INFLUENCE OF BREED, GENDER AND SLAUGHTER WEIGHT ON HISTOCHEMICAL TRAITS AND LONGISSIMUS QUALITY OF LAMB

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Introduction

Any increase in slaughter weight of lamb that could translate in improved carcass yield without affecting its fat cover represents a definitive economic advantage to producers, processors and consumers alike. Such gain however must not be realized at the expense of the quality of the meat as observed in other species. In lamb, a large genetic variability prevails and, relative to other species, there is a paucity of information with respect to muscle structure and meat quality. As muscle size increase, assessment of its chemical and histochemical composition may help in understanding and documenting the effects of production factors on meat quality which is the purpose of this study.

Materials and Methods

A total of 108 lambs (27 males and 27 females of each of the Suffolk (Su) and Dorset (DP) breeds) were allocated to one of three targeted slaughter weight (SW) intervals: 41-44kg, 46-49kg, 51-54kg in a 2x2x3 factorial design. These breeds were selected for their opposite pattern in fat deposition. Lambs were selected at weaning (approx. 55 d old) and were then raised under controlled conditions with an 18% protein concentrate fed *ad libitum* up to 35 kg BW. They were then fed a 15 % protein concentrate up to slaughter. High-quality hay and water were also provided *ad libitum*. There were 8 lambs of the same gender per pen, with 4 of each Su and DP. As they reached their SW, lambs were electrically stunned and slaughtered in a commercial abattoir after a 12 h feed withdrawal. Within 1h post mortem, a 5 g *Longissimus* (L) sample was taken and frozen in liquid nitrogen-cooled isopentane for further histochemical analyses. Carcasses were chilled for 24 h at 1°C and were graded according to Canadian regulations. Backfat (BF) thickness and loin eye area (LEA) were then measured between the 12^{th}-13^{th} ribs. The right L muscle (rack) was removed and frozen for ulterior quality analyses. After thawing at 4°C, a 3.5 cm thick chop was used for ultimate pH and colour (L*a*b*) measurements of the bloomed surface. This chop was then freeze dried for the determination of water, fat (3-AOAC 991.36) and protein (3-AOAC 992.15) content. Another 2.5 cm chop was used for drip loss measurement after a 48 h period at 4°C. Shear forces were measured across 6-9 (5 x 1 x 1 cm) cores prepared along the fibre axis of the remaining portion of the L muscle cooked to an internal 68°C with thermocouples. Cooking losses were also measured. Cryostat prepared transverse serial sections were stained for myosin ATPase following an alkaline pre incubation (pH 10.4) (1) for the determination of fibre twitch. Their oxidative capacity was assessed with SDH stain (2). Five serial bundles were analyzed per muscle with an image analysis system. Fibre cross sectional area was also measured. Fibres were classified as slow twitch oxidative (SO), fast twitch oxidative glycolytic (FOG) or fast twitch glycolytic (FG).

Results and Discussion

BF was thicker in DP than in Su. BF thickness was also superior in females than in males and an increase with slaughter weight was measured. LEA however increased with SW only (Table 1).

Only fibre distribution (% and relative area) are reported in table 2 as fibre size did not change. FOG fibres however were overall smaller (1796 μm^2) compared to SO (2352 μm^2) and FG (2273 μm^2). Contradictory results are found with respect to lamb fibre size (6, 8). Except for the RA of fibres from males Su, we report a proportion of FOG larger than that of FG compared to others (4, 5, 6, 7). These results could suggest uncompleted transformation of some FOG fibres into FG as growth occurs. However, no significant change in LEA was observed between lambs of the last two SW groups. In addition, comparison between breeds did show an increase in proportion of FG at the expanse of FOG population. In DP, FOG decreased and FG increased with SW. Much smaller variations were observed in Su. These breed x SW interactions for % FG and FOG were not significant in terms of relative area. With respect to gender, a similar pattern was observed. Su males which had the fastest growth rate (results not shown) had smaller % and RA of FOG and larger proportion and RA of FG than females while no gender effect were observed in FOG and FG distribution in DP. The smaller proportion of SO fibres was higher in male than in female.

Consequent with backfat thickness, females had greater intramuscular fat (IMF) and lower moisture content than males while DP had greater IMF and lower moisture than Su. Treatments had no effect on protein content and on both drip and cooking losses (results not shown). Observed colour differences were not of practical magnitude. Meat from male had greater shear force however there was no effect of breed. Unexpectedly, shear force decreased with SW which might be associated with possible cold shortening attenuation in larger and more insulated carcasses.

Table 1: Effects of breed, gender and slaughter weight on backfat thickness and loin eye area.

Parameters	Female						Male							Effect[2]			
	Dorset			Suffolk			Dorset			Suffolk							
	41-44[1] (n=10)	46-49 (n=9)	51-54 (n=9)	41-44 (n=9)	46-49 (n=9)	51-54 (n=9)	41-44 (n=8)	46-49 (n=9)	51-54 (n=8)	41-44 (n=7)	46-49 (n=9)	51-54 (n=8)	SEM	G	B	SW	X
Backfat (mm)	7.0	8.6	10.7	6.2	6.5	7.9	5.3	5.9	6.5	3.8	4.0	4.2	0.8	***	***	***	NS
LEA (mm^2)	1542.7	1612.8	1702.4	1584.5	1720.2	1639.9	1452.4	1665.4	1763.7	1534.1	1653.0	1693.7	68.1	NS	NS	***	NS

[1] Slaughter weight (kg); [2] G: Gender; B: Breed; SW: Slaughter weight; X: Interactions; [3] Backfat thickness and loin eye area (LEA) measured between the 12^{th} -13^{th} ribs; * P < 0.05; ** P < 0.01; *** P < 0.001

Table 2: Effects of breed, gender and slaughter weight on Longissimus histochemical traits.

Parameters[3]	Female						Male							Effect[2]			
	Dorset			Suffolk			Dorset			Suffolk							
	41-44[1] (n=8)	46-49 (n=6)	51-54 (n=7)	41-44 (n=3)	46-49 (n=5)	51-54 (n=8)	41-44 (n=4)	46-49 (n=8)	51-54 (n=8)	41-44 (n=1)	46-49 (n=4)	51-54 (n=6)	SEM	G	B	SW	X
SO (%)[3]	6.9	6.5	5.7	6.6	7.8	7.8	7.9	7.7	7.6	9.3	8.7	8.0	2.1	*	0.1	NS	NS
FOG (%)[3]	65.5	61.6	58.7	62.4	62.1	62.8	64.4	63.3	58.4	51.2	51.9	54.7	4.4	***	***	NS	BxSW BxG
FG (%)[3]	27.6	31.9	35.5	31.0	30.1	29.4	27.8	29.0	34.0	39.5	39.4	37.3	4.1	**	**	NS	BxSW BxG
RA SO (%)[4]	7.7	8.3	6.5	6.8	8.7	9.7	8.2	8.9	9.2	10.8	10.1	9.3	2.60	06	NS	NS	NS
RA FOG (%)	60.2	54.4	56.7	56.6	54.5	56.0	60.5	59.3	52.6	45.9	43.9	47.8	5.5	**	***	NS	BxG
RA FG (%)	32.1	37.4	36.7	36.6	36.8	34.2	31.2	31.8	38.2	43.3	46.0	42.9	5.5	*	**	NS	BxG

[1] Slaughter weight (kg); [2] G: Gender; B: Breed; SW: Slaughter weight; X: Interactions; [3] Muscle fibre type: SO (slow oxidative), FOG (fast oxidative glycolytic) FG (fast glycolytic); [4] RA: relative area; * P < 0.05; ** P < 0.01; *** P < 0.001

Table 3: Effects of breed, gender and slaughter weight on meat quality parameters.

Parameters[3]	Female						Male							Effect[2]			
	Dorset			Suffolk			Dorset			Suffolk							
	41-44[1] (n=10)	46-49 (n=9)	51-54 (n=8)	41-44 (n=9)	46-49 (n=8)	51-54 (n=9)	41-44 (n=7)	46-49 (n=8)	51-54 (n=8)	41-44 (n=5)	46-49 (n=6)	51-54 (n=8)	SEM	G	B	SW	X
pH	5.51	5.48	5.48	5.52	5.61	5.57	5.59	5.58	5.52	5.48	5.56	5.54	0.06	NS	NS	NS	BxG
Shear force (kg)	2.7	3.9	3.2	4.1	3.2	3.0	4.2	3.6	3.4	4.6	4.0	3.6	0.4	*	NS	*	NS
*a**	18.9	19.4	20.1	19.1	18.7	18.4	18.0	20.1	18.6	18.7	16.7	17.0	0.8	0.07	**	NS	BxSW
*b**	10.5	9.5	9.7	9.9	9.0	8.9	8.2	11.1	9.7	9.6	8.0	7.8	0.8	NS	NS	NS	BxGxSW
*L**	40.2	37.4	39.4	40.8	39.1	38.4	38.2	42.4	38.9	41.9	40.3	39.4	1.3	NS	NS	NS	NS

[1] Slaughter weight (kg); [2] G: Gender; B: Breed; SW: Slaughter weight; X: Interactions; * P < 0.05; ** P < 0.01; *** P < 0.001.

Conclusions

Large contribution of small FOG fibres in the L could suggest further growth potential and perhaps increasing risk for cold shortening. Overall, increasing slaughter weight had no negative effect on meat quality. However, high lean yield genotype such as Su should be preferred in order to maintain carcass yield. Histochemical profile from other muscles should complete such study.

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