INFLUENCE OF FAT CONTENT IN SALT PENETRATION IN REFRIGERATED AND FROZEN HAMS

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Background

Dry-cured ham is one of the most typical and consumed meat products in Spain, called "Serrano" when it satisfies some requirements. On the 1st of March 2000 the European Union published the conditions which defines the ETG "Jamón Serrano". Its manufacturing process comprises the following steps: classification, salting, post-salting, drying and ripening.

In the traditional salting method, the hams are stored salt-coated at low temperature and high relative humidity for a variable time. Following the addition of the curing agents, hams are placed in piles with alternate layers of sea salt and ham. New layers of hams and salt are added to the first layer till 4 or 5 layers are reached (piles). Salting time depends on the different weight of raw hams, and different times are applied in order to obtain an homogenous salt content in all hams.

During salting there are a penetration of salt to the inner part of the ham and a water loss due to a diffusion process that follow the second Fick's law. According to this law, diffusion depends on a coefficient which is characteristic of the product (Boadas et al., 2001). The existence of intra and intermuscular fat makes difficult the penetration of salt during the salting step (Arnau, 2000). The diffusion coefficient (Dc) is influenced by the amount of fat in the ham, and it decreases significantly in the presence of fat.

Raw hams used in the industry could be refrigerated or frozen. These hams are processed in the salting step in a different way. Dussap and Gross (1980) showed that the Dc of NaCl in refrigerated meat was $22\cdot10^{-10}$ m^2/s and in thaw meat was $39\cdot10^{-10}$ m^2/s. González-Menéndez et al. (1985) obtained higher Dc in thawed samples than in refrigerated ones. In the same way, León-Crespo (1997) established that it is necessary less salting time in frozen than in refrigerated hams.

In several studies (Pineda et al., 1993; Arnau et al., 2000), ham composition is analysed after salting taking one specific muscle, or a part of the ham and the results are extrapolated to the whole ham. However, few times the physico-chemical parameters of composition are analysed taking the whole ham and these results are considered here to know the influence of the fat content (fat or semi-fat) and the state of the raw material (refrigerated or frozen) in the amount of salt taken by hams.

Objectives

The principal aim of this study is to know the influence of fat content in the salting step of ham making, using whole hams to analyse the salt content. It is also studied if the modification of salting time allows to obtain an homogenous final product in salt content, using refrigerated or frozen hams.

Methods

Fat and semi-fat hams were selected with a weight of 11.5 Kg +- 150 g. All hams come from castrated male or female pigs and. Hams were classified as fat or semi-fat according to the amount of subcutaneous fat.

20 hams were studied, 10 refrigerated and 10 frozen, among these hams were selected 3 fat and 3 semi-fat ones. In fat hams the fat thickness at the bottom of the ham must be higher of 2 cm. For hams selected as semi-fat ones this thickness ranged between 1 and 2 cm.

All hams were salted in piles of 4 layers height, and all hams used in these study were placed in the second layer. The salting time was 8 days for frozen hams and 9 days for refrigerated ones.

After salting, hams were weight to obtain the weight-loss and boned, removing the bones, the subcutaneous fat and meat. In this study meat refers to the all muscles, fat, connective tissue and blood vessels after the removing of bones, subcutaneous fat, ham skin and the distal part of the ham piece from the calcaneus tuberosity.

In the meat the following physico-chemical analysis were done: moisture, salt and fat contents and pH. Moisture content was determined according to the international standard ISO 1442-1973, salt content according to Carpentier-Vohlard method, fat according to Soxhlet method described in AOAC (1990), and the pH was measured by a pHmeter GLP-21 (Crison. Barcelona, Spain).

Results and Discussion

In general the composition analysis of dry-cured ham has been done, traditionally, using a part of it and only few times it has been used all ham for this purpose. In this study, all muscles of ham (meat) have been analysed together after the salting step for moisture, fat and salt contents. These hams have been defined according to their conformation before salting, weight, perimeter, width and thickness of subcutaneous fat layer.

Table 1 (A and B) show the analytical values obtained in frozen and refrigerated hams for both kinds of fat and semi-fat hams.

Table 1.A shows the analytical data for frozen hams and it is remarkable that there are differences between fat and semi-fat hams only in the parameters related with the amount and distribution of fat (α=0.05). The fact that no significant differences have been observed between the other parameters means that the selection of these hams has been done correctly and they are alike and comparable. It is important to note that the salt content in both kinds of hams is more or less the same. Therefore, it is possible to say that quite similar amounts of salt have been absorbed by frozen hams with different fat content.

Table 1.B shows the analytical data for refrigerated hams. As it can be observed the results obtained are like to those in frozen hams. In this way, there are only differences in parameters related with fat (α=0.05), in the rest of parameters no significant differences have been found. That means that hams are very similar except in fat content. Again, the salt content is almost equal in both types of ham irrespective of the amount of fat. Gou et al. (2000) showed that an increase in the fat content of the ham implies a decrease in the diffusion coefficient Dc. If we consider these two last facts, it could be that the other steps of the ham making process play an important role in salt diffusion inside the ham. In fact, as it could be seen in Tables 1 A and B, the percentage of inter and intra muscular fat are different in both kinds of hams (α=0.05). It seems that as all hams are very similar in all parameters, the active surface to absorb salt is also the same apart from the subcutaneous fat content.

When frozen and refrigerated hams are compared, without taking into account the fat content, Table 1.C, it is possible to see that increasing one day the salting time in refrigerated hams, they achieved the same salt content that frozen hams with one day less. This effect is due to the injury that muscular cells suffer because the grow of ice crystals during the freezing process and storage and the thawing effect, that allows the drip loss (Martino et al., 1988). In this study the weight loss, which is a reflex of drip loss, is the only parameter that shows significant difference between the frozen and refrigerated hams (α=0.05). The remaining parameters present almost the same values, that means the all hams chosen for the study were comparable in morphology, pH, weight, moisture and fat contents, although fat and semi-fat hams are used, as it was demonstrated above. This fact let to evaluate strictly the difference between refrigerated and frozen hams. As the salt content of all hams hardly differs in both types of hams, the factory decision of keep the refrigerated hams one day more in the salting phase has been correct.

Conclusions

According to this study if the hams have similar morphological characteristics, that is, almost the same active surface to absorb salt, they will take more or less the same quantity of salt in the salting phase, irrespective of their amount of subcutaneous fat. As fat has a decreasing effect in salt diffusion inside the ham, intra and intermuscular fat content and distribution will be very important, and in this sense the further processing steps, after salting, will play an important role. More samples must be studied in order to know if could be some correlation between the thickness of subcutaneous fat layer and intra and intermuscular fat.

As it was expected, the salt content in refrigerated and frozen hams could be equal if the salting time is modified.

Pertinent literature

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Dates in the form of tables:

Table 1. Morphological and physico-chemical parameters en frozen and refrigerated hams with different fat content.

	A. FROZEN HAMS		B. REFRIGERATED HAMS		C. TOTAL HAMS	
	Fat	Semi-fat	Fat	Semi-fat	Frozen	Refrigerated
	n = 3	n = 3	n = 3	n = 3	n = 10	n = 10
Weight (Kg)	11.43±0.11	11.47±0.10	11.48±0.09	11.53±0.08	11.48±0.09	11.50±0.09
Perimeter (cm)	73.17±2.25	74.60±2.01	74.83±1.04	76.17±2.25	73.38±1.61	74.95±2.25
Thickness (cm)	17.33±0.29	19.47±1.21	15.83±1.26	15.1±0.17	17.89±0.86	15.9±0.99
pH	5.88±0.21	5.81±0.12	5.85 ±0.17	5.87±0.06	5.77±0.19	5.82±0.18
Weight loss (%)	4.98±1.53	5.98±0.71	3.89±0.17	3.96±0.65	5.60±1.21[a]	4.09±0.39[b]
Subcutaneous fat weight (Kg)	3.04±0.30[a]	2.27±0.20[b]	3.13±0.36[a]	2.37±0.24[b]	2.49±0.45	2.79±0.44
Bone weight (Kg)	1.51±0.05	1.41±0.06	1.51±0.17	1.41±0.05	1.50±0.11	1.50±0.10
Moisture (%)	65.13±2.08	65.4±3.63	67.03±0.88	68.13±0.19	67.37±1.4	67.55±0.92
Inner fat (%)[1]	7.38± 0.55[a]	2.68±0.91[b]	8.33±1.67[a]	4.57±0.94[b]	5.90±2.59	6.10±1.93
Inner fat (DM%)	21.19±1.75[a]	7.88±2.80[b]	25.23± 4.72[a]	14.34±2.94[b]	17.87±7.22	18.72±5.6
Salt (%)	2.54±0.12	2.80±0.52	2.08± 0.46	2.39±0.12	2.66±0.30	2.38±0.45
Salt (DM%)	7.30±0.24	8.05±0.66	6.32± 1.36	7.51±0.51	8.20±1.11	7.35±1.46
Salt (defatted DM%)	9.26±0.27	8.61±0.50	8.41± 0.67	8.76±0.42	9.95±0.45	9.01±0.44

For each type of comparison (A, B or C), means in a row followed by a different letter are significantly different ($\alpha=0.05$).

[1] Inner fat: inter and intramuscular fat content