DRY-CURED HAM TEMPERATURE INFLUENCE ON SALT DIFFUSION

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SUMMARY

Twelve green hams those which were salted during 11 days. The hams were separated in two batches: normal pH and high pH and each one of these groups was salted at two different temperatures: 2.2 and 3.5 °C. For this study three muscles were selected: *Biceps femoris*, *Semitendinosus* and *Semimembranosus*. Salt concentration in muscles during the salting stage was not uniform. Temperature and pH did not affect the salt diffusion.

INTRODUCTION

Dry-Cured ham is the most important meat product in Spain. This product is well known for its quality and sensorial properties; in general there are 3 principal stages: salting, postsalting and dry-maturation.

The aim of the dry cured process is to: 1°-To give stability to the product by lowering the water activity (Aw) to avoid microorganism growth. Spanish dry-cured ham is an intermediate moisture food, and it does not need refrigeration. 2°-It produces different reactions in muscle and fat components. These reactions produce the characteristic taste and flavour. The salting stage is very important because all salt uptake takes place. The hams are absolutely covered by salt during 1 to 1.5 day per kg. The postsalting stage takes place during 3-4 weeks, previously the excess of salt being washed previously. During the salting and postsalting stage the temperature must be lower than 3.3°C.

The force that stimulates the salt penetration is its concentration gradient, for this reason the rate of diffusion of salt decreases as the salt concentration has been lower. This process is finished when the balance takes place. There are two factors that influence the rate of penetration of salt in the product: 1) External: brine concentration and temperature. When these factors increase, the rate of penetration is faster. 2) Internal: higher pH values may be associated with a lower rate of diffusion (Körmendy et al., 1960). The presence of fat makes the salt diffusion difficult. To know the rate of diffusion of the curing agents it is necessary to determine the length of time required for procesing and the uniformity of cure distribution (Fox et al., 1980; Peña et al., 1992).

For this reason the aim of this work, was to study the diffusion of the salt, and the influence of the pH and temperature in the rate of diffusion of salt in Spanish dry-cured ham.

MATERIAL AND METHODS

Twelve green hams (8 kg approximately) those which were salted using a commercial combined dry/brine curing process, during 11 days. The hams were separated in two batches: normal pH (5.6-5.9) and high pH (>6.0) and each one of these groups was salted at two different temperatures: 2.2 and 3.5 °C. For this study three muscles were selected: *Biceps femoris* (BF), *Semitendinosus* (ST) and *Semimembranosus* (SM), each muscle was removed of fat and divided into three zones (2 cm), designated: outer, middle and inner.

Analytical methodology: Once homogenization is accomplished the following determination physicochemical was analized in the samples. Chloride content, according to the standard ISO R-1841. Moisture, (%) by the standard ISO R-1442.

The statistical analysis was made with BMDP program ver. rel. 9.0: 9D and 8V.

Calculation of the constant coefficient diffusion: By fitting a theoritical model, the validity of Fick´s law under the experimental conditions was asessed, and the coefficient diffusion calculated (Crank, 1975):

$$(Ce-C/Ce-Co)=4/\pi(\exp-\pi^2Dt/4rm^2)\cos(\pi r/2rm) \quad (1)$$

Nomenclature: C=salt experimental concentration (g/ds). Ce=ham-solution interface concentration (g/ds), (=35.7%) (Perry 1992). Co=initial salt concentration in ham (g/ds), (=0%). D=diffusion coefficient (m^2/s). t=time (s), (=950400 s). rm=thickness of ham in study (m), (0.201m). r=thickness of slice in study (m). ds=dry solid.

Several hypothesis for this system were made: 1.-The diffusion process during the salting of ham is one-dimensional. 2.-All muscles in green ham were salt free. 3.-The saturated brine concentration during the interphase(between ham and salt) at salting temperature was constant. 4.-The ham behavior is considered like an only muscle.

The diffusion modelization, is based on the following considerations: 1.-The salt diffusion in ham, is a single matter transport in a non-steady state condition. 2.-The salt concentration gradient, is directly proportional to the gradient concentration variation, in relation to its position. 3.-The salt diffusion in ham, follows the Fick´s second law. 4.-The ham is considered like a plane sheet, of finite thickness; and infinite width and length. 5.-The salt molecular diffusion, is constant during the salting process. 6.-The surface concentration (initial distribution), remains steady during the whole salting process. 7.-The initial salt concentration in ham, remains steady in the whole product.

RESULTS AND DISCUSSION

The coefficient diffusion was calculated using equation (1) and they are shown with the salt experimental concentration and moisture in tables 1, 2 and 3. Differences in salt concentration was found in different muscles but not for the temperature and pH.

The experimental model did not totally comply with the theoretical. That is due to the diffusion process not being absolutely one-dimensional, because the fat and skin are not totally impermeable to salt diffusion as can be observed in figure 1. And a higher salt concentration than the expected, was found in BFinner zone.

Different salt concentration was found between muscles (figure 2), because there are different muscle orientations, fat and connective tissue content to dificult the salt diffusion.(Körmendy et al., 1960). Significant statistcal differences ($p<0.05$) were not found in salt concentration for temperature and pH. This corresponds to Sayas et al. (1989) study in spanish dry-cured ham and Körmendi et al. (1960) for different pH. The coefficient salt diffusion calculated was similar to those obtained by Sayas et al. (1989)Palmia et al. (1991).

CONCLUSIONS

Salt concentration in muscles during the salting stage was not uniform. The highest salt concentration was found in SM (outer and middle zone) and BF (inner zone). A low salt diffusion across skin and fat was found. Temperature and pH did not affect the salt diffusion.

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