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EFFECT OF SALT REDUCTION ON THE LENGTH OF THE RESTING STAGE OF ITALIAN TYPICAL DRY-CURED HAM

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ABSTRACT

A pilot batch of dry-cured hams salted with a reduced amount of salt and placed in cold resting rooms for 85, 115, 145, and 160 days, was compared with conventionally processed Parma dry-cured hams (n = 9), taken at the end of resting period (lasting 80–100 days). The protracted time spent in the resting stage of reduced-salt hams, produced an increase in NaCl content of muscle *Biceps femoris* and a reduction of moisture and water activity (a_w), achieving values similar to conventionally processed dry-cured hams. In the experimental condition adopted in this study for reduced-salt hams, the inner a_w value, regarded as a safety threshold in traditional Parma dry-cured hams ($a_w \leq 0.96$ at the end of resting), is attained after 140–150 days of resting stage and about 18–19% weight loss.

Key words: dry-cured ham / salt reduction / resting

1 INTRODUCTION

Italian dry-cured hams with protected designation of origin (PDO), i.e. Parma and San Daniele to mention the most known brands (nearly 12 millions/year), are manufactured with thighs of domestic heavy pigs (at least 9-months old at slaughter, carcasses weight between 110 and 155 kg, fresh hams weight between 12 and 14 kg). Typical dry-cured hams are processed in plants operating in accordance with mandatory regulations given by the Consortium (Parma Ham Consortium Regulation, 1992); no preservatives other than salt (NaCl) are allowed. Salt is the key ingredient of dry-cured ham because it decreases water activity, and contributes to the development of texture, and characteristic taste and flavour (Ruiz-Ramírez *et al.*, 2006; Desmond, 2006; Morales *et al.*, 2007). Salt reduction is an on-going process within dry-cured ham industry, to reduce the contribution to health diseases related to dietary sodium intake (Sofos and Raharjo, 1994; Rohrmann *et al.*, 2013). In dry-cured hams, salt uptake can be managed by means of the selection of raw matter, by varying the length of the salting phase or by reducing the salt amount added to fresh ham. The processing step following salting is resting, a cold phase enabling the salt still located near the ham surface to penetrate the deeper zones, thus decreasing the water activity and ensuring ham preservation in the following steps (drying-maturing) at room temperature.

In the case of hams with reduced salt, several issues should be addressed like ham safety, proteolysis control, and sensory quality. The aim of this study was to determine the resting time needed to achieve, in the reduced-salt dry-cured hams, salt contents and water activity values similar to those found in the conventionally-processed dry-cured hams.

2 MATERIALS AND METHODS

2.1 SALTING AND RESTING OF REDUCED-SALT HAMS

Thirty-seven fresh hams were selected in a local slaughterhouse within a narrow range of weight (from

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12.9 to 13.9 kg) and pH_{24h} (from 5.50 to 5.90) in *Semimembranosus* muscle (Hamilton glass electrode probe and WTW pH330 portable pH meter). For each ham, subcutaneous fat thickness under *Caput femoris* bone was manually measured. The hams were trimmed to achieve a standard exposed lean surface and then scanned using the Fat-Analyzer™ system (Lenz Instruments, S.L., Barcelona, Spain) to predict the lean content (Simoncini *et al*. 2012). Four homogeneous sub-groups were formed with selected hams (no difference for weight, pH_{24h}, fat thickness, and predicted lean content among ham groups), which underwent different resting times. Hams were salted by manual salt addition (wet and dry salt). Used salt approximated the lowest limit of salt range generally added to Parma hams during salting (Parolari, 1996). After 7 days in a cold room at 1–4 °C, and 80–90% RH, the unabsorbed salt was removed, the hams were salted again. Salting (1–4 °C, 75–85% RH) was completed when there was no visible salt on the lean exposed surface (6–7 d). Subsequently, hams were brushed to remove unabsorbed salt, placed in a pre-resting room at 2–4 °C and 60–65% RH for two weeks, and then moved to a resting cellar at 1–4 °C and 70–75% RH until 85, 115, 145, and 160 days.

All hams were weighed at the end of salting and resting stages. Weight losses were calculated as the difference between the trimmed ham weight and the weight of ham at the end of salting and resting, expressed as per cent of trimmed ham weight.

2.2 RESTING OF STANDARD-SALT HAMS (CONTROL)

Nine hams were purchased, at the end of resting, from plants producing Parma dry-cured hams (1–2 ham/plant). These hams were regarded as controls, and used as references of the standard industrial resting treatment (time period generally lasting 80–100 days).

2.3 SAMPLING AND ANALYTICAL DETERMINATIONS

The processed and the control hams were cross-sectioned above the hipbone producing the proximal quarter (hip cut) for muscle *Biceps femoris* (BF) sampling. Next the hams were dissected to divide the lean part (including lean, inter and intramuscular fat), from the subcutaneous fat, rind and bone. The BF and the lean part were minced and submitted to the following:

– Moisture, according to AOAC 960.39 official method (2002).
– NaCl, by chloride potentiometric titration of the aqueous extract with Titrando 809 Metrohm Ltd (Herisau, Switzerland).
– Water activity (a_w), by LabMaster (Novasina), according to International Standard ISO/FDIS 21807 (2004).

2.4 STATISTICS

Data were analyzed using the One-Way Anova procedure of SPSS package ver.13.5 (SPSS inc., Chicago, USA). When the effect was significant (P-value < 0.05) the mean values were compared using Fisher's least significant difference (LSD).

3 RESULTS AND DISCUSSION

Salting and resting weight losses of reduced-salt hams are reported in Table 1. The 1st salting weight loss was consistent with values currently reported for Parma ham (Schivazappa and Virgili, 2011); on the contrary, the low value of 2nd salting weight loss was due to the decrease in the overall salting time established in this study. The resting weight losses increased over time, even if progressively lower daily values were observed for the hams with protracted resting times.

The increase in cold resting time is aimed at achieving, in reduced-salt hams, a dehydration degree and a salt diffusion comparable to traditional hams, generally recognized as ''safe". The latter, at the end of resting, have a higher salt concentration in the outer muscles than in the central ones, while moisture content of the inner muscles exceeds that of the outer ones (Schivazappa *et al*., 2010; Arnau *et al*. 1995). As a rule, salt diffusion takes longer in BF than in other muscles: accordingly, BF has been analysed to compare the reduced-salt hams with the traditional ones (control).

At conventional resting time (80–100 days), BF moisture was higher in the reduced-salt hams than in

Table 1: *Descriptive statistics of salting and resting weight losses of reduced-salt hams*

Stage		Days	No. of hams	Weight loss, %
Salting	1st	7	37	1.5 (0.51)
	2nd	7	37	0.8 (0.21)
Resting		85	6	14.5 (1.15)
		115	9	15.7 (1.24)
		145	11	19.1 (1.57)
		160	11	18.9 (1.21)

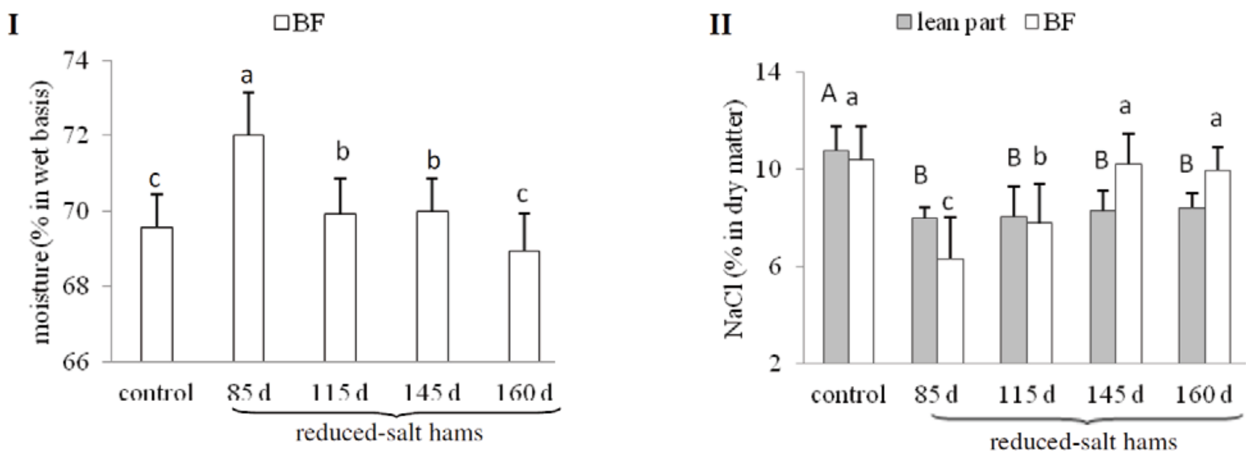

Figure 1: *Mean values and standard deviations of BF moisture (I) and NaCl content in lean part and BF (II) of controls (traditional hams resting 80–100 days) and of reduced-salt hams at established resting days. For the same variable bars with different letters are significantly different (P < 0.05)*

the controls (Fig. 1/I); next, the moisture content progressively decreased and reached the same content as the controls at 160 days of resting. In order to compare hams with different dehydration degree, NaCl content (%), of both total lean part and BF was expressed on a dry matter basis. The mean NaCl found in the total lean part of controls was consistent with values reported by Schivazappa *et al.* (2010) for Parma ham, whereas, the NaCl content of the lean part of the reduced-salt hams was lower ($P < 0.05$): in the latter, the NaCl content of BF has been equal to controls at 145 days of resting. A change in the $NaCl_{lean\ part}/NaCl_{BF}$ ratio of controls and reduced-salt hams (Fig. 1/II) was observed during resting, as a likely consequence of the time-related differences in salt diffusion process, occurring from external to inner muscle during the resting stage.

As a rule, for any change to dry-cured ham early processing, a_w of inner muscle must be evaluated to ensure product safety. During resting, salt diffusion from external muscles and dehydration, caused the increase of NaCl concentration in the BF liquid-phase (Z^{NaCl}) and a_w decrease (a_w *vs.* Z^{NaCl}, $r = -0.933$, $P = 0.000$) (Fig. 2). For reduced-salt hams both Z^{NaCl} and a_w at 145 and 160 days of resting achieved values comparable to controls (4.3% and 0.963 respectively), matching the target 0.96 a_w, regarded as threshold value for product safety (Leistner, 1988).

4 CONCLUSIONS

Some processing changes in salting and resting phases have been made, to fulfill both safety requirements and 25% salt reduction in fully ripened dry-cured hams

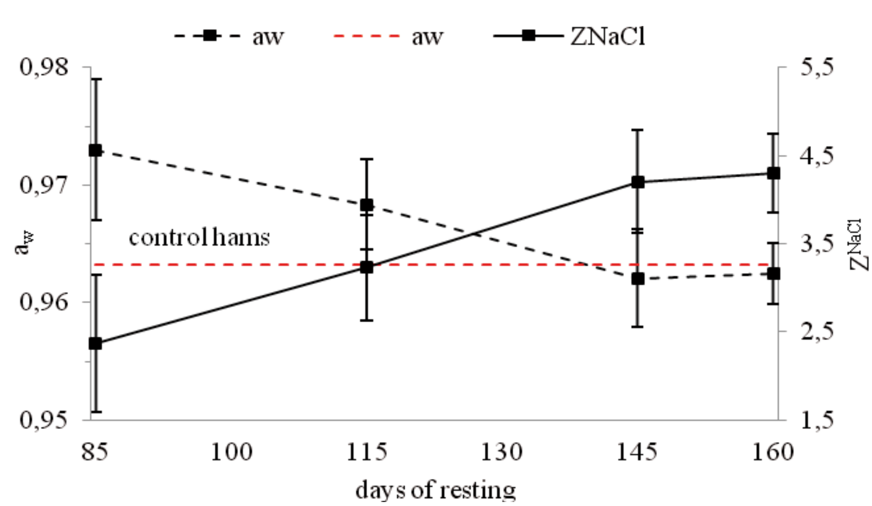

Figure 2: *Mean values ± standard deviations of Z^{NaCl} and a_w of BF at 85, 115, 145, and 160 days of resting and a_w value of control hams*

(comparison made with the current average production of typical dry-cured hams). The extension of resting time until 140–150 days (nearly 2 months longer than traditional manufacturing of typical Italian dry-cured ham) allowed, in BF muscle, the achievement of 0.96 a_w, NaCl and moisture contents similar to those found in conventional traditional dry-cured hams. At the end of resting, a significant decrease in overall salt content has been found when comparing reduced-salt and conventional dry-cured hams. Further research is in progress to evaluate the effect of different resting times on the properties of reduced-salt dry-cured hams.

5 ACKNOWLEDGEMENTS

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