

# EFFECT OF RELATIVE HUMIDITY OF DRYING AIR DURING THE RESTING PERIOD ON THE APPEARANCE, TEXTURE AND FLAVOUR OF DRY-CURED HAMS

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## Introduction

In dry-cured hams, a relative humidity (RH) lower than 75% produces a marked decrease in the equilibrium water content in salted fresh ham muscles (Comaposada *et al.*, 2000) and encourages oil drip on salted subcutaneous fat (Arnau and Gou, 2001). Arnau *et al.* (2003) observed that hams stored at  $52\pm 3$  % RH during resting have a white appearance on some parts of the rind and have a larger surface area with oil drip. Hams stored at  $78\pm 3$  % RH show no white rind at the end of resting, and at the end of the process the surface covered with oil drip is slightly smaller than the surface of those hams stored at 52%. Storage of hams at  $85\pm 3$  % RH increases surface pH, phosphate crystals, NPN/N<sub>T</sub> at the end of the resting period and it also increases superficial pH, decreases  $a_{ws}$  and the surface covered with oil drip at the end of the process. Moreover, the application of liquid subcutaneous pork fat on ham surface increases the aged flavour (Sanchez-Molinero and Arnau, 2005).

The aim of this study was to evaluate the effect of three different percentages of relative humidity during resting on the appearance, texture and flavour of dry-cured ham at the end of the process.

## Materials and Methods

### Raw material selection and processing

Two batches of 18 carcasses were selected at a commercial slaughterhouse. The pH in *Semimembranosus* muscle (SM) at 24 hours was lower than 6.2. The ham rind was partially removed to obtain the typical 'V' cut found on some Spanish Serrano hams. One ham per carcass was manually rubbed with 30 g NaCl, 0.5 g of sodium nitrite, 0.5 of potassium nitrate and 0.5 sodium ascorbate per kg of ham. After 7 days the hams were salted again with 30 g of NaCl per kg of green ham. Hams remained 18 days at 1-3 °C and 80-90 % RH. Afterwards, they were rinsed in cold water and randomly introduced into three resting chambers (70-75 %, 75-80 % and 80-85 % RH) at 2-4 °C until day 104. Then hams were hung together in a drying room for 12 months. The RH ranged from 60 to 70% and the temperature from 12 to 30 °C.

### Sensory analysis

The external appearance of the hams was evaluated in one session by six experts in sensory analysis of dry-cured ham. The proportion of area covered with mould (mouldiness) and oil (oiliness) was evaluated on the external part of ham; colour, marbling, brightness, red rings, white film and phosphate crystals on the cut surface and sweetness, saltiness, piquantness, bitterness, metallic, aged flavour, adhesivity, hardness, crumbliness, pastiness and stringiness on 2 mm thick slices in SM and *Biceps femoris* (BF) muscles by using a 10 points scoring scale where 0=absence and 10=maximum intensity. The assessors were selected and trained following ASTM standards (1981). The panelists had a minimum experience of 10 years in descriptive analysis of a wide range of foods.

### Statistical analysis

The data were analysed by ANOVA using the GLM procedure of SAS (2001). The differences between the three different RH treatments were tested by Tukey test. A Chi Square test was applied to compare the distribution of the frequencies of aged flavour according to the intervals established.

## Results and Discussion

No significant differences ( $P>0.05$ ) were found in weight losses between treatments, which ranged from 37.3% to 38.9%. Table 1 shows the mean values for those attributes where significant differences ( $P<0.05$ ) were observed. White film was higher in 70-75% RH treatment. The lean and subcutaneous fat surface covered with oil drip at the end of the process was lower when the RH during resting period was above 80%. This could be due to the higher pH (Arnau *et al.*, 2003) or to the higher microbial growth during the resting period at higher RH. The surface covered with mould increased significantly according to the RH on the lean surface, but on the fat surface there was a significant increase in fat mouldiness but only when the RH was above 80%. Hams with slight and moderate aged flavour scores were significantly higher in the 70-75% treatment and lower in 80-85% treatment in BF muscle, but the differences were not significant in SM muscle (Table 2). This could be due to the higher oil drip, which coincides with the higher aged flavour obtained when liquid subcutaneous pork fat is applied to the lean surface during ageing (Sanchez-Molinero and Arnau, 2005). The oil drip is oxydated more easily, and this could increase some aged flavour nuances, which are appreciated by some consumers of dry-cured ham. Piquantness was significantly higher in 80-85% RH than in 75-80%

RH. Bitterness was significantly higher at 80-85% with respect to the other two treatments and sweetness tended to decrease as the RH increased ( $p > 0.05$ ).

**Table 1:** Mean values for each batch regarding the significant attributes.

Attribute	p	Relative Humidity			RMSE
		70-75	75-80	80-85	
White film <sup>1</sup>	0.0361	6.7 <sup>a</sup>	4.8 <sup>b</sup>	4.6 <sup>b</sup>	1.9266
Fat Oiliness <sup>2</sup>	<0.0001	6.5 <sup>a</sup>	4.8 <sup>a</sup>	1.9 <sup>b</sup>	2.2917
Fat Mouldiness <sup>2</sup>	<0.0001	1.0 <sup>b</sup>	1.5 <sup>b</sup>	5.4 <sup>a</sup>	2.9704
Lean Oiliness <sup>2</sup>	<0.0001	4.8 <sup>a</sup>	2.9 <sup>b</sup>	1.0 <sup>c</sup>	1.5107
Lean Mouldiness <sup>2</sup>	<0.0001	2.3 <sup>c</sup>	4.6 <sup>b</sup>	7.7 <sup>a</sup>	1.8668
Piquantness <sup>3</sup>	0.0489	2.2 <sup>ab</sup>	2.0 <sup>b</sup>	2.7 <sup>a</sup>	0.6183
Bitterness <sup>3</sup>	0.0031	1.8 <sup>b</sup>	1.7 <sup>b</sup>	2.8 <sup>a</sup>	0.7547

<sup>1</sup>: White film on cut surface; <sup>2</sup>: on ham; <sup>3</sup>: on BF muscle; a,b,c: in a row mean values with different superscripts were significantly different ( $p < 0.05$ ); RMSE: Root mean standard error.

**Table 2:** Frequency of each category of aged intensity attribute evaluated on BF and SM muscles.

Aged flavour intensity <sup>1</sup>	<i>Biceps femoris</i>			<i>Semimembranosus</i>		
	70-75	75-80	80-85	70-75	75-80	80-85
Low	3	7	11	6	7	9
Slight	2	1	1	1	1	1
Moderate	7	4	0	5	4	2

Aged flavour intensity<sup>1</sup>: Low <0.5; Slight = [0.5, 1.5]; Moderate = (1.5, 4.0].

### Conclusions

A RH higher than 80% during the resting period decreases oil drip during the ageing process and also the aged flavour and increases the bitterness of partially skinned dry-cured hams at the end of the process.

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