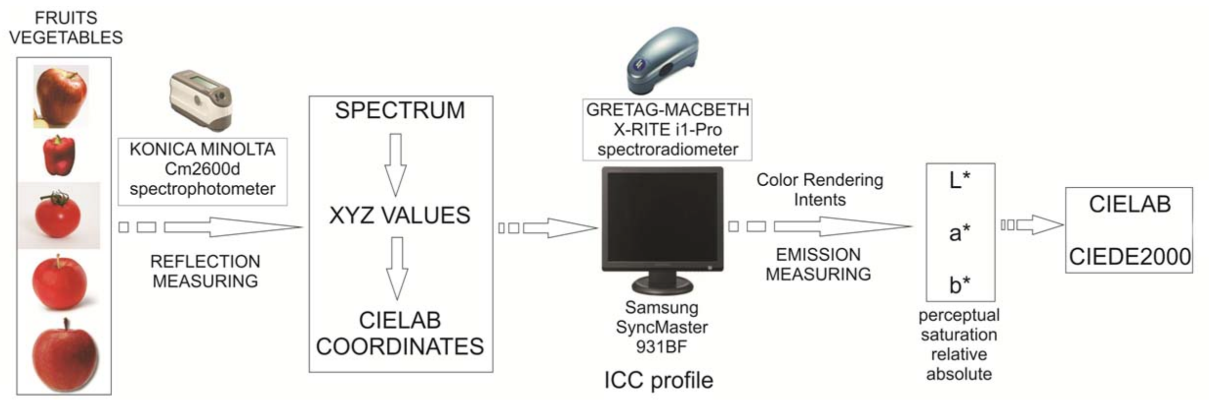

Figure 1. Measurement and calculation sequence.

5. RESULTS

Color differences between the original and displayed color stimuli were calculated using the CIE ΔE*ab and the CIEDE 2000 methods (Johnson and Fairchild 2003). With the help of these methods we were able to determine the color management method providing the lowest color difference when displayed on the monitor. Table 1 shows the color difference calculation results for some specific fruits and vegetables with different color appearances.

6. CONCLUSION

In our work we have compared the four color management system methods applied when displaying color stimuli of fruits and vegetables on the computer monitor. The differences between the original and displayed colors were determined using CIE color difference calculation methods. For all samples we have found that the ΔE^*_{ab} and the CIEDE 2000 values correlate to a high extent ($R^2 > 0.96$ for intents Perceptual, Relative Colorimetric and Saturation and $R^2 > 0.92$ for Absolute Colorimetric) which has proven to be a similar result to other studies (Lee 2005). ΔE^*_{ab} values were also found to be significantly higher (25% for intents Perceptual, Relative Colorimetric and 34% for Absolute Colorimetric).

Comparing the values between the four intent types no significant differences were detected between the Perceptual, Relative Colorimetric and the Saturation intents. On the other hand the Absolute Colorimetric intent differed significantly ($p < 0.01$) from all others providing larger color difference values for both ΔE^*_{ab} and the CIEDE 2000 thus this latter is not recommended when displaying fruit or vegetable colors.

Summarizing the results we can say that the expectations were fulfilled meaning that color stimuli will appear different from their originals on the computer display. However based on our results we are able to recommend color management methods to be applied for providing fruit and vegetable color appearances closer to reality.

Table 1. Typical results for some of the measured fruits and vegetables.

Fruit/vegetable	Intent	CIEDE2000	ΔE^*_{ab}
Garlic	perceptual	12.85	18.36
	saturation	12.49	18.09
	relative	12.65	18.36
	absolute	21.31	34.91
Lemon	perceptual	8.96	13.70
	saturation	8.93	13.65
	relative	8.97	13.75
	absolute	10.10	18.47
Green California Pepper	perceptual	8.41	9.77
	saturation	8.47	9.84
	relative	8.63	10.02
	absolute	13.23	15.70

Fruit/vegetable	Intent	CIEDE2000	ΔE^*_{ab}
Orange	perceptual	5.61	8.20
	saturation	5.48	8.19
	relative	5.67	8.31
	absolute	7.07	15.76
Tomato	perceptual	7.48	9.75
	saturation	7.54	9.77
	relative	7.46	9.62
	absolute	10.29	14.84
Purple onion	perceptual	7.00	10.35
	saturation	7.19	10.58
	relative	6.91	10.18
	absolute	11.03	17.44

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Contribution of chromatic information in depth perception with rapidly changing dynamic stereograms

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ABSTRACT

Chromatic contribution to human stereopsis is evaluated. We used stereograms comprised of sinusoidal gratings rapidly changing spatial positions but having constant disparity (dynamic random phase stereograms, DRPS). Chromatic grating stereograms alternated with similar luminance stereograms having the same disparity but opposite polarity. Spatial positions of both stimuli were randomized every time they appear (refresh rate = 33Hz). Pedestal luminance contrast was added to the chromatic stimulus and systematically varied to obtained the null points where the depth signal from the chromatic and luminance pairs cancel each other. From the results, we calculated the effective contrast of chromatic stimuli, and it is always larger than the luminance pairs contrast. Thus, we concluded that chromatic information contributes to human stereopsis.

1. INTRODUCTION

Earlier studies on chromatic contribution to human stereopsis using random-dot stereograms reported negative results (e. g. Lu and Fender 1972, Gregory 1977, DeWeert 1979), but later studies where they used random dot stereograms, in general, acknowledged positive results, although the effect was much reduced than luminance contribution (De Weert and Sadza 1983, Greenberg and Williams 1985). Livingstone and Hubel (1986) criticized these results by arguing that these positive results were obtained due to luminance aritifacts such as chromatic aberration, and the effect disappeared when such artifacts were removed. In this study, we examined the chromatic contribution to human stereopsis by using relatively low frequency sinusoidal gratings and contrast cancellation method that are presumably invulnerable against chromatic aberration.

2. METHOD

2.1 Stimulus

Component stereograms were comprised of two pairs of sinusoidal gratings of 1 c/deg, one was luminance and the other was chromatic pair (G/R chromatic sinusoidal grating). The two pairs had the same disparity (1/4λ) but in opposite polarity. Thus, the stereo information from luminance and chromatic channels are processed separately and the effectiveness of the separate information are equivalent, the depth impression should be cancelled. We confirmed that this actually occurs in pilot studies. The chromatic grating was generated by adding green and red antiphase sinusoidal gratings. The luminance of red grating varied sinusoidally between 0 and fixed maximum value of 4.51 cd/mm^2 (Rmax), while the maximum value for green was manipulated between 0 and 26.3 cd/m^2 in 11 steps (Gmax). This chromatic grating was, then, combined with luminance pair that had a fixed pedestal luminance contrast (C_P). Both had the same disparity, but opposite polarity. Relative phase difference between the two pairs was randomized. The component pair was replaced with a new component pair with the same disparity but randomized phase position and relative phase difference between chromatic and luminance pair at a refresh rate of 33 Hz. We call this stimulus dynamic random phase stereograms (DRPS) and this is basically a 1-dimensional version of dynamic random-dot stereograms. The luminance contrast of luminance pair was varied in 4 steps (20, 30, 40, 50% contrast, comparison contrast, C_M). Two reference stimuli comprising of yellow luminance gratings of 1 c/deg (50%) were presented above and below the stereo stimulus. The orientation of the three stimuli was vertical, and all subtended 4 x 1 deg. The stimulus were presented on a CRT screen and subjects observed the stimulus through regular mirror stereoscope at a distance of 57 cm.

2.2 Procedure

There were 88 conditions in total (4 pedestal luminance × 11 green luminance levels × 2 depth orders). Each condition was repeated for 8 times. Subjects task was to judge whether the experimental stimulus appears closer or farther relative to the reference stimulus.

3. RESULTS AND DISCUSSION

The results are shown in Figure 1. In this graph the ratio of depth judgments based on luminance and chromatic disparities are plotted against Gmax, separately for each comparison contrast. The fitted curves were derived from cumulative normal distributions. The zero value in ordinate (indicated by a horizontal dotted line) is where the two systems balance.

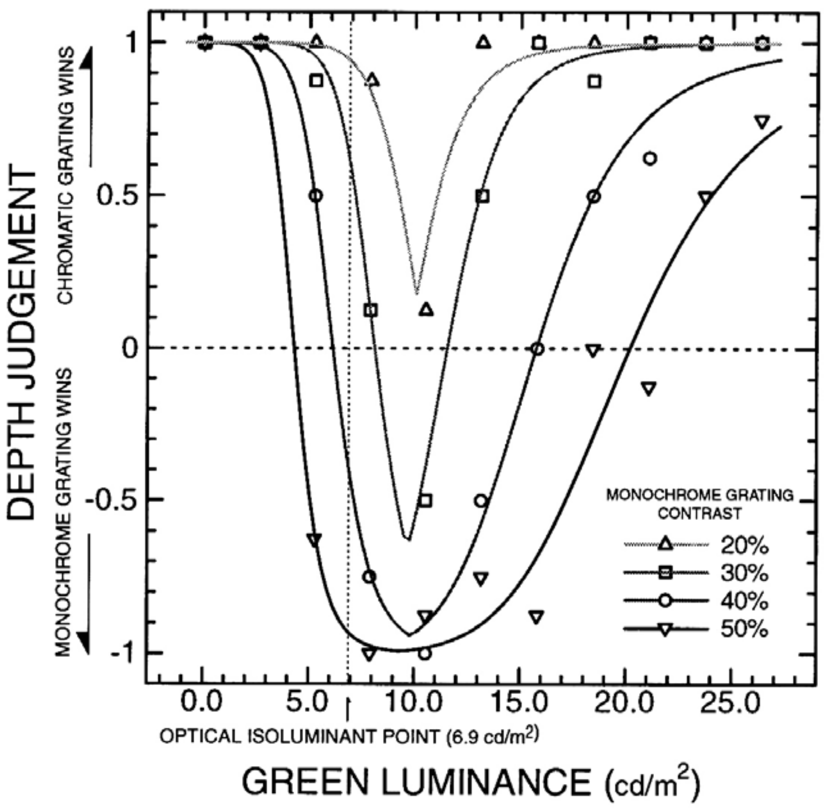


Fig. 1. Results. Depth judgments plotted against Gmax.

The judgments curves are supposed to intersect this line at two points when Gmax was gradually increased from very low level to very high level since there are two places where total effective contrast (C_T, C_T = pedestal luminance contrast (C_P) + equivalent contrast of chromatic component (C_C)) is equal to the contrast of luminance grating (C_M). This actually is the case except for the lowest C_M (20%); the pedestal contrast of the comparison stimulus (C_L) was probably too low and did not match the total equivalent contrast (C_T).

C_T presumably is equal to C_M at balancing points, and C_P is physically defined. Thus C_C can be obtained by subtracting C_L from C_M. Averages of obtained pedestal (C_P) and equivalent chromatic (C_C) contrasts are shown in Table 1. C_C should be constant regardless of the comparison or pedestal contrast if the luminance and chromatic signals are processed independently. However, actual C_C values seem to systematically increase as C_M and C_P increase. This is supposedly an effect of C_P rather than C_M since C_C has to be added to C_P before the results are compared to C_M.

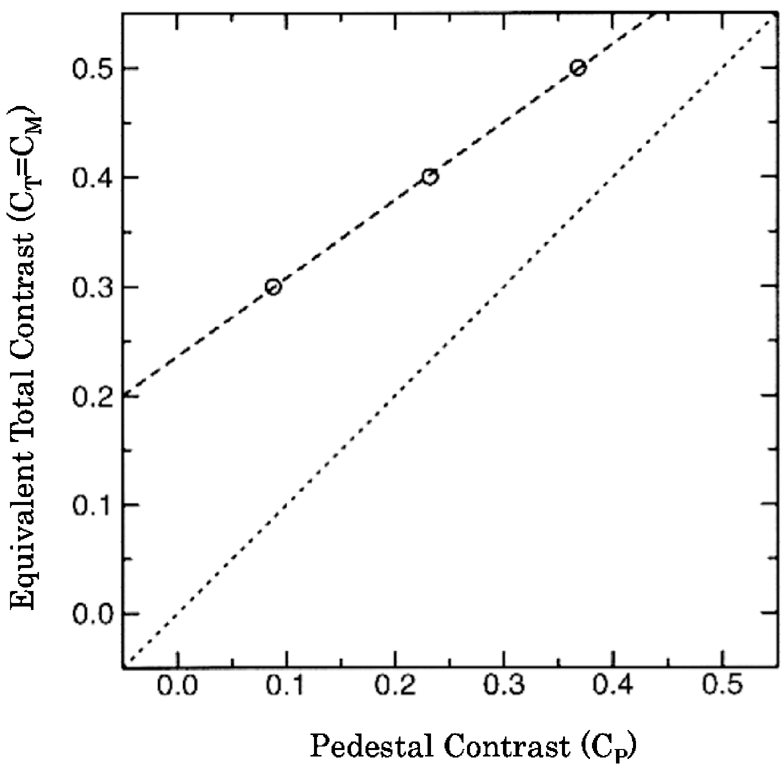
Table 1. Pedestal (C_P) and chromatic (C_C) contrast at balancing points.

Comparison (C_M)	20%	30%	40%	50%
Pedestal (C_P)	N/A	0.088	0.232	0.368
Equivalent(C_C)	N/A	0.212	0.168	0.132

Based on this assumption, we analyzed the relationship between CT and CC by using linear regression. The results are shown in Figure 2 where CT values are plotted against CP values. The regression analysis yielded the following linear equation.

$$C_T = 0.236 + 0.714{*}C_L \quad (r = 0.999)$$

Table 2. The relationship between Equivalent total contrast and Pedestal contrast.



From the graph we can see a linear increase of CT as CP increases. However, the CC, which is read from the vertical distance between the obtained linear line and diagonal line, decreases as CP increases. The diagonal line (CT = CP) indicates the prediction when there was no chromatic contribution. The intercept value indicates that real equivalent contrast of chromatic component when there was no luminance component is 0.236. From this equation, we can predict that CC will be zero at CP = 0.83.

4. CONCLUSIONS

Present results indicated that chromatic information contributes to human stereopsis. The results are not likely from artifacts such as chromatic aberration, since the method we used in this study is presumably effective to minimize such contaminations. The effectiveness of chromatic contributions decreases when it is mixed with luminance component. Effective contrast of R/G signal is approximately 24% where there was no luminance pedestal, but it decreases as pedestal contrast increases and becomes zero at 0.86 of pedestal.

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Colour opponency in chromatic after-effects

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ABSTRACT

We measured the aftereffects of chromatic adaptation following the stimulation of L and M cones with different colors and the same color to validate the hypothesis that chromatic adaptation is achieved by not only photoreceptors but also a binocular integrated process occurring at the cerebral cortex. As taste is a sensation in which a higher cognitive mechanism integrates sensory information, we also explored the effects of chromatic adaptation on taste. Simultaneous stimulation of L and M cones in opponent processes led to yellow appearance; however, mutual stimulation in opposing processes negated the beneficial effect on red-green signals. Therefore, not only photoreceptors but also a higher integrated cortical process plays an important role in chromatic adaptation; further, the perceived taste of food is affected by chromatic adaptation in a higher-order cortical process.

1. THE EFFECT OF STIMULATION ON CONES

Two views on chromatic aftereffects have been reported: chromatic aftereffects are attributable to bleaching of photopigments present in the retina (Hunt 1950, Nayatani et al. 1987), and they occur not only due to photoreceptors but also due to a higher-order process (De Valois and Walraven 1967, Eisner and Enoch 1982, Neitz el al. 2002, Wade and Wandell 2002). Our aim was to determine the aftereffects of nonmetameric matched stimuli. We used different phase stimulation (light images) and metameric stimuli (real images) to elucidate the mechanism of chromatic adaptation.

1.1 Methods

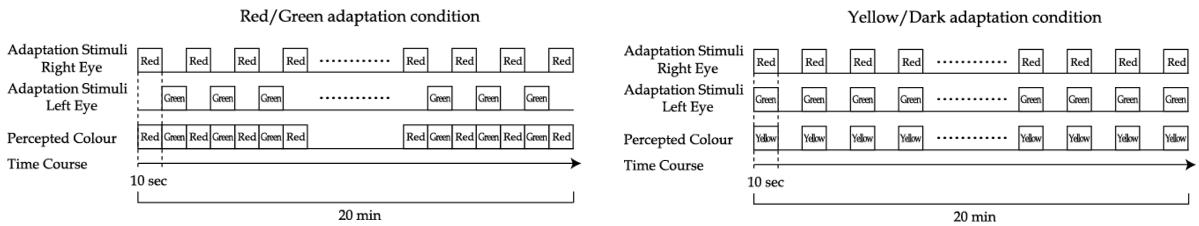
Observers: Nine subjects with normal color vision according to Ishihara pseudoisochromatic plates were enrolled. The experiment adhered to the tenets of the Declaration of Helsinki.

Apparatus: All stimuli were presented on a CRT screen (Nanao FlexScan T561; 1024 × 768 pixel; 120 Hz) driven by a personal computer. Each subject observed the stimuli through a 2-mm artificial pupil with a chin rest by a haploscopic device in a dark room.

Adaptation Conditions: We used two adaptation conditions: the mutual adaptation condition, in which L and M cones were mutually exposed to red and green adaptation stimuli, respectively (Red/Green adaptation condition); the simultaneous adaptation condition, in which L and M cones were simultaneously exposed to red and green adaptation stimuli that appeared yellow and whose intensity was previously adjusted to be isoluminant to the red and green stimuli (Yellow/Dark adaptation condition). On one hand, according to the hypothesis that the hue of chromatic aftereffects is regulated by a higher-order binocular cortical mechanism, simultaneous inputs from L and M cones will drive the yellow-blue channel but will cancel their respective effects on the red-green channel. On the other hand, mutual inputs from L and M cones will not appear in the output of either chromatic channel.

Stimuli: The visual angle of the adaptation stimuli was 23.5° × 31°, and the stimuli were presented to only one eye. The size, luminance, and presentation duration of the monocular process were the same in both conditions. To measure the strength of the aftereffects and interocular transfer, a circular test stimulus with a visual angle of 2° was changed from yellow-blue or red-green, which have subjective luminance equality.

Procedure: To measure chromatic aftereffects, each subject was exposed to 15 min of dark adaptation and then adjustment to a test stimulus presented against a black background, setting the stimulus to a color with no perceptible redness, greenness, yellowness, or blueness by the method of adjustment. The two adaptation conditions were maintained for 20 min and repeated thrice (Figure 1). In the mutual adaptation condition, red and green adapting stimuli were alternately presented to one eye for 10 s (Figure 1.a). In the simultaneous adaptation condition, an adapting light was presented to one eye for 10 s and a state with no stimulus was maintained for 10 s (Figure 1.b). The aftereffects were measured at 20 min intervals, and the procedure was repeated 12 times; finally, the adjustments were averaged.



1.a) Red/Green adaptation condition. *1.b) Yellow/Dark adaptation condition.*

Figure 1. The two types of adaptation conditions.
Each box shows the presentation of the colour stimulus in each eye.

1.2 Results and discussion

Although adapting stimuli were presented to only one eye, the effects of adaptation were measured in both eyes. The sensitivity of each cone, which was assessed by Stockman and Sharpe (2000), was compared to reveal changes in the hue of chromatic aftereffects. The strength of adaptation was defined as the distance of the L/(L+M) and S/(L+M) chromaticity, which represents color appearance before and after chromatic adaptation on the chromaticity diagram (MacLeod and Boynton 1979). In comparison with before chromatic adaptation, the post-adaptation color appearance of the exposed eye ($p < .01$) and unexposed eye ($p < .01$) changed in the yellow-blue direction, but the color appearance was not changed in the red-green direction in both eyes ($p > .10$, Figure 2). The results showed that the mutual adaptation condition was stronger than the simultaneous adaptation condition in subjects who adapted to both conditions, and chromatic adaptation represented interocular transfer, which suggests that a higher visual mechanism after binocular fusion was also affected by chromatic adaptation.

The red and green light caused a sense of yellow due to bleaching of photopigments in the photoreceptors. We considered that long-term mutual adaptation to red and green light would induce the same effects on each photoreceptor as yellow adaptation. Then, the hue of aftereffects would show blueness; however, the results of this experiment showed yellow aftereffects. Reportedly, the aftereffects of chromatic adaptation show the same color as that of the adaptation light (normal aftereffects) in the exposed eye but may also show the opposite hue (negative aftereffect) in the unexposed eye (Shimakura and Sakata 2009). Therefore, the results strongly suggest the effect of the opposite color process in chromatic adaptation.

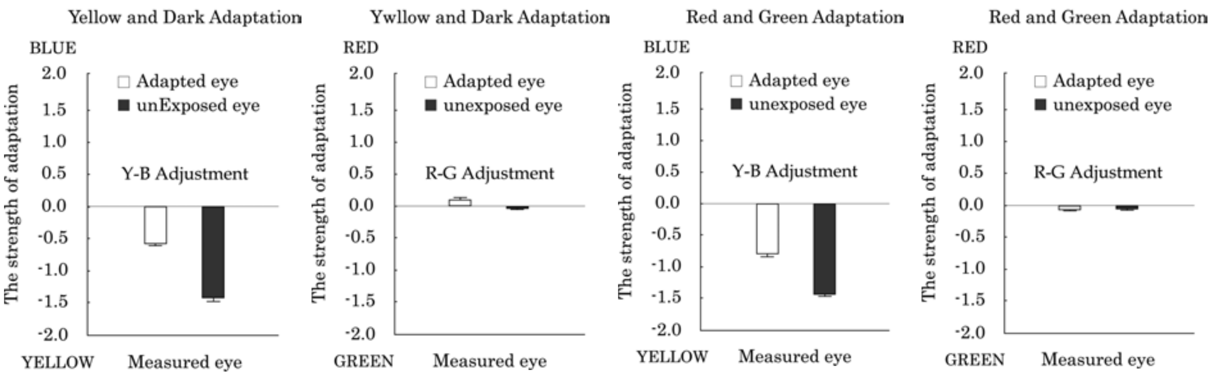


Figure 2-a Figure 2-b Figure 2-c Figure 2-d

Figure 2. Strength of adaptation in both adaptation conditions. The bar charts presents the amount of after-effects after chromatic adaptation for 60 min. Error bars present one standard deviation (SD). The (a, b) yellow/dark adaptation and (c, d) red/green adaptation. (a, c) Adjustment for yellowness or blueness and (b, d) adjustment for redness or greenness. The empty bar represents the exposed eye and the filled bar indicates the unexposed eye.

2. THE APPARENT TASTE OF FOOD DEPENDING ON THE CHROMATIC AFTEREFFECTS

We examined the performance of the highly cognitive process (Experiment 1) during a natural scene composed of a complicated distribution of wavelengths opposite to the CRT stimuli presented in Experiment 1.

2.1 Methods

Observers: Four subjects with normal color vision assessed by using the Ishihara plates were enrolled. The experiment on human subjects adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained after explanation of the nature of the study.

Apparatus: The test stimuli were presented on a CRT screen. Each subject observed the stimuli through an artificial pupil with a chin rest in a dark room.

Stimuli: Goggles with a green narrow bandpass filter (BPB 50: peak = 500 nm, (x, y) = (0.0969, 0.5279), Fujifilm) and neutral density filter (ND 0.3: OD = 0.3, transmittance = 0.5, Fujifilm) produced adaptation stimuli to increase the perceived redness of objects after adaptation. The subjects judged the taste of 11 food items and their LCD images containing redness (strawberry, paprika, and yogurt), greenness (kiwi, paprika, and yogurt), yellowness (mango, paprika, and yogurt), and blueness (blueberry and yogurt) under illumination by a D65 simulator (FL20S·N-EDL, TOSHIBA) in a dark room after 40 min green adaptation. The colors of the real food items were very close to those of the LCD images on the CIE 1931 chromaticity diagram.

Procedure: First, the apparent achromatic color was measured as a standard for comparison after 15 min dark adaptation. After 40 min chromatic adaptation, each subject sat in the dark before testing began. The subjects observed the food items and their pictures, and assessed each food according to a nine-point rating scale (like/dislike, delicious/bad taste, want to eat/hate to eat). Chromatic adaptation was confirmed by repeating the apparent achromatic color measurement.

2.2 Results and discussion

The subjective scoring (like, delicious, want to eat) of the real food items with redness improved on green adaptation (Figure 3.a), but this effect did not appear with the other color foods (Figure 3.b). We conclude that the perceived redness of the foods increased their apparent taste, a sensation whose information is integrated in a higher cognitive process. Further, the real food items had better scores than the LCD images (Figure 3.c). The difference in scores caused by chromatic adaptation, food color, and real or metameric images suggests that the apparent taste of food is affected by chromatic adaptation in a higher-order cortical process.

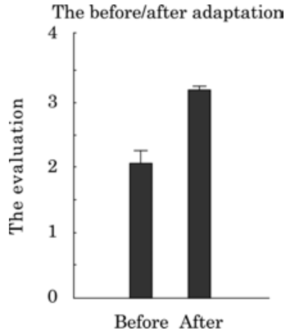


Figure 3-a

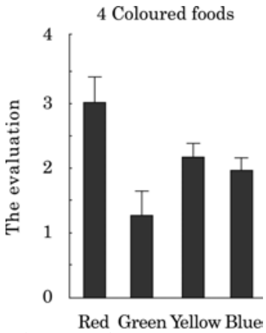


Figure 3-b

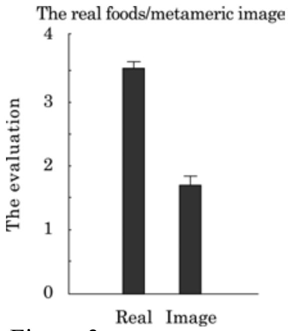


Figure 3-c

Figure 3. The evaluation of apparent taste, (a) before/after adaptation (foods with redness), (b) 4 coloured foods, and (c) the food items and their metameric images (foods with redness). All differences were significant ($p < .01$).

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Effect of chromatic assimilation (Bezold effect) in the vision of the content in a dinner plate

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ABSTRACT

The colour perception of the olives, beans, anchovies... in a dinner plate depends of the colour and distribution of the surrounding content. In this paper we generalize this dependence analyzing how vary the vision of a gray rectangle seen through a monochromatic red grating in doing so the frequency and orientation of both.

1. INTRODUCTION

Daily experience shows that in the perception of a color, the surrounding areas or the areas intercalated in the object, have a great influence. In most cases this influence makes the object vary towards the complementary colour of these disturbing areas, and this variation is known as simultaneous and spatial contrast (to distinguish it from temporary contrasts in the post-images) or chromatic contrast. If the disturbing areas (surround) are achromatic (white, grey or black) the contrast makes the object look darker or lighter.

With certain spatial distributions, the colors intercalated can add to the object. This fact originally discovered by Chevreul (1839) was subsequently described by Bezold (1876), and is known as Bezold effect, Albers (1963), assimilation effect, Evans (1948), expansion effect or simply chromatic assimilation.

2. DISCUSSION

Without denying the possibility that the expansion effect could be justified physiologically as Hurvich and Jameson (1981) claim, due to the existence of receiving units of different sizes in the area where the image is formed, we believe this effect can be explained psychologically as per Gestalt theory, Wertheimer (1912). According to this theory, Rubin (1921), the vision is a consequence of the brain's interpretation of radiant energy received from the total visual field. We always see objects as part of the set they are in (for example, in a marine landscape, any distant object will always be a boat.)

Many authors have intented to justify the Bezold effect, while for the study of the simultaneous contrast, the justifications are consistent in the scientific community, no such clear justification has been found for the assimilation effect. Burnham (1953) made his experiences with drawings based on the original Bezold plates, noting that the Bezold effect appears by viewing displays with a lack of sharp focus. Helson (1963) claimed that assimilation occurs when there are small differences between inducing and test areas. On the other hand, Helson (1964) says that assimilation occurs when the inducing region is small relative to the test region.

In our laboratory we are working on the same way as: Agostini and Galmonte (2000), Bressan (2001), White (1981), Economou, Annan and Gilchrist (1998). Because we believe that the Bezold effect can not be justified by the contrast theories.

3. EXPERIMENTAL TECHNIQUE

The tests have three grey straight parallel sequences with a width equal to their separation (1 cm), these sequences have a Ronchi grating with 2 cm period covering 22 cm diameter of the circle in the background. The central sequence is superimposed over the red stripes of the grating and the lateral ones over the white stripes (Figure 2).

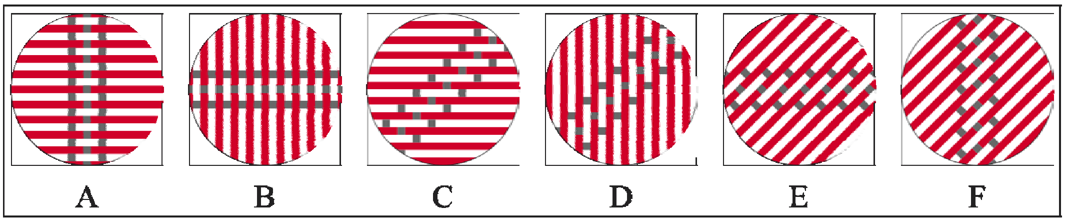

Figure 2. Gratings used in the tests. Only the central sequence is analyzed.

It was checked that the lateral sequences with squares coinciding with the white lines experienced a color variation (redness plus saturation) due to the expansion effect (redness) and the direct contrast (saturation increase). It was also checked that the central sequence with squares coinciding with the red lines experienced the opposite variation (saturation decreases and luminosity increases). Starting from a distance of 4 meters, the observers get closer (4, 3, 2, 1, 0.5 and 0 meters) until they cannot perceive any difference between the central and lateral sequences. At the time the observer is on the position "0" it is not 0 meters, is around 0.2 meters distance observer-test.

Measuring the color received from grey central sequence on a scale that goes from zero (meaning the central white sequence is not identified) to ten, the observer indicates, as he gets closer, the value (V) he thinks the central sequences has. Helson (1963), made a similar assessment using the words from very very much lighter, through equal, to very very much darker. The verbal categories were translated into numbers from 1 to 9 with 5 standing for equality, Helson (1964). With that value we determine the chromatic contrast between the central and lateral sequences, such that the Bezold effect can be quantified. This expression is not exact although we get very approximated results.

$$Bezold\ effect = \frac{10 - V}{10}$$

All tests took place under the same conditions, same luminance (200 luxes) with a incandescent lamp. The colours are red (x = 0.57; y = 0.38) and grey (x = 0.43; y = 0.44), all with the same β, (β = 0.5). The observations were made by three students aged between 20 and 25 years. All of them had normal vision, making a total of 10 measurements for each observer and test.

4. RESULTS AND CONCLUSIONS

The most interesting results are listed in Tables 1, 2 and supported by Figure 3, of which we deduce the following conclusions:

1. With the horizontal Ronchi grating (orientation of the stripes) the Bezold effect obtained is a first approximation, independent of orientation (Figure 2A-2C) of the sequence object. Conduct that claims the gestaltian theory in visual perception of concrete objects, in which the most important factor is the surrounding stage (in this case Ronchi grating) in which they are immersed.

Table 1. Bezold effect on the monochromatic grating (red-white) with gray sequence in its six variables.

Separation observer-test (meters)	**Grating frequency (period/degree)**	**Bezold effect**					
		Sequence perpendicular to the grating: (A)		Grating H/V, sequence 45º inclined: (B)		45º inclined grating, sequence H/V: (C)	
		Grating (H)	Grating (V)	Grating (H)	Grating (V)	Sequence (H)	Sequence (V)
4	3.5	0.83	0.38	0.79	0.41	0.66	0.56
3	2.6	0.65	0.24	0.64	0.29	0.46	0.44
2	1.8	0.42	0.11	0.44	0.19	0.27	0.27
1	0.9	0.23	0.07	0.23	0.12	0.14	0.17
0.5	0.4	0.12	0.05	0.12	0.07	0.05	0.08
0	0	0.00	0.03	0.03	0.02	0.00	0.02

Table 2. Linear equations corresponding to the six variables (y = e.Bezold, x = frequency of the grating).

	Grating orientation	**Sequence orientation**	**Linear equation**
Line A	Horizontal	Vertical	$y = 0{,}23x + 0{,}04$
Line B	Vertical	Horizontal	$y = 0{,}10x + 0{,}01$
Line C	Horizontal	45º Inclined	$y = 0{,}22x + 0{,}03$
Line D	Vertical	45º Inclined	$y = 0{,}11x + 0{,}02$
Line E	45º Inclined	Horizontal	$y = 0{,}19x + 0{,}02$
Line F	45º Inclined	Vertical	$y = 0{,}16x + 0{,}02$

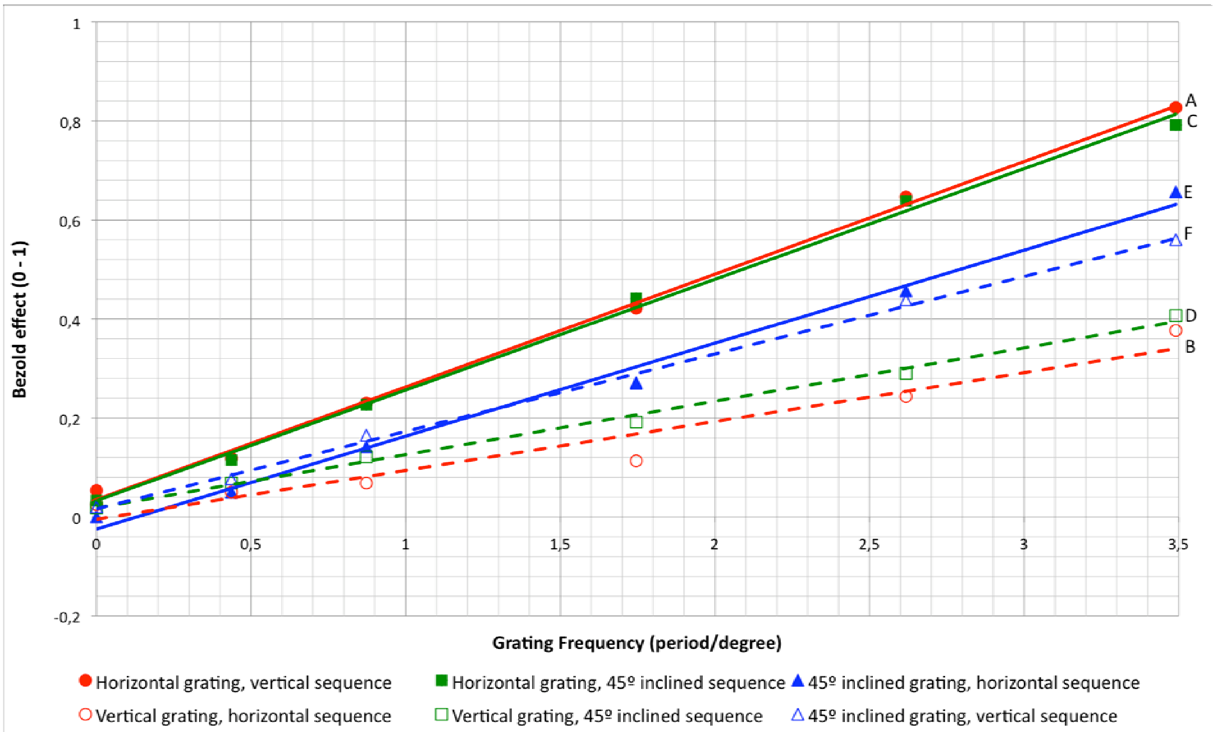

Figure 3. Graphic representation of the Bezold effect depending on the frequency of the grating. Averages of the results obtained with the different orientations of the sequence. Nomenclature for those represented in Figure 2 and Table 2.

2. The increase in the Bezold effect of the order of 0.45 (Table 1) by changing the horizontal-vertical orientation of the grating (Figure 2A-2B) is due to the improved vision with horizontal orientation to vertical.

3. With the 45º inclined Ronchi grating (Figure 2E-2F) the Bezold effect, as is the case with the horizontal and vertical grating (Figure 2B-2D), is almost independent of the orientation of the sequence.

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