SALT UPTAKE BY HAMS DURING DRY CURING

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INTRODUCTION

Much research has been devoted to studying the rate of diffusion of curing salts in meat, since in many cases it determines the length of time required for processing and the uniformity of cure distribution. This aspect of the problem has been thoroughly investigated, particularly in conditions resembling those of tank curing (Körmendy & Gantner, 1958; 1960; Wistreich **et al.**, 1959; 1960; Wood, 1966; Fox, 1980), but also in experiments designed to account for industrial dry curing (Andújar & Tarrazo, 1981; Andújar **et al.**, 1983).

All these results, however, take only into consideration the intrinsic properties of meat, and not the practical situation of a meat joint, where factors such as skin and fat cover or surface to weight ratio play a very important role.

Meanwhile, in industry, the length of time that dry-cured hams should be left rubbed with salt, before washing, is usually decided applying a far too simple rule-of-thumb based only on the weight of the hams.

The purpose of this work is to study the total salt uptake and salt distribution at different salting times, in the dry-curing of hams of different green weights.

MATERIALS AND METHODS

In all, 20 hams corresponding to 3 weight categories between 6 and 9 kg were trimmed and rubbed with a curing salt containing 95,8 % sodium chloride; 0.4 % sodium nitrite; 0.8 % sodium nitrate and 3 % sucrose. They were then stored in a chilled chamber at 2-4°C.

At 3-day intervals, up to a total of 18 days, a 40 mm-thick cross-section was cut at the thickest part of one ham out of every weight group. The cut was further divided in 36 pieces (Figure 1) in each of which average NaCl content was determined. The rest of the ham was also analyzed for average NaCl content, so that a weighed average concentration could be calculated for the total ham.

Each sample was minced twice through a 3 mm plate, mixing thoroughly after each operation. NaCl determination was carried out following a variant of Mohr's method, correcting the results after Venegas and Andújar (1979) to compensate for the systematic error.

Data was thus collected on NaCl concentration in each of 36 areas of the cross-section, as well as the complete joint, for hams of three different weights, at six different salting times. The effect of ham weight on salt uptake was studied through analysis of variance, and the variances of each set of data of NaCl content per portion in cross-sectional samples were calculated as indices of distribution evenness.

The average moisture content of the cross-sectional samples was also determined (AOAC, 1980), in order to estimate the average water activity (aw) of the hams from their salt and moisture contents, according to the method of Krispien **et al.** (1979).

After the 18-day salting period, the two remaining hams were washed and left in refrigerated storage (equalization period) for 30 and 60 days, respectively, after which they were sampled in the same manner as the rest, for comparison purposes.

RESULTS

Table 1 shows average chloride contents in hams. Salt concentration was not significantly affected by ham weight at $P<0.05$, as show by analysis of variance.

This might indicate that the effect of weight, however obvious, may not be as

decisive as some rules appear to suggest (e.g. "cure for two days per every kilogram ham weight"). Other factors, such as the degree of trimming of skin or fat, usually very variable, bear considerable influence in this respect.

Figures 2 to 4 show the distribution of salt in cross-sections at 3, 9, and 18 days salting, respectively. Salt distribution was very uneven from the beginning of the process, very high salt concentrations near the surface, particularly in areas with little or no skin or fat cover, being noticeable.

As the salting period progressed, total salt uptake increased steadily, but the unevenness in salt distribution remained and, in fact, tended to increase. This can be appreciated in the figures, but is more clearly shown by variance data in Table 2.

Even at the end of the salting period, there are areas of the ham, particularly around the center, where salt concentration is not high enough to ensure adequate preservation by itself, a reason to keep the temperature low during the subsequent equalization period.

Taking into account the average salt uptake and the effect of weight loss (up to 35 % during drying) on salt concentration, 15 days salting should suffice in order to obtain an organoleptically good, microbiologically safe product.

Figures 5 and 6 show the changes in salt distribution during the equalization period. It can be seen that, with no further salt uptake, salt concentration tends to even out throughout the cross-sectional area. The corresponding variance data is included in Table 2.

CONCLUSIONS

Average salt concentration in hams during salting was independent of ham weight in the range of 6-9 kg.

Total salt uptake after 15 days salting should guarantee an organoleptically good and microbiologically safe final product.

After salting, NaCl distribution is still very uneven, so that a fairly low temperature is required during the equalization period.

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Table 1.- Average chloride content in hams of different weight ranges, at different salting times

Salting time	Weight range (kg) 6-7	7-8	8-9
3 days	1.53	1.14	1.04
6 days	2.16	1.88	1.55
9 days	2.33	2.49	2.65
12 days	2.89	3.14	3.64
15 days	2.48	3.13	3.07
18 days	4.26	3.52	2.31
Mean value	2.61[a]	2.55[a]	2.38[a]

[a] Mean values do not differ at $P<0.05$

Table 2.- Weighed variances of salt distributions in cross-sections, at different salting times.

Salting time (days)	Weighed variance of salt distribution
3	1.897
6	5.723
9	6.189
12	7.340
15	6.110
18	9.260
30*	3.294
60*	2.268

* Equalization times

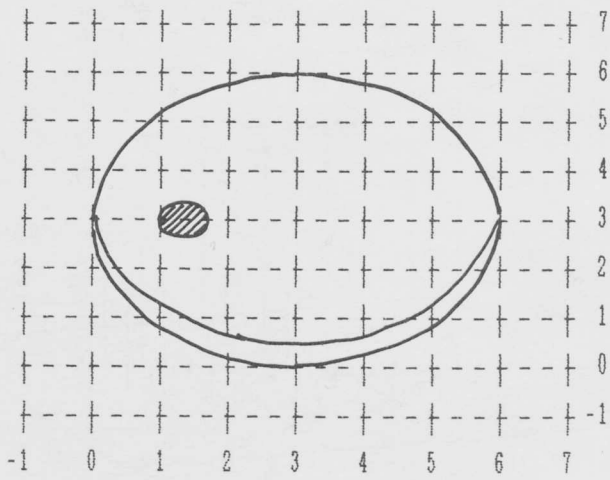

Figure 1.- Portioning pattern used for ham cross-sections

FIGURE 2.- NaCl CONTENT PER PORTION IN HAM CROSS-SECTION. 3-DAY SALTING

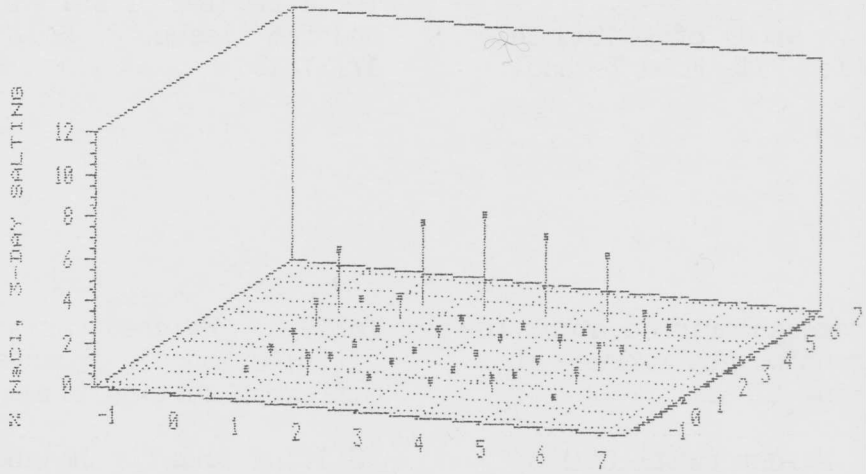

FIGURE 3.- NaCl CONTENT PER PORTION IN HAM CROSS-SECTION. 9-DAY SALTING

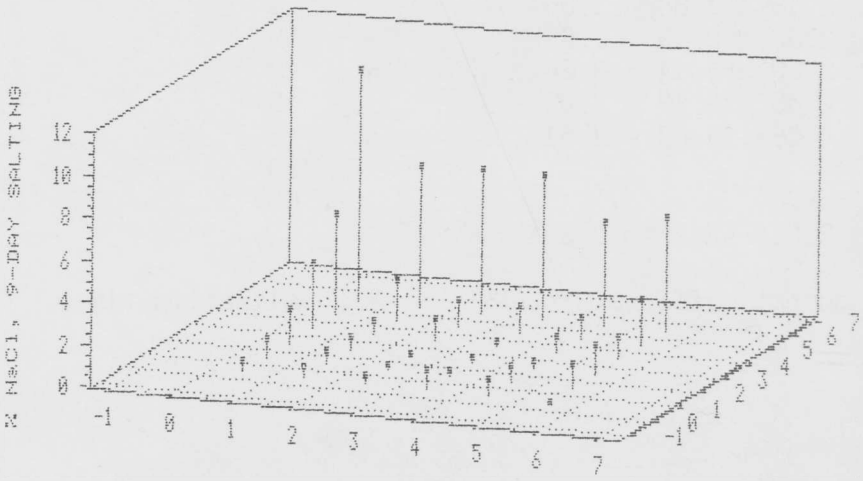

FIGURE 4.- NaCl CONTENT PER PORTION IN HAM CROSS-SECTION. 18-DAY SALTING.

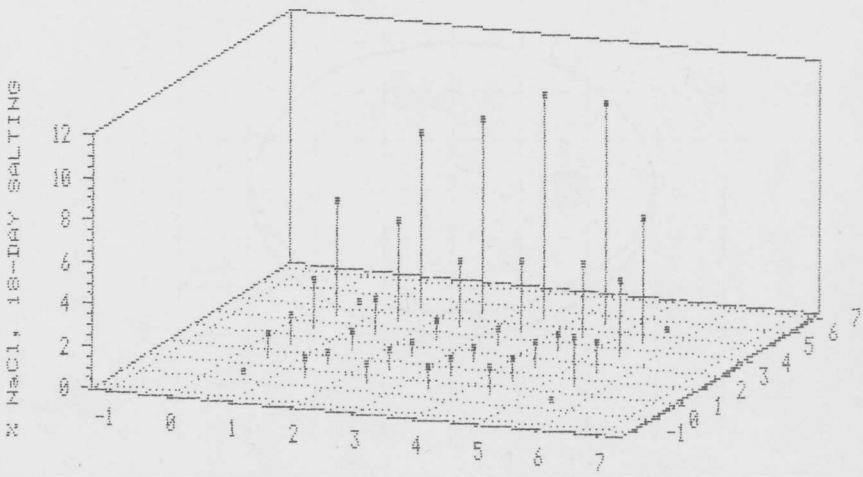

FIGURE 5.- NaCl CONTENT PER PORTION IN HAM CROSS-SECTION, 30-DAY EQUALIZING

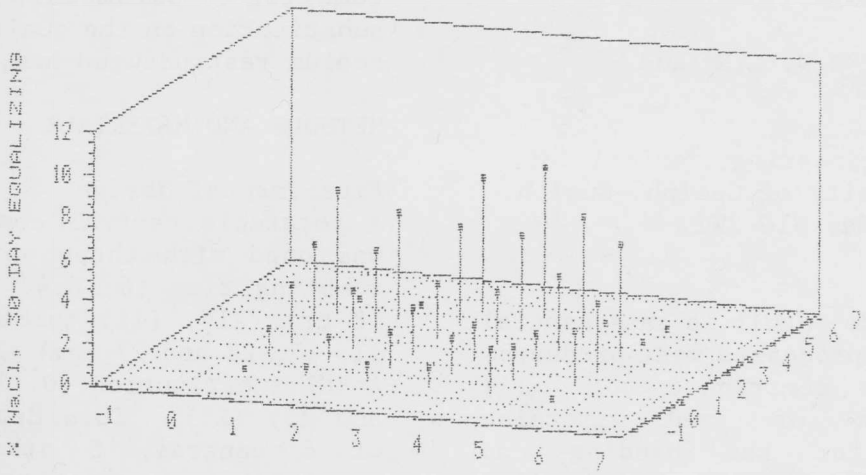

FIGURE 6.- NaCl CONTENT PER PORTION IN HAM CROSS-SECTION, 60-DAY EQUALIZING.