TRADITIONAL AND FAST SALTING EFFECT ON PHYSICOCHEMICAL AND ULTRASTRUCTURAL PROPERTIES OF SPANISH DRY-CURED HAM

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BACKGROUND

The elaboration technology of dry-cured ham is principally directed to get a right stability product with sensorial desirable properties. This is a long process, which has three principal stages: salting, postsalting and dry-maduration. Salting is the first stability stage of the product. In Spain salting is, usually, made according to the traditional dry-cured method. Salting time of the pieces is differs from one process to another, it depends on the raw material, maker´s experience and used technology. It can change between 1 to 1.5 days per kg of raw ham in the traditional cured method. There are different points of view which range from 0.7 day to 1 day per kg of ham in the fast salting method.

OBJECTIVES

The general purpose of the research was to study the effect of the traditional and fast salting on the physical (lightness), chemical (moisture and salt content), physicochemical (pH and water activity) and ultrastructural properties of the different muscles (*Semimembranosus, Semitendinosus y Bicepes femoris*) of the Spanish dry-cured ham.

METHODS

Materials. Eighteen hams were selected from 6 month old pigs with a pH (5.6-6.0), measured in *Semimembranosus* muscle. The surface of the hams was immediately nitrified with a dry salt mixture (0.9g of NaCl, 0.6g of $NaNO_2$ and 0.4g of $NaNO_3$ per kg of ham). After 24 h the pieces were completely covered with salt in a cold storage room (T: 3±0.5°C y R H: 90±5%), the half pieces for 15 days (traditional method) and the other half pieces for 9 days (fast method). At the end of the salting stage the excess salt was brushed off and the hams were washed with cool water (< 10°C). Two cross cuts were made to obtain 6 cm thick slices (center section) in each ham. 3 muscles were selected in each slice: *Semimembranosus* (SM), *Semitendinosus* (ST) and *Biceps femoris* (BF).

Physicochemical analysis. pH determinations were taken using a Crison 507 pHmeter and a Crison CAT. nº 52-32 electrode (Crison Instruments, S.A., Alella, Barcelona, Spain). The measurements of water activity (aw) were made in a Novasina Thermoconstanter TH2 at 25 °C.

Chemical analysis. The moisture content was determined according to the ISO method (1975a) and the results were expressed as water (g)/ 100 g tissue. Chloride concentration was determined according to the ISO method (1975b) and the results were expressed as NaCl (g)/ 100 g tissue. All physicochemical and chemical analysis were performed in triplicate.

Physical analysis. The lightness color co-ordinate (L*) was determined using a Minolta CM-2002 spectrophotometer (Minolta Camera Co. Ltd., Osaka, Japan), with D65 and 10° according to Cassens *et al.* (1995). The lightness of each sample was determined by 9 measurements.

Transmission Electron Microscopy. For this study small samples were taken from each muscle and were immersed in a fixative solution with glutaraldehyde (pH 7.03) overnight, followed by a postfixation with osmiun tetraoxide for 5 hours. After fixation, samples were dehytrated in different solutions of acetone and embedded in epon. These sections were made with an ultramicrotome (Reichert Jung). Electron micrographs were obtained with a transmission electron microscope (Zeiss EM109).

Statistical analysis. Statistical analyses (ANOVA) were carried between types of salting (two levels) and muscles (three levels). Tukey and Scheffe test were applied. All statistical analysis were made using BMDP Stadistical Software.

RESULTS AND DISCUSSION

Table 1 reflects the means of chemical, physicochemical and physical parameters in muscles for the traditional and fast salting.

pH. ANOVA results for this parameter pointed out significant differences between salting types and muscles factors ($P<0.01$). The fast salting showed the highest values ($P<0.05$). This behaviour could be because of a higher phosphate loss a higher contact time with salt, a higher salt enter and finally due to a higher loss of other basics compounds, in the traditional salting (Arnau *et al.*, 1995; Nayak *et al.*, 1996). Both traditional and fast salting, showed significant differences between all muscles studies (SM, ST and BF) ($P<0.05$).

Water activity (aw). The ANOVA results for this parameter showed significant differences between traditional and fast salting and between muscles ($P<0.01$). The hams of traditional salting, in average, had lower values ($P<0.05$). No significant statistical differences ($P>0.05$) were found in both muscles ST and BF, but statistical differences ($P<0.05$) were found between these two muscles and the SM (table 1). The differences between the two kinds of salting must be at SM muscle, which has a higher surface in contact with salt and it receives, mainly, the entrance of salt. In the hams from traditional salting this muscle showed a lower values than the same in the fast salting (0.990±0,003). No muscles in the two salting methods reached aw values to inhibit the growth of *C. botulinum*.

Moisture. Significant differences were found between fast and traditional salting ($P<0.01$) and between muscles ($P<0.01$). Tukey test pointed out significant differences ($P<0.05$) between all the muscles (SM, ST and BF) for both salting methods. Moisture average was lower in the SM muscle, due to the higher osmotic effect produced by salt that covered the surface of the ham. ST muscle showed the highest moisture values (Table 1). Hams from traditional salting presented lower moisture values ($P<0.05$), it could be the higher osmotic effect. These differences between the salting processes was due to SM muscle, so the days of salting did not affect the inside muscle (ST and BF).

Chloride concentration. Significant statistical differences in chloride concentration were between both factors, salting ($P<0.05$) and muscles ($P<0.01$). The hams from traditional salting had a higher chloride concentration ($P<0.05$), due to higher time that the hams remained in salt. These differences between both salting methods are due to the SM muscle. Tukey test concerning the muscle factor showed that both salting methods did not present significant statistical differences between the ST and BF muscles ($P>0.05$) but

significant differences were found between these and the SM ($P<0.05$). The small salt concentration in the BF muscle suggests the diffusion of salt through the skin, fat and connective tissue, in small amounts.

Lightness (L*). ANOVA results concerning the lightness showed significant statistical differences ($P<0.01$) between salting methods and between muscle. Significant differences between all muscles ($P< 0.05$), in both salting processes, were obtained. The hams from traditional salting had lower lightness values, it would be due to a higher salt incorporation, so the movement and wastage of water were larger than in fast salting. These differences could be due mainly at the SM muscle that received the higher salt concentration. The decrease in the lightness values can be due to different phenomena, such as the salt concentration and the increase of the water holding capacity (WHC) (Sayas-Barberá, 1997; Fernández-López, 1998). The muscles from fast salting, altogether, suffered the salt effects in a smaller degree. The decrease of the lightness values found when this aditive was incorporated has been reported by others authors in dry-cured sausages model systems and in cooked meat products (Pérez-Alvarez *et al.*, 1997; Fernández-López, 1998). The lightness depends on the factors such as pH, water content (moisture), WHC, additives and species incorporated, muscle structure and the water movement (dehydration) into the piece (Swatland, 1995; Varnam and Sutherland, 1995; Sayas-Barberá, 1997; Rosmini *et al.*, 1998).

Transmission Electron Microscopy. The electron micrograhs of SM muscle showed a disappearance of the H-band and the loss of intensity A-band. These could be due to extractions of myosine in a high NaCl concentration during salting stage (Offer & Knight, 1983; Griethyusen & Knight, 1991). Transversal breakings is observed near the Z-disc, which can be due to the enzymatic activity of the meat. During the salting stage of dry-cured ham process calpain activity has been detected which is responsible for the degradation of the Z-disc (Sárraga *et al.*, 1993). *Semitendinosus* and *Biceps femoris* muscles did not show any changes. This could be due to its lower salt concentration (table 1).

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TABLE 1.- Mean values of chemical, physical and physicochemical parameters in *Semimembranosus* (SM), *Semitendinosus* (ST) and *Biceps femoris* (BF) muscles, for the traditional and fast salting.

SALTING	MUSCLE	pH	Aw	Moisture (% wet basis)	Chloride (% wet basis)	L*
TRADITIONAL	SM	5.75 a	0.983 a	65.30 a	7.06 a	37.94 a
	ST	5.78 b	0.995 b	72.89 b	0.79 b	42.87 b
	BF	5.67 c	0,995 b	71.14 c	1.06 b	45.80 c
FAST	SM	5.70 a	0.990 c	67.89 d	4.47 c	41.09 d
	ST	5.64 d	0.997 b	73.12 b	0.50 b	43.25 b
	BF	5.79 c	0,996 b	71.58 c	0.76 b	47.50 c

a-d For each variable, means within the same column with different superscripts differ significantly ($P<0,05$).
aw (water activity), moisture (moisture content), chloride (chloride concentration), L* (Lightness)