Color evaluation of Chorizo de Pamplona, a Spanish dry fermented sausage: Comparison between the CIEL*a*b* and the Hunter Lab systems with two illuminants (D65 and C).

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ABSTRACT

Objective color evaluation was determined in 33 samples of “chorizo de Pamplona”using the CIEL*a*b* and the Hunter systems with two kinds of illuminant (D65 and C). High statistical significant differences between the measures obtained with the two studied illuminants were found for the 3 color coordinates (L*a*b* and Lab) in both systems. Given the highest coefficient of variation for b in the Hunter system and for a in the CIEL*a*b* system we conclude that the CIE system would be better for separating samples according to their yellowness, while Hunter would be better than CIE for separating samples according to their redness. Anyway, correlations with sensorial evaluation were similar for both systems and illuminants, with the lowest values being for yellowness.

INTRODUCTION

Color is considered to be one of the main organoleptic characteristics in order to establish the quality and acceptability of meat products. It is recognized that the use of sensory panels to measure color is complex, time-consuming, expensive and subject to error due to the variability of human judgment. It would thus seem interesting to have available a permanent and objective system for the measurement of the spectral character and color coordinates of samples.

Early methods of evaluating the color of meat products in an objective way were made by the determination of pigment content (Santamaría *et al.*,1992; Sakata and Nagata 1992; Ibañez *et al.*1995). These methods involve the use of chemical reagents and are more time-consuming than making physical measurements, such as spectral reflectance curves. From these spectral curves it is possible to calculate the tristimulus values defined in 1931 by the CIE (X,Y,Z). Several mathematical transformations of these values allow the three color coordinates to be obtained which describe a color in each color space. One of these coordinates concerns lightness (L* in the CIE L*a*b* system, L in the Hunter Lab system or Y in *xy*Y system) and the two others concern chromaticity (a*,b* in the CIE L*a*b* system ; a,b in the Hunter Lab system and *xy* in the *xy*Y system).

Various authors have applied some of these methods of color evaluation to determine this feature in meat and meat products with different purposes.

Color changes in raw fermented sausages during manufacture and ripening were studied by Pribis and Svirzic (1995) using CIE, CIELAB and Hunter

systems. These authors stated that their results showed that all three instrumental color measurement methods accurately measured color changes during ripening.

The evolution of color during fermentation and ripening of dry fermented sausages (chorizo and salchichón) was studied by Gago-Gago *et al.*(1992) and Pagan-Moreno *et al.*(1992) using the CIEL*a*b* (10º,D65) system. Demeyer *et al.* (1992) used the Hunter Lab system (defined using illuminant C) to check the effect of nitrate, nitrite and ascorbate on the color and color stability of dry fermented sausages. Ferreira *et al.*(1992) used different systems and illuminant C to evaluate the color of chicken and pork meat loaf. They observed that the Hunter Lab and L*a*b* systems presented the best coefficients of correlation between the visual and objective evaluations of the color sample. They also found that chromaticity was best expresed by the hue angle of the CIEL*a*b* system.

The CIEL*a*b* system and illuminant D65 were used by Perlo *et al.*(1995) to evaluate the modification of colour parameters during the marketing of paté.

As can be observed, there is no uniformity when a method or illuminant has to be chosen to measure color. The purpose of the present work was to compare the two most widely used color measurement systems (CIE L*a*b* and Hunter) in order to determine which is most suitable for further research into the color evaluation of a typical Spanish dry fermented sausage:Chorizo de Pamplona. Within each system, a comparison between the two most frequently used illuminants (D65 and C) was also made.

Furthermore, correlations between these objective measurements and sensorial judgements of color were calculated.

MATERIALS AND METHODS

Samples

33 samples of “chorizo de Pamplona” were randomly purchased from different markets.

Objective measurement

Samples were homogenized, placed in 1.5 cm deep boxes and packed firmly. To cover the samples, a transparent polythene film was positioned with pressure to obtain a uniform, bubble-free surface. Reflectance spectra were determined with a UV/VS Perkin Elmer Lambda 5 Spectrophotometer at 400-700 nm, using an integrating sphere. The spectrophotometer was connected to a computer that calculated values for the color coordinates under the two illuminants used (D65 and C) for both systems (CIE L*a*b* and Hunter Lab). The software package used for the calculations was PECOL (Perkin Elmer). Color evaluation was done using a 5 nm data interval and the observer angle used was always 10º. Each sample was measured at four different locations on the surface and an average score was taken.

Sensory evaluation

This was carried out by a panel of 8 trained judges. Slices of samples of usual thickness in this type of product (about 2mm) were presented on white backgrounds with 2 letter codes and randomly distributed. The panellists were asked to mark the samples for lightness, redness and yellowness, giving a score between 1 and 9 in each case. This was a graduated scale where a score of 1 was described as extremely dark and a score of 9 was described as extremely light in the ligthness scale. A score of 1 was described as no redness and no yellowness in their respective scales, whereas a score of 9 was described as very red and very yellow. As no significant differences were found between judges , the average score was taken for each sample.

Data analysis

A paired t test was applied to analyse whether there were significant differences between measures obtained with the two illuminants for each system and parameter. The correlation (r) between objective and sensory evaluations was obtained together with levels of significance.

RESULTS AND DISCUSSION

33 samples of “chorizo de Pamplona”, a typical Spanish dry fermented sausage, were analysed by the CIE L*a*b* system and Hunter Lab system using two types of illuminant: D65 and C. These two illuminants are the most frequently used nowadays among those selected by the CIE in order to standarize lightning conditions of color measurement (Calvo, 1996).

Variations of the lean and fat ratio in the path of the incident light beam lead to dispersion of the data within one sample. Consequently, measurements were carried out on homogenised product instead of making them on intact and unaltered product. Table 1 shows the results obtained for objective color evaluation carried out in CIE and Hunter systems with D65 and C. All parameters showed a certain variability among samples.

Higher coefficients of variation represent a greater dispersion of the data, which, with regard to color analysis, could signify an increased capacity of the color scale to separate the different samples from each other (Ferreira *et al*., 1994). Comparison of the CIE and Hunter systems for the same illuminant showed that for both illuminants the coefficient of variation was greater in the Hunter system of the 'L' and 'a' coordinates, but not for 'b' coodinates. It can be also observed that L (ligthness) showed the lowest coefficient of variation, being slightly higher (+0.76%) in the Hunter system. Mielnik and Slinde (1983) used the CIE 1932 and the CIE L*a*b*1976 systems (both calculated on the basis of C illuminant) to evaluate the color changes of the cut surface of sausages when small amounts of blood were added. They found that both systems could be used to evaluate the change in lightness, with this parameter being the most informative to show color changes. Ferreira *et al.*,(1992) also pointed out that lightness is the main parameter governing the evaluation of meat loaf color but that the importance of controlling the levels of red color should not be ignored. In our study a (redness) and b (yellowness) showed the highest coefficient of variation in the Hunter and CIE systems, respectively. As a result of this, it could be said that the CIE system is better than Hunter

for separating samples according to their yellowness and is worse for separating them according to their redness. Mielnik and Slinde (1983) also observed that the higher the amount of blood added the higher a* was.

A further objective of this work was to compare the two most widely used illuminants to determine if there were differences between the measures obtained. Small numerical differences were observed between the means of each parameter within each system, specially in ligthness, which is only governed by the tristimulus Y, less dependent of the illuminant used than redness and yellowness. A paired t test was used to compare the data obtained for each parameter (L,a,b) with both illuminants. Despite these small differences, the test revealed high statistical significant differences between all 3 color coordinate (L* a* b* and Lab) in both systems. As can be appreciated in figures 1 and 2, these differences are even more evident in the Hunter system than in the CIE.

A sensory analysis on intact slices of the product was carried out with the aim of stablishing a correlation between the sensorial characteristics related to colour with their corresponding objective measure.

Coefficients of correlation between both (sensorial and objective) evaluations are shown in table 2. The lowest coefficient of correlation was found for yellowness in both systems for both illuminants. Sandusky (1994), measuring color with the CIEL*a*b* system in broiler chicken meat, found that sensory and instrumental results were comparable for redness but panellists were unable to detect the measured differences in yellowness. Our data showed quite similar correlations for both systems, with the a (redness) of Hunter system being the parameter with the highest correlation. This

parameter also had the highest coefficient of variation. Therefore, redness seems to be the parameter best appreciated by panellists. Coefficients of correlation between sensory lightness and a* and b* were also calculated, but low values of r were obtained.

In summary, the results of the present study pointed out that in relation with the use of both illuminants, D65 and C, highly statistically significant differences were found between all 3 parameters (L* a* b* and Lab) in both systems. However, these differences did not have a reflect from a sensorial point of view, because similar correlations were found for both illuminants within each system. Furthermore, both CIE and Hunter systems also showed similar correlations with subjetive measures of color.

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Table 1. Data obtained for the color coordinates measured with both illuminants and both systems.

		CIEL*a*b*			Hunter Lab		
		L*	a*	b*	L	a	b
D65	mean	47.73	23.69	15.71	40.75	17.06	12.20
	SD	2.92	3.15	2.57	2.80	2.93	1.62
	CV(%)	6.11	13.30	16.37	6.87	17.15	13.25
C	mean	47.85	22.76	15.90	40.87	18.53	10.97
	SD	2.92	3.02	2.60	2.81	2.93	1.64
	CV(%)	6.11	13.27	16.36	6.88	15.82	14.95
L.S.		***	***	***	***	***	***

Data obtained from 33 samples. SD:Standard deviation. CV:Coefficient of variation. L.S.:Level of signifficance; ***p<0.001

Table 2. Coefficients of correlation between sensorial and objective measurements.

		CIE L*a*b*			Hunter Lab		
		Lightness	Redness	Yellowness	Lightness	Redness	Yellowness
D65	CC	0.761	0.767	0.605	0.759	0.783	0.731
		(***)	(***)	(**)	(***)	(***)	(**)
C	CC	0.764	0.769	0.606	0.765	0.785	0.698
		(***)	(***)	(**)	(***)	(***)	(**)

CC. Coefficient of correlation (r).
(**) p< 0,01; (***) p< 0,001

Figure 1. a*b* diagram for data obtained in the CIE system with D65 (°)and C (×).

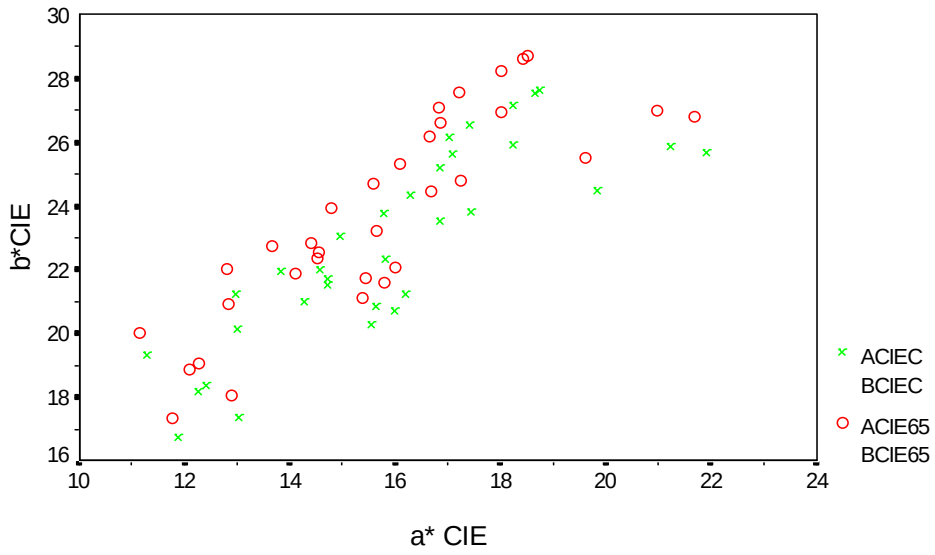

Figure 2. a b diagram for data obtained in the Hunter system with D65 (°) and C (×).