Effects of dry ageing in bag and thermal processing on the fatty acid profile of Serpentina chevon

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I. INTRODUCTION

Goat meat is recognised as a high quality product, for its leanness, low cholesterol and saturated fatty acid content [1], while rich in protein of high nutritional value, leading to strong market value. However, older animals produce less tender meat, often used as by-products, due to its devaluation and consequent sale at lower prices [2, 3]. In Portugal, the consumption of goat meat is a deeply rooted tradition, where *Serpentina*, a native goat breed has been granted IGP status ("Protected Geographical Indication") [4]. In-bag dry-ageing is a meat ageing technique commonly applied to beef, in which cuts of meat are packed in bags that are highly permeable to water vapour and then stored in refrigerated environments, at temperatures between 1 and 4 ºC for a limited period, in order to produce more tender, tasty and succulent meats [5, 6]. Therefore, the aim of this study was to evaluate the effects of dry ageing in bag and thermal processing, on the fatty acid composition of the *Longissimus dorsi* muscle of 5 female *Serpentina* goats, slaughtered between 8 and 12 years old.

II. MATERIALS AND METHODS

Five *Serpentina* females from the same farm were used in this study. The animals were slaughtered between 8 and 12 years of age, with an average final carcass weight of 28.4 ± 4.4 kg, in accordance with European Commission regulations. On the second day *post-mortem*, *longissimus thoracis et lumborum* muscle (LTL) was cut from both sides of the carcass and vacuum-packed. On the third day *post-mortem*, the left *longissimus dorsi* was packed in bags with an O_2 transmission rate of 24 $cm^3/(m^2$ 24 h) at 23 ºC and 0% RH; a CO_2 transmission rate of 78 $cm^3/(m^2$ 24 h) at 23 ºC and 0% RH; and a water vapour transmission rate of 44 $g/(m^2$ 24 h) at 38 ºC and 100% RH (LID540X, Cryovac). Afterwards, they were allowed to age for 46 days at 2±2 ºC with a relative humidity of 60-90%, in the dark, with unfiltered air and protected from UV light. From the right side of the LTL muscle, 200g were removed for analyses and the remainder was frozen at -80 ºC to serve as a reference of unaged meat. Both aged and unaged meat were cooked in a dry oven at 150 ºC until the internal temperature reached 68 ºC. The fatty acid composition was determined in all samples from the lipid extract of the freeze-dried meat, by direct transesterification with 0.5 M sodium methoxide in methanol, at 50 ºC for 30 minutes, followed by reaction with 1.25 M HCl in methanol, at 80 ºC for 15 minutes. The fatty acids were then extracted using hexane and the excess solvent was removed by a nitrogen stream at 37 ºC. The fatty acids were identified by comparing the gas chromatography retention times with commercial standards and published chromatographs [7]. The data was analysed in SAS following a 2x2 factorial design with PROC MIXED procedure, with ageing and cooking as fixed effects, and their interaction. Significant interactions were indicated when $P \leq 0.05$.

III. RESULTS AND DISCUSSION

The fatty acid composition of the meat is shown in Table 1. A significant interaction between ageing and thermal processing on the total fatty acid content (TFA) was observed. It should be noted that although the total fatty acid content showed a significant increase in aged meat

(126 mg/g) when compared to non aged meat (63 mg/g), probably due to the effect of ageing process, after heat treatment, no significant differences were observed between aged and unged cooked samples. Saturated fatty acids (SFA) proved to be the most abundant category, followed by monounsaturated acids (MUFA), and lastly, polyunsaturated fatty acids (PUFA), with no significant interaction effect (ageing x cooking). Myristic (14:0) and arachidonic (20:4n-6) fatty acids showed a significant interaction between ageing and thermal processing. Palmitic acid (16:0) stood out as the most predominant SFA, while oleic acid (18:1c9) was the most abundant MUFA, and linoleic acid (18:2n-6) was the most abundant PUFA. Oleic acid (18:1c9), with contents between 38.23 and 39.74 g/100g of total fatty acids, was the major MUFA, contributing with about 86% of the total MUFA. There was no significant interaction between ageing x thermal processing and no main effect of thermal processing for 16:0 (P > 0.105). Ageing resulted in an increase in 16:0 (P = 0.006) and a decrease in 18:2n-6, 18:3n-3 and 20:5n-3 (P < 0.05) as shown in Table 1. These results are in line with the changes observed in SFA and PUFA.

Table 1: Total fatty acid content (mg/g DM) and fatty acid profile (g/100g total acids) of unaged and dry-aged meat samples (raw and cooked).

Traits	Control		Dry-Aged		SEM	Effects		
	Raw	Cooked	Raw	Cooked		Dry-Aged	Cooked	Dry-aged*Cooked
TFA	63^{b}	100^{ab}	126^{a}	81^{ab}	11.6	0.084	0.781	<0.001
12:0	0.07	0.09	0.08	0.07	0.006	0.975	0.332	0.053
14:0	1.90^{b}	2.25^{a}	2.17^{ab}	2.17^{ab}	0.071	0.197	0.029	0.031
16:0	24.15	23.01	24.64	24.57	0.304	0.006	0.073	0.105
16:1*c*9	1.65	2.45	1.72	2.14	0.217	0.589	0.016	0.409
18:0	18.94	18.27	21.91	19.13	0.937	0.063	0.091	0.279
18:1*c*9	38.86	39.74	38.23	39.69	1.384	0.809	0.416	0.839
18:2n-6	3.45	2.99	2.28	2.42	0.235	0.003	0.504	0.224
20:0	0.07	0.09	0.10	0.08	0.010	0.377	0.864	0.132
18:3n-3	1.11	0.96	0.82	0.86	0.084	0.037	0.573	0.295
20:4n-6	1.85^{a}	1.28^{ab}	0.79^{b}	1.16^{ab}	0.207	0.015	0.648	0.041
20:5n-3	0.71	0.46	0.29	0.45	0.097	0.048	0.658	0.057
22:5n-3	0.90	0.74	0.48	0.63	0.138	0.082	0.989	0.282
∑SFA	47.28	46.55	51.34	48.37	1.152	0.025	0.134	0.351
∑*cis*-MUFA	42.47	44.84	41.84	43.93	1.510	0.620	0.166	0.929
∑*trans*-MUFA	1.24	1.31	1.50	1.36	0.128	0.242	0.796	0.435
∑PUFA	9.01	7.31	5.32	6.34	0.84	0.017	0.689	0.132

Means followed by different superscripts within a column differ significantly at $P \leq 0.05$; SEM: standard error of the mean.

The increase in SFA and decrease in PUFA with ageing is likely due to lipid peroxidation during the long ageing period. Lean meat is particularly rich in phospholipids, which contain membrane long-chain PUFA, motably 20:4n-6. On the other hand, meat with a high intermuscular and subcutaneous fat content are comprised mostly of triacylglycerols rich in SFA and MUFA and a lower content of long-chain PUFA [7].

IV. CONCLUSION

Serpentina chevon aged for 46 days and thermally processed presented a fatty acid profile predominantly composed of 18:1c9, 16:0, 18:0, 18:2n-6 and 20:4n-6. Ageing and thermal processing showed significant impacts on 14:0 and 20:4n-6 fatty acids, highlighting the influence of these processes on the lipid composition of meat.

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