EFFECT OF FROZEN STORAGE ON MORPHOLOGY AND FIRMNESS OF PORK BELLY

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I. INTRODUCTION

Pork belly is a valuable cut for the meat industry. Belly dimensions and firmness are important quality traits because they influence the processing aptitude especially when bellies are sliced. Freezing bellies before processing (e.g. slicing, curing) is a common procedure by some producers, but it can lead to textural and functional defects [1] and probably to morphological changes. Frozen storage modifies the physical properties of pork meat, with a significant influence on exudate, pH, colour, and tenderness [2]. Nevertheless, there is little data reporting the consequences of storage under frozen conditions on belly quality. Thus, the aim of this work was to evaluate morphological and mechanical (firmness) traits of pork bellies before and after a frozen storage of 4 months at -20 °C.

II. MATERIALS AND METHODS

Nine bellies were obtained from 9 commercial crossbred pigs that were slaughtered in two batches at the IRTA's abattoir using standard procedures. At 24 h post-mortem, bellies were cut from the right half carcass and deboned. The weight, length and width were recorded. The thickness of the bellies was also measured in the centre of dorsal, cranial, ventral, and caudal sections and the average thickness was calculated. After that, in the same 4 sections, the skin was stretched using tweezers until the base of the belly lifted and the height was measured. The difference between the initial height (thickness) and the final height was calculated and used as a measure of firmness in terms of subcutaneous fat and skin separation. Firmness was also determined by the flop distance and angle measured skin above and below using the bar-suspension method [3]. Next, bellies were individually wrapped in a plastic bag and frozen at -20 °C for four months in a commercial chamber in the darkness. After that time, bellies were thawed at 4 °C for 24 h and the same morphological and firmness traits were determined as previously described. Analysis of variance was performed with SAS Software (version 9.4) including the treatment (fresh vs. frozen) and batch as fixed effects.

III. RESULTS AND DISCUSSION

Table 1 presents the least squared means for the evaluated traits before and after frozen storage. Belly weight did not significantly change with frozen storage. In terms of morphology, the length was lower after storage while the width and the average thickness did not significantly change. For the fat and skin separation, only a tendency for a higher firmness (lower height increase) after frozen storage was found in the ventral region ($P<0.10$). The fat and skin separation of the other sections did not change with storage. For the flop test, a higher angle ($P<0.05$) and distance ($P<0.10$) was found after frozen storage when the measurements were done positioning the belly with the skin above, indicating an increase in belly firmness. In this line, Robles [4] reported a higher incidence of bacon slice shattering when comparing frozen bellies for 15 days with fresh bellies, which was more pronounced in the fatter regions of the slice and suggested a damage of adipose tissue with freezing. These results were linked to a decrease in bacon slicing yield with the frozen storage, while other processing characteristics (e.g., smokehouse yield) or total yield were not affected. The findings observed in our study could be explained by a contraction of the skin and the attached subcutaneous fat layer with the

freezing process, which may cause a shortening and hardening of the entire piece. The integrity of muscle and fat structures of the bellies have not been measured, but they do not seem to have been damaged since the observed changes in shape and firmness did not affect all measurements equally and were not concurrent with weight loss. The increase in firmness in frozen bellies might make them more suitable for bacon processing and for export requirements [5]. Nevertheless, the shortening of frozen bellies should be considered since it will reduce the slicing yield and, therefore, the economic gains.

Table 1. Morphological and firmness measurements of pork bellies in fresh and after frozen storage

	Fresh	Frozen	RMSE	P-value
Weight (g)	3380	3338	677.0	0.897
Length (cm)	37.4	33.9	2.66	0.013
Width (cm)	23.6	24.8	2.29	0.276
Average thickness (cm)	3.39	3.44	0.456	0.982
Height difference in dorsal region (cm)	0.49	0.43	0.224	0.606
Height difference in cranial region (cm)	1.60	1.39	0.484	0.370
Height difference in ventral region (cm)	1.53	1.11	0.431	0.055
Height difference in caudal region (cm)	1.73	1.10	1.075	0.231
Flop distance skin above (cm)	10.1	12.3	7.80	0.549
Flop angle skin above (º)	31.4	43.3	24.88	0.327
Flop distance skin below (cm)	10.7	17.2	7.09	0.072
Flop angle skin below (º)	33.5	62.3	25.11	0.028

IV. CONCLUSION

Under the conditions of this study, it can be concluded that frozen storage modified the length and firmness of pork bellies, but it did not cause significant weight losses. These findings are relevant for meat producers because the increase in firmness after a frozen storage can improve the processing aptitude of the bellies, but the resulting shortening can reduce the slicing yield and compromise the economic profits. Chemical and microbiological changes associated to frozen storage were not considered in this study and would allow a global assessment of belly quality.

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