EFFECT OF FREEZING AND ITS STORAGE LENGTH ON PHYSICOCHEMICAL CHARACTERISTICS OF MEAT FROM HEAVY PIGS

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I. INTRODUCTION

Freezing is an excellent way to preserve meat (pork, beef, poultry, lamb) and it is essential in ensuring the safety [1]. Storage time of meat depends on market demand, so it may vary from short to long periods, which could have some consequences on its end quality [2]. In heavy pigs (>130 kg), as those intended for dry-cured ham elaboration, it achieves higher relevance because it's special quality (higher intramuscular fat content and then higher juiciness and tenderness [3]), and much money is usually paid for it than in the case of lighter pigs (90-100 kg). The aim of this experiment was to determine the effect of freezing and its store length on some physicochemical properties of meat from pigs intended for Spanish dry-cured ham production. In the current trial, the loin was chosen as representative sample of pork due to its economic value.

II. MATERIALS AND METHODS

The experiment involved 12 crossbred barrows derived from Duroc sires and Landrace x Large White dams. The castration was done at five days old and the farm management was the same for all of them. The slaughter was carried out when they weighed 135 kg because of being intended for "Teruel ham", which is a Protected Designation of Origin of dry-cured ham in Spain. At the abattoir, the left loin from each pig was collected and cut in five chops (60 samples in total). Thus, one chop from each animal, also from the same location in the loin, was allocated to one of the following five experimental treatments (n=12): refrigerated at 4˚C for 1 day or frozen at -20˚C for 2, 5, 12 or 24 weeks. The thawing process of the frozen samples consisted in leaving the meat for 24 h at 4˚C. The freezing conditions were very precisely controlled through the trial. The chemical components (moisture, protein and intramuscular fat-IMF) were analysed by a near infrared transmittance meat analyser (Tecator, Sweden). The pH was measured by a portable pH-meter equipped with a glass electrode (Crison Instruments, Spain) and colour with a chromameter (Minolta Camera, Japan), which provided the CIELAB values. Thawing loss was calculated taking into account the fresh and thawed weight. Cooking loss determination was carried out using a water bath (Selecta SA, Spain) and hardness was measured, in cooked samples, with a Warner-Bratzler device attached to an Instron Universal testing machine attached to a PC. Fatty acid (FA) profile of IMF was determined by a gas chromatograph (Agilent Technologies, USA) equipped with a flame ionization detector, a Hamilton injector and a capillary column with He as the carrier gas. Data were analysed using the GLIMMIX procedure of SAS package by including the frozen storage length as main effect and the meat sample as random effect. Means were separated by Tukey test and the experimental unit was the animal.

III. RESULTS AND DISCUSSION

Although numerically moisture decreased and IMF increased as the freezing store length increased, the differences were not significant (p>0.10) (Table 1). Alonso *et al.* [2] found that IMF was higher in two years- than in one month-frozen pork. A tendency (p=0.06) in pH was found; it seems to be higher in fresh than in frozen meat and also to decrease with longer storages. There was no influence (p>0.10) of experimental treatment on *L** value but fresh meat showed higher *a** value than frozen pork for 12 or 24 weeks (p=0.0004) and fresh and 2 week frozen samples had higher (p<0.001) H^o values than those frozen for 12 or 24 weeks. Although some authors found similar results, there is controversy with others probably because of the different freezing length [2,4]. No effect (p>0.10) was observed on thawing losses but fresh meat presented less cooking losses than 5, 12 or 24 week frozen pork (p=0.0003). In addition, fresh meat was harder (p<0.0001) than frozen meat which agrees with Lagerstedt *et al.* [5]. Those authors found similar results in beef, using

instrumental determinations, but contrary by sensorial measures. It could be due to the different procedures in freezing time and thawing time/temperature and also to the fact that shear force evaluates partially different characteristics in comparison with organoleptic tenderness. In relation to the composition of IMF, total saturated FA proportion was higher (p<0.0001) and total polyunsaturated FA was lower (p=0.03) in fresh than in that frozen with no differences in total monounsaturated FA.

Table 1. The effect of freezing and the length of frozen storage on physicochemical characteristics of meat from heavy pigs.

	Fresh meat	2 weeks frozen	5 weeks frozen	12 weeks frozen	24 weeks frozen	SEM[1] (n=12)	Significance[2]
Chemical composition, %							
Moisture	72.9	72.6	72.6	72.4	72.2	0.31	ns
Protein	22.5	22.7	22.6	22.4	22.3	0.16	ns
Intramuscular fat	3.58	3.53	3.63	3.76	4.34	0.375	ns
pH	5.89	5.75	5.73	5.72	5.71	0.049	0.06
Colour variables							
Lightness (L^*)	47.7	48.8	48.6	47.2	48.3	1.23	ns
Redness (a^*)	2.71^{a}	2.06^{ab}	1.96^{ab}	1.68^{b}	1.43^{b}	0.309	0.0004
Yellowness (b^*)	5.12^{ab}	4.92^{b}	5.81^{ab}	6.08^{a}	5.64^{ab}	0.536	0.03
Chroma (C^*)	5.37^{b}	6.43^{a}	6.23^{a}	5.52^{b}	6.33^{a}	0.519	0.04
Hue angle (H^o)	74.3^{a}	73.1^{a}	70.2^{ab}	65.2^{b}	64.2^{b}	3.50	0.0006
Water-holding capacity							
Thawing losses, %	-	7.67	8.08	8.53	8.73	0.744	ns
Cooking losses, %	16.4^{b}	18.8^{ab}	20.2^{a}	20.3^{a}	20.5^{a}	1.12	0.0003
Warner Braztler shear force, kg	3.84^{a}	3.13^{b}	2.84^{b}	2.83^{b}	2.73^{b}	0.207	<0.0001
Fatty acid profile of IMF[3], %							
Total SFA	43.0^{a}	42.2^{b}	41.9^{b}	42.0^{b}	42.0^{b}	0.75	<0.0001
Total MUFA	48.8	49.1	49.1	49.0	49.0	0.65	ns
Total PUFA	8.21^{b}	8.69^{a}	8.97^{a}	8.99^{a}	8.99^{a}	0.398	0.03

[1]SEM: standard error of the mean.
[2]ns: not significant (p>0.10). Within a row, means with different superscript letter differ (p<0.05).
[3]IM: Intramuscular fat; SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; and PUFA: polyunsaturated fatty acids.

IV. CONCLUSION

Under our experimental conditions, we can conclude that the freezing had a significant impact on pork quality, because it reduced the water holding capacity, decreased the hardness and altered the colour and the fat composition, but the frozen storage length until six months scarcely affected.

ACKNOWLEDGEMENTS

The authors thank Jamones y Embutidos Alto Mijares S.L. (Formiche alto, Teruel, Spain) and Integraciones Porcinas S.L. (Alcorisa, Teruel, Spain) for allowancing the meat sampling. We are also grateful to the staff of the Estación Tecnológica de la Carne (Guijuelo, Salamanca, Spain) for the help in some analyses.

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