INFLUENCE OF ALBEDO ON COLOR IN DRY-CURED SAUSAGE MODEL SYSTEM

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Background

Health conscious consumers are demanding meat products based on health concerns, color and taste are still important factors in food-purchasing decisions. Developed countries suffer from emerging pathologies related to fat consumption and, consequently, health concerns and consumer demands have motivated a growing interest in fat substitutes (Chin *et al.,* 1999; Lyons, *et al.,* 1999; Kerry *et al.,* 1999). Citrus fiber, albedo, is an ingredient with possibilities as a partial fat-replacer. The addition of albedo in dry-cured meat products have not been studied yet. Dry-cured sausages are one of the oldest forms of preserving meat and are typical of Mediterranean countries with a dry climate (Pérez-Álvarez *et al.,* 1999). The "longaniza de pascua" is a typical sausage form the south-east of Spain.

Objective

The aim of this work was to study the evolution of the color parameters (CIEL*a*b*) on dry-cured sausage model system containing different percentages of citrus fiber (albedo) and to determinate the influence of this ingredient during its processing.

Methods

Materials: The sausages were prepared using pork lean meat (52,49%), bacon (45%), and additives: salt (2%), sodium nitrate (0,01%), dextrose (0,2%), species: black pepper (0,2%) and anise (0,05%); the raw material was ground and mixed. The albedo was obtained from lemons of the variety Verna. The albedo was chopped, packaged and frozen for later use. Two different treatment were applied to albedo: raw and cooked.

Manufacture: The meat (lean pork) and fat, was chopped and introduced into a mincing machine (Mainca PM-98, Equipamientos Cárnicos S.L., Barcelona, Spain) which included a plate with 6 mm holes and then were mixed with the additives and species, in 5% water, for 5 minutes. The mixing was stuffed into lamb nature casing of 20-23 mm diameter, using a piston stuffer (Mainca EM-12, Equipamientos Cárnicos S.L, Barcelona, Spain). The length of each sausage was 20 cm. Finally, the sausages were dried over 6 days under the following conditions: temperature 14-17ºC, relative humidity 65-70% and air speed 0,20±0,05 m/s.

Determinations: Color measurements were taken, immediately after cutting the samples, on the cut surface in accordance with the recommendations of the American Meat Science Association (Hunt *et al.,* 1991). The CIEL*a*b* color space was studied in accordance with Cassens *et al.* (1995). The following color co-ordinates were determined: lightness (L*), redness (a*), yellowness (b*), chroma (C*) and hue (H*), using a Minolta CR-300 colorimeter (Minolta Camera Co., Osaka, Japan). Illuminant D_{65} was chosen and a 10º standard observer. Low reflectance glasses CR-A51 (Minolta Camera Co., Osaka, Japan) were placed between the samples and the equipment.

Statistical analysis: Statistical analysis of the variance (ANOVA) with three factors were applied: albedo type (raw and cooked), percentage of albedo (five levels: 0%, 2,5%, 5%, 7,5%, 10%) and processing time (six levels: days 0, 1, 2, 3, 4, 5) and the Tukey test was applied (Gomez and Gomez, 1976; Afifi and Azen, 1979; Gacula and Singh, 1984). All the analysis were carried out by means of the statistical package Statgraphics Plus for Windows, vers. 2.1 (Statistical Graphics Corp., Rockville, U.S.A).

Results and discussion

Lightness (L*): The ANOVA shows that three studied factors significantly affect lightness ($P<0.01$). The lightness of meat products, depends on water holding capacity, pH, myoglobin (Mb) concentration and state, moisture and fat content (Hunt *et al.,* 1991; Onyango *et al.,* 1998; Pérez-Álvarez *et al.,* 1998; Fernández-Ginés, 2001) as well as on the technological treatments applied (García-Marcos, 1996; Fernández-López, 1998; Pérez-Álvarez *et al.,* 1999). In the Tukey test (Table 1) it is observed that lightness decreased with albedo addition, raw or cooked; it decreased, as well, with different percentages of fiber added. The decreasing of lightness, along the drying process, is attributed to moisture lost, such as occurs in other dry-cured products (Pérez-Álvarez, 1996; Sayas, 1997). The values of lightness for the sausage with 10% of albedo, could be explained by the white-yellow component of albedo, imperceptible at low concentrations in the product but with an increasing impact in final color at high concentrations (Fernández-Ginés *et al.,* 2001).

Redness (a*): The ANOVA shows that albedo type, albedo percentage and days of processing significantly affect redness ($P<0.01$). Observing the Tukey test (Table 1), addition of albedo, cooked or raw, increased values of redness. With the percentages of albedo, redness increased, but the upper values are showed in the 5%, and then decreased. Along the days of processing, redness increased too. The albedo percentage that most increased redness is the raw form, because it have the possibility to absorb more water that the cooked form.

Yellowness (b*): The three factors studied by ANOVA significantly affect yellowness ($P<0.01$). In the Tukey test (Table 1), it can be observed that the b* values increased with the addition of cooked albedo, and decreased with raw albedo. The b* values slightly increased regarding to the control having a maximum value in 5% albedo addition. This could be due to the yellow component of the albedo which contributes to increase the values of b*, independently of the percentage of albedo added (Fernández-Ginés *et al.,* 2001). With the drying process, values of b* decreased. These results show that yellowness behaves in the opposite way to redness co-ordinate. In studies of the color parameters in different meat products, Pérez-Álvarez *et al.,* (1998) reported that the Mb concentration is not an important factor for this co-ordinate.

Chroma (C*): The ANOVA carried out found significant differences ($P<0.01$) for this parameter. The albedo addition, raw or cooked and in different percentages, increased values of C*, showed the maximum value in 5% albedo percentage. Along the drying process, C* decreased. Chroma, depends on Mb concentration (Johansson *et al.,* 1991), although Pérez-Álvarez (1996) also mention that it might be related with the state of Mb, and diminished as the proportion of metamioglobyn (MMb) increases.

Hue (H*): ANOVA showed significant differences ($P<0.01$) for three factors. The Tukey's test (Table 1) showed that with addition of raw albedo the hue values decreased, and increased with cooked albedo respect to control. At lower concentrations of albedo (2.5% and 5%) hue values decreased, meanwhile, at higher concentrations (7.5% and 10%) increased. Along the drying process, hue values decreased, like in other dry-cured products. The hue depends on Mb concentration (Pérez-Álvarez, 1996) and on its state (Johansson *et al.,* 1991) so that, if Mb concentration is considered as constant, the hue values, after drying process, would more related to Mb state.

Conclusions

The albedo incorporation, raw or cooked, decreased lightness (L*) and increased redness (a*), yellowness (b*), chroma (C*) and hue (H*), like albedo percentage added. The time of processing decreased L*, b*, C* and H*, and increased a*, independently of addition, or non, of albedo.

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Table 1.- Results of Tukey test of color co-ordinates, lightness (L*), redness (a*), yellowness (b*), chroma (C*) and hue (H*) of dry-cured model system for the factors albedo type, albedo percentage and days of drying processing.

	Albedo type			Albedo percentage					Days					
	Control	*Cooked*	*Raw*	*0%*	*2,5%*	*5%*	*7,5%*	*10%*	*0*	*1*	*2*	*3*	*4*	*5*
L*	48.17bc	47.38b	47.27b	48.17d	46.88b	45.54a	46.31b	47.17c	52.62f	49.40e	47.71d	45.72c	43.47b	41.96a
a*	5.87a	6.08a	7.13b	5.87a	8.12c	8.07c	6.71b	6.97b	5.91a	6.59b	6.93c	7.13c	7.98d	8.35e
b*	7.61b	8.54c	7.29a	7.61a	8.01b	9.56c	9.37c	9.32c	10.38e	9.50d	8.81c	8.29b	7.94a	7.72a
C*	9.97a	10.75b	10.57b	9.97a	11.71b	12.76c	11.71b	11.85b	12.15c	11.75b	11.43a	11.15a	11.47a	11.67b
H*	53.59c	55.69d	47.38a	53.59c	46.08a	50.41b	54.54c	54.06c	61.96f	56.75e	53.37d	50.25c	45.34b	42.74a

a-f Values in the same row bearing different letters are significantly different ($P < 0.05$)