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Pre-rigor processing of cooked ham without added phosphates reduces technological quality problems (#335)

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Introduction

Technological quality problems in cooked hams (cooking loss, texture and colour) related to PSE and PSE-like destructured zones, have important economic and product quality impacts for meat processors [1, 2]. Pre-rigor NaCl brine injection can improve meat quality by decreasing high pre-rigor temperature [3] and by inhibiting post-mortem glycolysis and actomyosin formation [4, 5]. The purpose of the present study was to evaluate the effect of pre-rigor processing in the technological and sensory quality of cooked hams elaborated without added phosphates.

Methods

Three male (experiment 1, Exp.1) and three female (experiment 2, Exp.2) Pietrain×(Landrace×Large White) crossbred pigs were stunned (90% CO_2) and slaughtered individually at IRTA Monells slaughterhouse. The right hams (**pre-rigor**) were hot-boned and trimmed at 30 min post-mortem (p.m.), weighed, mechanically tenderized (roller-prongs) and injected within 45 min p.m. with a spray meat injector, and tenderized again. Subsequently, each ham was individually tumbled (Exp.1: 60 min, 14 rpm, Exp.2: 20 min, 14 rpm), followed by tumbling of the grouped hams. Muscles of the same ham were labelled using colour strings. All hams were injected to 120% of their initial weight with a brine without phosphates, containing 87.6% water, 10.8% NaCl, 1.2% dextrose, 0.3% sodium ascorbate and 0.09% sodium nitrite. The temperature of the brine injected in pre-rigor hams was +13ºC. The left hams (**post-rigor**) were removed from the refrigerated carcass at 24 h p.m. and were processed following the same procedure as in pre-rigor hams, but with the brine injected at -3ºC.

In Exp.1, hams were tumbled 1470 cycles with a total maturation time (after injection) of 6 days (pre-rigor) and 5 days (post-rigor). After, 6.3 kg hams were vacuum-packed in cook-in shrink bags and cooked in stainless steel moulds at 68ºC until reaching 66ºC core temperature. In Exp.2, hams were tumbled 2800 cycles with a total maturation time of 3 days (pre-rigor) and 2 days (post-rigor), and 6.8 kg hams were cooked at 70ºC (68ºC core). After cooking, all hams were cooled with a water shower (15ºC, 20 min) and stored refrigerated (2ºC).

The pH of left hams was measured at 45 min p.m. in *Semimembranosus* (SM) (pH_{45SM}) and at 24 h p.m. (pH_{24SM}). Cooking yield was expressed as percentage of initial weight after cooking. Cooked-ham pH (penetration electrode) was measured in a central cut of the ham. A Quantitative Descriptive Analysis was performed in 6 sessions in 2-mm thick slices assessing the following attributes: odour intensity, presence of holes, destructured zones, redness, colour homogeneity, slice consistency, flavour intensity, sweetness, saltiness, astringency, hardness, elasticity, cohesiveness, juiciness, pastiness and fibrousness. The two hams of one animal were assessed in each session. An analysis of variance was performed with the SAS 9.4 GLM procedure. The model included animal and treatment as fixed effects. Average scores for each sensory attribute were used.

Results

Average carcass weights (Mean ±SD) were 92.9 ±2.5 kg (Exp.1) and 90.1 ±6.4 kg (Exp.2). Regarding meat quality characteristics, pH_{45SM} were 6.32 ±0.10 (Exp.1) and 6.72 ±0.03 (Exp.2), whereas pH_{24SM} were 5.58 ±0.04 (Exp.1) and 5.46 ±0.03 (Exp.2). Results (**Table 1**) show a significant effect of pre-rigor processing (30-45 min p.m.) in cooking loss in both experiments. Cooking loss differences between pre- and post-rigor hams were much higher in Exp.2, probably due to its lower pH_{24SM}, shorter maturation time and higher cooking temperature with respect to Exp.1. Pre-rigor cooked hams showed a significantly higher pH of the final product in both experiments, which could be explained by an earlier p.m. anaerobic glycolysis arrest due to the NaCl brine injection [3, 4, 5]. In general, regarding the sensory attributes of cooked hams, similar results were found in both experiments. Pre-rigor processing significantly improved the technological quality [3, 5] of cooked hams by reducing the presence of holes and destructured zones (**Fig. 1**). It also increased odour intensity (Exp.2), redness, colour homogeneity and slice consistency. Pre-rigor processed hams also showed significantly lower astringency and higher elasticity and cohesiveness scores than post-rigor hams.

Conclusion

Despite the important organisational changes required at the slaughter and carcass processing lines, pre-rigor ham processing could allow using pig breeds and lines with good productive traits (feed intake, growth efficiency, carcass yield and lean percentage), but with poor technological meat quality (if processed post-rigor), to produce high quality cooked ham without added phosphates.

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References

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Notes

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Table 1. Cooking loss, pH and sensory attributes in pre-rigor and post-rigor processed cooked hams elaborated without added phosphates.

	Experiment 1 Cooking T= 68ºC (core 66ºC)				Experiment 2 Cooking T= 70ºC (core 68ºC)			
	Pre-Rigor	Post-Rigor	*P-value*	RMSE	Pre-Rigor	Post-Rigor	*P-value*	RMSE
n	*3*	*3*			*3*	*3*		
Cooking loss (%)	8.18	14.82	*0.010*	0.83	9.10	22.79	*0.001*	0.48
pH cooked ham	6.30	5.93	*0.008*	0.04	6.34	5.90	*0.001*	0.01
Odour								
Odour intensity	4.7	5.2	*0.361*	0.59	6.2	7.0	*0.011*	0.10
Slice visual aspect								
Presence of holes	0.3	5.9	*0.011*	0.74	2.1	6.8	*0.019*	0.81
Destructured zones	0.3	6.1	*0.016*	0.92	1.0	5.7	*0.009*	0.56
Redness	6.1	3.5	*0.031*	0.57	5.9	3.8	*0.015*	0.32
Colour homogeneity	6.1	4.3	*0.005*	0.16	6.6	4.7	*0.055*	0.59
Slice consistency	8.3	3.2	*0.001*	0.24	6.8	3.8	*0.006*	0.28
Flavour								
Flavour intensity	4.8	5.4	*0.160*	0.35	6.3	6.6	*0.208*	0.22
Sweetness	2.1	1.8	*0.412*	0.40	2.0	2.0	*0.879*	0.31
Saltiness	2.7	3.2	*0.327*	0.44	3.9	3.3	*0.297*	0.51
Astringency	2.7	5.7	*0.035*	0.71	1.0	2.5	*0.009*	0.18
Texture								
Hardness	4.0	3.9	*0.728*	0.26	4.1	4.4	*0.597*	0.57
Elasticity	2.5	1.3	*0.021*	0.22	3.4	1.8	*0.019*	0.27
Cohesiveness	4.2	2.8	*0.006*	0.14	5.8	3.3	*0.048*	0.67
Juiciness	6.8	7.0	*0.184*	0.15	6.7	5.7	*0.195*	0.64
Pastiness	0.6	2.2	*0.011*	0.20	1.0	2.8	*0.146*	0.95
Fibrousness	3.7	6.3	*0.057*	0.82	2.5	3.5	*0.074*	0.35

Table 1

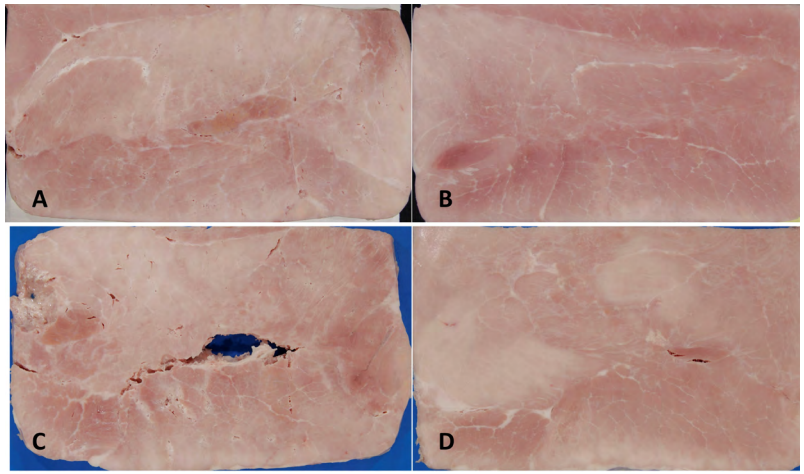

Fig. 1. Post-rigor and pre-rigor processed cooked hams without added phosphates. Experiment 1: (**A**) post-rigor and (**B**) pre-rigor cooked hams of the same animal. Experiment 2: (**C**) post-rigor and (**D**) pre-rigor cooked hams of the same animal.

Notes