PHYSICOCHEMICAL CHANGES DURING THE POSTSALTING PERIOD OF IBERIAN HAMS

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INTRODUCTION

The Iberian ham is an uncooked, salted and dried meat product of high quality produced in the southwest of Spain. Its processing has two definite steps: salting-postsalting and ripening. During the first period, salting and surface drying is combined with low temperature to reduce the risk of bacterial spoilage. Next, the hams are left to mature up to 12 months at environmental conditions (temperature ranges between 20°C and 37°C) to let their particular flavour develop.

The production of dry-cured hams from Iberian pigs has increased rapidly during the last few years. The Ministry of Agriculture Fisheries and Food (MAPA, 1984) estimates that about 1 million hind legs from Iberian pigs are processed into cured hams each year. Despite their economic importance, no systematic work on the processing of Iberian hams has been carried out until now although some data on chemical composition, characterization of lipids and fungal flora have been reported (León Crespo et al, 1982; Flores et al., 1988; Monte et al, 1986).

This study was undertaken to elucidate the processes leading towards the microbiological stabilization and the formation of desirable ham flavour. It was conducted to clarify the phenomena taking place during the salting-postsalting period, with particular attention to changes that could influence bacterial spoilage and proteolytic/lipolytic activity along ageing.

MATERIALS AND METHODS

Sixteen thighs from Iberian pigs (160 Kg live weight) were selected and handed to a plant to be processed in the traditional way. The lot was divided into 4 groups of 4 hams each to fit in the following sampling protocol:

-Green state (G): the hams were held after slaughter for 48 hours at 0°C
-Salted (S): the hams were introduced into a pile of salt (containing nitrate and nitrite) for 8 days at 0-4°C.
-Postsalting-1 or resting (PS1): the hams brushed to free them from salt left on their surface, were kept at 0-4°C for 62 days
-Postsalting-2 or pre-maturing (PS2): during this period the hams were transfered to a chamber with increasing temperature and kept for 45 days until the average temperature reached 18°C.
After this first period, hams are usually left to mature for 12 month at environmental conditions (temperature higher than 20°C).

Samples of Biceps Femoris (BF) and Semimembranosus (SM) muscles of each ham were taken and analysed as follows:

Moisture (M) and protein nitrogen (PN) were determined following ISO recommended methods (ISO/R 1442 and ISO/R 937). For non protein nitrogen (NPN) determination, the aqueous extracts of muscles were treated with an equal volume of 0.6N-$HClO_4$, then filtered through a Whatman-1 paper and the nitrogen content analysed after the method of Johnson (1941). The pH was measured in a homogenized slurry made of 10 g of sample and 10 g of destilled water. The water activity (a_w) was determined at 20°C by the graphic interpolation method using saturated salt solutions as standards (Landrock and Proctor, 1951). Nitrite and nitrate were analysed spectrophotometrically by using the Griess reaction (ISO/DIS 2918) and the brucine method (AOAC, 1984) respectively. NaCl was measured

as chloride by titration with $AgNO_3$-NH_4CNS (AOAC, 1984). Fat was extracted according to the method of Bligh and Dyer (1959). The subsequent determination of free fatty acids (FFA) was done by the method described by Pearson (1968).

RESULTS AND DISCUSSION

Data from chemical and physical analysis of BF and SM samples from processed hams are summarised in Table 1.

Moisture loss and salt penetration processes were slow in these hams in comparison to other dry cured hams due to its high fat content (intramuscular fat was 28.05% of dry matter in SM and 36.57% in BF). As expected, the moisture content in SM decreased progessively whereas only a slight reduction was observed in BF due to its deeper position. On the other hand, NaCl levels after salting were lower in BF than in SM. Then, NaCl concentration in BF increased gradually and at the end of PS2 salt equalization was effective. Consequently, the a_w reached values lower than 0.90 in SM and was always higher than 0.96 in BF. pH values ranged from 5.75 to 6.20.

According to these results, the low temperature seems to be the main limiting factor for bacterial growth in BF. Microbial spoilage in deep muscles (called "cala") account for more than 2% losses through the ageing period in Iberian hams. Putrefaction is related to microbial growth due to insufficient NaCl concentration in the hook or ilium-femur joint when the hams are placed into pre-maturing chambers (increased temperature) before salt equalization. Assuming that there is adequate salt applied initially, these conditions can be minimized in commercial processing plants by increasing up to 60 days the PS1 period to assure sufficient salt penetration into these areas of the ham. Also the presence of residual levels of nitrate and nitrite (Table 1) could be useful as bacteriostatic

Table 1.- Chemical and physical characteristics of Iberian hams throughout the salting-postsalting period. Values are means of 4 samples. NaCl, NO_3 and NO_2 are expressed as realted to dry matter.

	Green	Salting	Post-salting-1	Post-salting-2
Semimembranosus				
Moisture (%)	67,06	65,24	61,33	56,84
Water activity	0,98	0,89	0,90	0,90
pH	6,19	5,81	6,07	6,07
NaCl (%)	----	18,59	13,27	10,46
NO_3 (ppm)	----	1245	615	425
NO_2 (ppm)	----	32	19	8
Biceps Femoris				
Moisture (%)	71,72	69,25	67,56	64,92
Water activity	0,98	0,97	0,97	0,96
pH	5,98	5,75	5,95	6,08
NaCl (%)	----	5,48	9,59	10,24
NO_3 (ppm)	----	746	385	374
NO_2 (ppm)	----	9	8	7

agent due to its recognized inhibitory effects on toxin production by *Clostridium botulinum* and development of other putrefactive microorganims (Greenberg, 1972; Bulman and Ayers, 1952).

The results obtained (Figure 1) show a large amount of protein degradation during the period under study as revealed by the increase of (NPN/PN) × 100 from 3.82 in fresh hams to 13.66 at the end of PS2. The highest protein breakdown takes place in the initial phase of processing (salting) when the NPN fraction increased nearly 2-fold. Next, NPN concentrations raised continously until reaching values of over 1.0% of dry matter. It is expected that intense proteolitic activity will occur at the higher temperatures of the following stages of processing (ripening) considering that NaCl concentrations (≈0.04M) at the end of PS2 are favourable to CASF and

catepsines activity. Also, lipolitic activity was found as assessed by the changes of lipid samples acidity (Figure 2). The FFA content in SM fat was higher than in BF. This was attibuted to high salt concentration and increased fat exposure to atmospheric oxygen as a consequence of its more external situation.

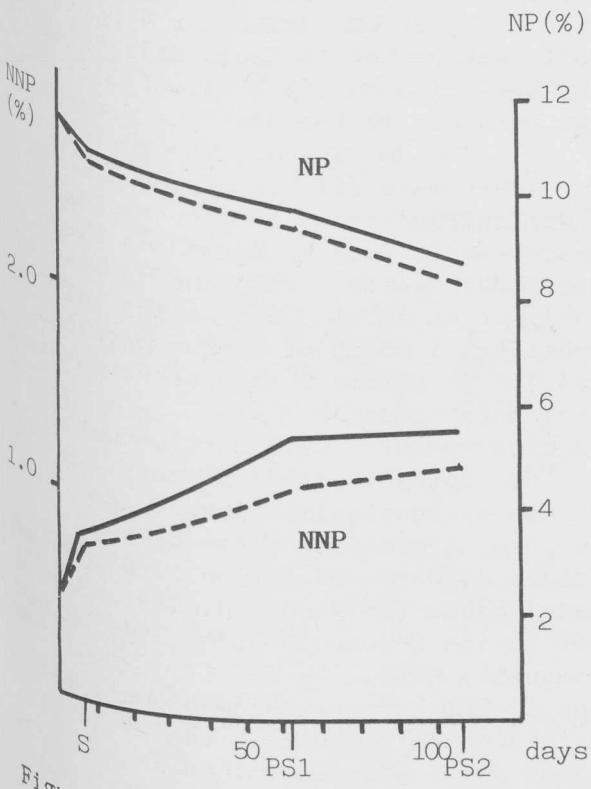

Figure 1.- PN and NPN content in Iberian hams (——BF, - - -SM). (Expressed as percentage of dry matter)

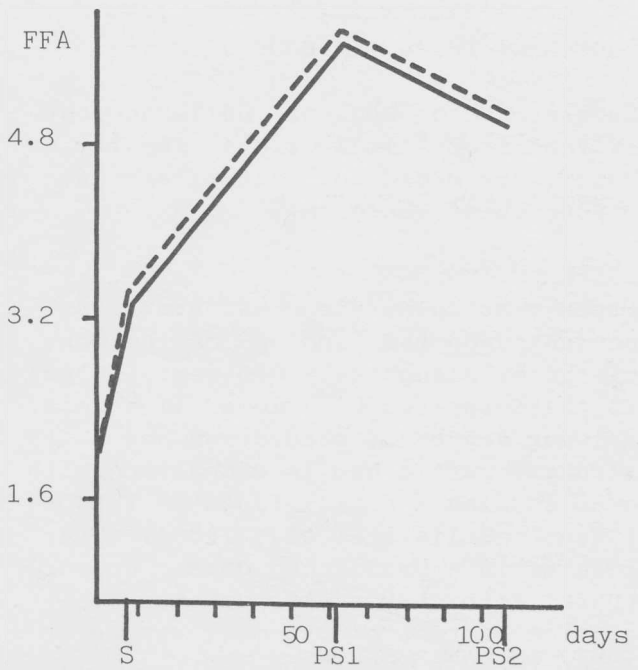

Figure 2.- Development of lipolysis in Iberian ham samples expressed as percent of oleic acid/100g of fat (BF——, SM - - -)

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