THE EFFECT OF INOCULATION OF A STARTER CULTURE ON SENSORY CHARACTERISTICS OF DRY-CURED HAMS USING TWO DIFFERENT RESTING TECHNOLOGIES

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INTRODUCTION

Dry-cured ham is a traditional product in which texture, aspect and flavour have been found to be related to raw material (Arnau et al., 1994; Parolari et al., 1994; Gou et al., 1995), proteolysis and lipolysis during aging (Buscailhon and Monin, 1994) and, to a lesser extent, with microbial flora, since the microbial population inside of the ham is relatively low (Huerta, 1986; Carrascosa et al., 1988; Silla et al., 1989). Although some authors have used starter cultures to improve the quality and safety of dry cured hams (Bartholomew and Blumer, 1977; Marriot et al., 1987), no similar studies have been found using traditional Spanish drying technology. The aim of this study was to evaluate the effect of using a commercial mixed starter culture in the manufacture of hams using Spanish drying technology with two different types of resting.

MATERIAL AND METHODS

Processing of hams

36 paired partially skinned hams, each pair coming from the same carcass, were selected in a local meat processor within 8 hours *post-mortem* (9.5 ± 1.0 Kg in weight). After 48 hours storage at 2-3 °C, they were thoroughly rubbed with a mixture of 35 g NaCl, 0.15 g $NaNO_2$, 0.30 g $NaNO_3$ and 5 g dextrose per Kg of ham. The hams were vacuum packaged in plastic bags (Cryovac BB4-L, W.R. Grace & Co.), and placed on a horizontal position in a room at 2-3°C. After 5 days, the bags were opened and the hams were rubbed with 30 g of salt per Kg of ham, vacuum packaged again and left in the same conditions as before for another 16 days. After this salting period, the hams were washed with cold water and, according to the experimental design (Table 1), some hams were rubbed with 0.1 g /Kg ham of a commercial lyophylised mixed starter culture (Elce 10, RP Texel, Groupe Rhone-Poulenc) on the lean side and/or vacuum packaged. The starter culture contained *Lactobacillus sake (L), Staphylococcus xylosus II, Staphylococcus carnosus* and *Debaryomyces Hansenii*.

Table 1: Experimental design

Treatment	Starter	Vacuum	Hams[1]					
S	Yes	No	1i 2d 3 i	4d 5 i 6d	7i 8d 9i			
SV	Yes	Yes	1d 2 i 3d			10 i 11d 12i	13d 14i 15d	
C	No	No		4i 5d 6i		10d 11i 12d		16i 17d 18i
V	No	Yes			7d 8i 9d		13i 14d 15i	16d 17i 18d

[1]The number indicates the carcass. i=left ham. d= right ham.

The hams were either hung (treatments C and S) or left on a horizontal position (treatments V and SV) at 2-3 °C in a drying room with a relative humidity (RH) between 75 and 85% for 36 days (resting period). After that, the V and SV hams were taken out of the bags and hung in a drying room at 15°C and RH of 40-50%. On the following day, the pairs of hams from each of the 18 carcasses were hung one in front of the other, facing the lean surfaces at 5 cm of distance, in a drying room at 15°C and 70-80% RH. During the following 250 days (ageing period), the temperature was gradually increased up to 27 °C and the humidity lowered to 50%. The average weight loss of hams at the end of the process was 35%.

Microbial analysis

Samples were taken at the surface of hams as follows: the area of *Adductor* muscle delimited by a steel circle of 7.0 cm diameter was swept with a sterile cotton swab previously moistened with a sterile solution of 0.1% peptone and 4% NaCl and pH 7.0 (dilution medium). Then, the swab was put into a tube containing 10 ml. of dilution medium. This procedure was repeated in *Gracilis* muscle with another cotton swab, which was put into the same tube as before. Surface sampling was done at three points of the process: at the end of the salting period (8 hams at random), at the end of the resting period and at a 120 days of processing. The samples were homogenised in 90 ml of dilution medium with a Stomacher 400 for 1 minute. In the latter three samplings 16 paired hams were used (4 from each treatment). The microorganisms studied were: *Micrococcaceae*, *Enterobacteriaceae*, Sulphite reducing clostridia, lactic acid bacteria (Silla et al., 1989), anaerobic microorganisms, moulds and yeasts (CENAN, 1982) and halotolerant aerobic microorganisms (PCA agar with 4% NaCl incubation at 30 °C for 3 days).

Sensory analysis

The sensory evaluation was carried out by a panel of 6 assesors as described by Arnau et al., (1997) in *Biceps femoris* (BF) and *Semimembranosus* (SM) muscles in 9 sessions. Four paired hams processesed with the 4 different treatments were assesed in each session. The area of ham lean covered by moulds was also scored by the panel, using a 0-10 non-structured scale (0 for absence, 10 for lean surface completely covered). Visual assesments were performed at 125, 210 and 312 days of processing.

Statistical analysis

A least square analysis of variance was carried out on sensory and microbiological data, using the GLM (General Linear Models) procedure from SAS (SAS 1987). The model included starter aplication (STA), vacuum resting (VAC), their interaction (STA*VAC) and carcass as fixed effects. The least significant difference (LSD) test was applied.

RESULTS AND DISCUSSION

Table 2 shows, for each level of starter and vacuum packaging, the means of some sensory characteristics of the final product. BF muscle was not affected by either STA or VAC ($p<0.05$) and did not present musty flavour. In SM muscle, the use of the starter significantly increased musty and "feeding stuff" flavours and lowered sweetness, aged flavour and acceptability. The difference in sweetness may be due to the fact that at the beginning of ageing period, the number of microorganisms was higher in the surface of inoculated hams. The increase of temperature made better environmental condition for the microorganisms to grow and consume dextrose. Vacuum resting of hams was considered as a modelling of a salting system which is used in some manufacturing companies, where the hams remain dip in the liquid exudated during salting. Vacuum resting produced a slight increase of musty flavour in SM and of "feeding stuff" and a decrease of hardness, aged flavour and acceptability. The differences in musty flavour could be accounted for the fact that surface counts for *Micrococcaceae* and halotolerant aerobic flora at resting and ageing period were higher in the hams subjected to vacuum resting. This may be due to the higher water content they had during the whole process, specially when the ageing period started, as a consequence of not being dried during resting. This difference in water content may also account for the lower hardness of V and SV hams. There was a STA*VAC interaction ($p<0.05$) effect only in musty flavour, which was highest in SV hams (0.9 ± 0.3), followed by S (0.4 ± 0.2) V (0.4 ± 0.6) and C (0.2 ± 0.2). Therefore, the increase in musty flavour produced by inoculation was higher in the hams processed with vacuum resting. The decrease in the number of hams with aged flavour produced by STA and VAC factors may be due to changes in the ham surface, specially those changes related to water content. The floral flavour, which is due to phenylacetaldehyde (Berdague et al., 1991), was only present in the SV hams, so this flavour could be related to some microbial activity. Regarding the visual aspect of hams, there were significant STA, VAC and STA*VAC effects in surface mould growth during ageing. The C hams showed the highest mould growth, followed by V hams, whereas SV and S hams had almost no moulds.

To sum up, inoculation did not improve flavour of dry-cured hams in any of the two resting technologies, although it was very efficient in developing a homogeneous flora at ham surface and preventing mould growth, specially in the hams processed with a resting phase in air.

Table 2 Starter and vacuum packaging effects on some sensory characteristics of BF and SM muscles[1]

		BF MUSCLE						SM MUSCLE					
Factor	Level	Sweetness	Saltiness	Aged[2]	"F. stuff"[3]	Hardness	Aceptability	Sweetness	Saltiness	Aged[2]	"F. stuff"[3]	Hardness	Aceptability
STA	Yes(n=18)	0.5	3.4	0	0.7	4.1	4.6	1.0^{a}	2.5	2	1.7^{a}	5.8	4.7^{a}
	No (n=18)	0.8	3.5	3	0.4	4.1	5.0	2.0^{b}	2.6	9	0.9^{b}	5.5	5.7^{b}
VAC	Yes(n=18)	0.7	3.5	2	0.6	3.9	4.8	1.6	2.5	2	$^{4}1.7^{a}$	5.1^{a}	4.9^{a}
	No (n=18)	0.6	3.4	1	0.4	4.3	4.8	1.4	2.6	9	$^{4}0.9^{b}$	6.2^{b}	5.5^{b}
S.E.M.[5]		0.1	0.1	-	0.2	0.1	0.2	0.2	0.1	-	0.3	0.3	0.2

[1]Within starter or vacuum packaging effect, means with different superscripts are significantly different ($p<0.05$). [2]Number of hams which presented aged flavour. [3] Feeding stuff flavour. [4]$p<0.06$. [5]Standard error of the mean.

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