

The effect of gender on meat quality of lamb longissimus dorsi

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Background

The gender of lambs is known to have an effect on their growth rates. Entire males grow faster and leaner than their castrated counterparts and from a production viewpoint entire males have similar body weight gains to females. These facts have resulted in a trend in New Zealand of male lambs being left entire and raised in the same environment as female lambs. To date however, there has been little research on the comparison of entire male and female lambs raised in the same environment and the quality of their meat. This is particularly important as markets move to procuring meat to quality specifications based on tenderness and pH standards.

Objective

The objective of this research is to investigate whether the gender of an animal is a factor influencing meat quality specifications and what potential financial implications this might have for producers and processors. Quality parameters measured were ultimate pH and shear force at 2, 7 and 42 days post-mortem. Calpastatin was measured in a subset of the muscle samples. We also investigated whether there was an interaction between the gender of the animals, the stress they experienced and the application of high voltage electrical stimulation (HVES) during processing. Stress and HVES are known to affect meat quality characteristics.

Methods

Animals

Experiment 1

A mob of 100 Dorset Down x Coopworth lambs were transported to the processing plant via truck and held overnight before slaughter. A group of 50 lambs were given two swim washes on arrival and a third swim wash in the morning before slaughter and were driven to the ramp of the stick pen with dogs, this was the high stress group. The remaining 50 lambs were given one swim wash on arrival and were driven to the ramp of the stick pen without the use of dogs, this was the low stress group. Half of the carcasses from the high stress and the low stress groups were immobilised using low voltage ES (LVES) and subjected to HVES within 30 min postmortem. The other half of the carcasses received only LVES. Carcasses were chilled and the pH and temperature in the loin was recorded at 1, 2, 7 and 42 days. At 2 days postmortem the loins of 10 carcasses from the 25 in each of the four treatment groups were excised. Tenderness and related attributes were determined at 2 days, 7 days and 6 weeks postmortem. The remaining 15 carcasses from each treatment group had two mid loin chops removed and tenderness and related attributes were determined at 2 days and 6 weeks postmortem.

Experiment 2

A second mob of 100 Dorset Down x Coopworth lambs was divided in 3 groups prior to transport to the processing plant. One group was mixed sex [ewes (n=21) and rams (n=19)], the second group consisted of 22 rams and the third group contained 38 ewes. The ram only group was penned out of sight from other mobs containing ewes during the overnight holding period at the processing plant. All lambs were swim washed once and dogs were not used to drive the lambs up the processing ramp. LVES and HVES were applied to all the carcasses.

Experiment 3

A third mob of 98 Dorset Down x Coopworth lambs was divided by gender into a male mob (n=31) and a female mob (n=67) and treated as in experiment 2 with the exception that both mobs were penned close to other mobs being held in the yards.

Meat Quality Measurements and Analysis

Shear force (kgF) was determined using the MIRINZ tenderometer. Midloin chops for shear force determinations were stored at -30°C and thawed overnight at 2°C before cooking. The extent of muscle contraction was determined by measuring the sarcomere length (µm), using phase contrast microscopy on washed muscle fibres at 1000x magnification. The activity of calpastatin, the inhibitor of the calpains, was determined at 2 days postmortem with samples prepared according to Shackelford et al. (1994) and activity determined according to Koochmaraie (1990). The myofibrillar fragmentation index (MFI) was determined on washed myofibrils at 2 days and 6 weeks postmortem (Olson et al., 1976). The extent of muscle contraction was determined by measuring sarcomere length (µm) using phase contrast microscopy of washed muscle fibres at 1000 x magnification (Cross et al., 1981). Data was analysed by ANOVA using Minitab 11.

Results and Discussion

In experiment 1 the application of stress in the form of extra handling of the lambs did not have a significant effect on the ultimate pH or tenderness of the midloin chops at 2 days or 42 days postmortem (Table 1). The application of HVES also did not have an effect on the ultimate pH of lambs nor on the tenderness of the midloin chops at either time point tested (Table 1). Consistent with the lack of any tenderness differences across groups was that the treatments did not produce any significant difference in calpastatin levels or sarcomere length. The MFI of samples from the low stress LVES treatment did differ significantly from the two HVES treatments, but this was not reflected in a significantly higher shear force.

Table 1 The effect of electrical stimulation and pre-slaughter stress on shear force and ultimate pH of lamb LD.

Characteristic	Day	HVES-LS	HVES-HS	LVES-LS	LVES-HS	SEM
LD pH	2	5.81	5.72	5.83	6.00	0.12
Shear force	2	7.78	7.62	8.19	7.12	0.15
Shear force	42	3.56	3.62	3.53	3.69	0.5
Sarc. Length	2	1.80	1.77	1.77	1.75	0.005
MFI	2	82 ^a	91 ^a	52 ^b	72 ^{ab}	0.78
Calpastatin	2	3.35	2.73	3.02	3.01	0.02

^{a,b} Means with different superscripts differ ($p < 0.05$) LS= low stress, HS = high stress

The wide variability in ultimate pH was disconcerting until the data was analysed on a gender basis, Table 2 shows that rams had a significantly higher pH than ewes at 48h postmortem but there was no significant difference in tenderness. To examine whether this gender effect on ultimate pH could be modulated by changes in preslaughter handling Experiment 2 employed a mixed sex group and two single sex groups. Keeping rams and ewes separate in the 24 hours prior to slaughter improved the ram LD ultimate pH, which was significantly lower than that from rams in the mixed sex group (Table 3). Separation from rams also had a positive effect on ewe LD ultimate pH which bordered on being significantly different from that of ewes in the mixed sex mob ($p = 0.058$). It is likely that rams in the mixed sex group depleted their muscle glycogen with the exertion of frequent mounting as has been observed in beef cattle (Warriss et al., 1984) and this behaviour appeared to be reduced when rams and ewes were separated. Tenderness was only determined on samples from the mixed sex group but there was no significant difference in the shear forces of LD from rams and ewes.

Table 2 Ultimate pH and 48h LD Tenderness Data from Experiment 1

Tenderness	Mean pH	% > pH 5.8	48 h LD
Rams (n=57)	5.91 ^a	54	6.54 ^a
Ewes (n=43)	5.74 ^b	37	6.80 ^a

^{a,b} Means with different superscripts differ ($p = 0.013$)

Table 3. Effects of penning lambs in mixed or single sex mobs on meat quality - Experiment 2

	n	Mean pH	% > pH 5.8	48 h LD Tenderness
Rams (mixed)	19	6.11 ^a	68	5.20 ^a
Ewes (mixed)	21	5.70 ^b	14	6.13 ^a
Rams (ram mob)	22	5.73 ^b	23	ND
Ewes (ewe mob)	38	5.62 ^b	3	ND

^{a,b} Means with different superscripts differ $p < 0.001$ level. ND = not determined.

In Experiment 3 a mob of 98 lambs was divided into single sex mobs as in Experiment 2, but the ram mob was not physically separated from the other sheep being held in the processing plant yards prior to slaughter as the ram mob had been in Experiment 2. As is shown in Table 4 the ultimate pH of LD from rams and ewes was significantly different and over half the ram carcasses would fail to meet an ultimate pH specification of 5.8 tested on LD. This suggests that visual as well as physical separation from ewes was responsible for the improvement in ultimate pH readings for the ram mob seen in Experiment 2 (Table 3). However the ultimate pH data from the ewe only mobs in both Experiments 2 and 3 is consistent in that the mean ultimate pH is lower than for ewes from the mixed sex mobs in Experiments 1 and 2. This suggests the best quality meat can be obtained from ewe lambs held in single sex mobs prior to slaughter. Table 5 shows that when data for all lamb carcasses that had records for ultimate pH and tenderness were divided into pH ranges, irrespective of sex that there are significant differences in meat tenderness within specific meat pH ranges. Clearly the desirable pH range is < 5.8 which is associated with meat of acceptable tenderness and good keeping qualities.

Conclusions

If these results are representative of most lambs mobs containing rams that have reached sexual maturity, improvements in meat quality may be achieved by separating lambs into single sex mobs when they are drafted for transport to the processing plant.

Literature

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Table 4 Ultimate pH Data from Experiment 3

	Mean pH	% > pH 5.8
Rams (n=31)	5.88 ^a	52
Ewes (n=67)	5.67 ^b	1.5

^{a,b} Means with different superscripts differ ($p = 0.000001$)

Table 5: The effect of ultimate pH on shear force of lamb longissimus.

pH range	n	Shear force (kgF) day 2	SEM
>6.2	66	5.53 ^a	0.11
5.8 - 6.2	14	6.40 ^b	0.26
< 5.8	58	6.01 ^b	0.13

^{a,b} Means with different superscripts differ ($p < 0.05$)