AUSTRALIAN SHEEP MEAT 1. EFFECT OF SHEEP TYPE ON MEAT QUALITY

Hopkins, D.L.[1*], Thompson, J.M.[2], Baud, S.[3], Pethick, D.W.[4]
[1]NSW Agriculture, PO Box 129, Cowra, New South Wales 2794, Australia
[2]University of New England, Armidale, New South Wales 2351, Australia
[3]Victorian Institute of Animal Science, Agriculture Victoria, 600 Sneydes Road, Werribee, Victoria 3030, Australia
[4]School of Veterinary Studies, Murdoch University, Murdoch, Western Australia 6150, Australia

Background

A number of studies have reported an effect of lamb genotype particularly the Merino on muscle pH *(Young et al., 1993; Gardner et al., 1997; Hopkins & Fogarty, 1998)* across several muscles. This has in the past been linked to differences in meat flavour *(Young et al., 1993)*, although there is evidence that the Merino produces fat with a different fat composition to other breeds and this could explain flavour differences *(Young et al. 1997)*. With this knowledge it was considered important that muscle pH be studied as part of a major program of research and development undertaken to develop the basis for an eating quality scheme for Australian sheep meat. Another characteristic studied in this program has been tenderness measured both objectively and subjectively, given its importance to consumers. Although previous research had indicated that genotype was unlikely to effect tenderness *(Hopkins & Fogarty, 1998)* there was no published Australian work which had included a comparison of unweaned and weaned lambs. Research in the UK had shown that weaned lambs produced tougher meat than unweaned lambs *(Ellis et al., 1997)*. Given the widespread call by processors to include hogget within the lamb category the meat and eating quality of this class of sheep has also been studied.

Objective

This paper reports on a study, which examined the impact of "genotype" and age on meat quality. The second paper will detail eating quality results from this work.

Methods

Animals and management: One hundred and twenty animals were used in the experiment. These animals comprised five groups of 24 as follows; Poll Dorset or White Suffolk x Border Leicester x Merino (Second cross unweaned lambs, mixed sex, 3-4 months of age); Poll Dorset x Border Leicester x Merino (Second cross weaned lambs, mixed sex, 9 months of age); Border Leicester x Merino (First cross weaned lambs, mixed sex, 9 months of age); Merino x Merino (weaned wether lambs, 9 months of age) and Border Leicester x Merino (First cross hoggets, mixed sex, 20 months of age). Within each group 12 animals came from two different properties. All animals were run together on green pasture (grass and subterranean clover) and supplemented with lucerne hay for 5 weeks prior to slaughter.

Slaughter procedures: Animals were randomly allocated to slaughter day and slaughter group within slaughter day; they're being 2 slaughter days and 4 slaughter groups. All animals were yarded (13:00 h) on the day prior to the first slaughter and those allocated to the first slaughter day were trucked (15:30 h) to the abattoir a trip of 55 km's arriving at 17:00 h. Sucker lambs were weaned onto the truck and the mothers retained with the remainder of the animals, which were returned to the paddock. At the abattoir the animals were held in 2 pens (in slaughter groups) away from an undercover lairage area until the night slaughter of pigs had finished. Subsequently at 21:30 h they were placed in 2 pens (in slaughter groups) on grating and undercover. Remaining animals (second slaughter day) were handled in the same way and slaughtered 2 days after the first group.

Animals were slaughtered in 2 groups (n = 30) on each kill day to ensure that all carcasses could be electrically stimulated within 1 h of death. All animals were electrically stunned (head only) in a commercial abattoir and trimmed according to the specifications of *AUS-MEAT (Anon, 1992)*. Two carcasses were unsuitable for sampling, due to disease and 3 were trimmed during dressing. Subsequently each carcass was individually subjected to high voltage stimulation (700 V, for 60 seconds at 14 pulses per second) and then chilled at 2-4°C.

Sampling and consumer testing: After 19-22 h of chilling the caudal end of the left m. *longissimus thoracis et lumborum* (LL) was exposed to air at chiller temperature for 30 min and the meat colour measured on the cut surface using a Minolta Chromameter (Model CR-300) set on the L^*, a^*, b^* system (where L^* measures relative lightness, a^* relative redness and b^* relative yellowness). The chromameter was operated using Illuminant C and a white tile standard (Y = 93.1, x = 0.3135, y = 0.3197). Three replicate measurements were taken at the same position with special effort to avoid areas of connective tissue or intramuscular fat. Ultimate pH of the LL was measured at the same site as the colour measurement after calibrating the meter at chiller temperature. Ultimate pH of the SM and m. *semitendinosus* (ST) was measured after peeling back the superficial muscle where the seam runs between the SM and ST. Samples of the LL were taken for shear testing and held at chiller temperature and frozen after 5 days of ageing. These were subsequently mircowaved for 30 seconds, left to thaw for 5 h in a chiller at 4°C and then prepared into 70 g blocks. The 70-g samples were cooked for 35 minutes in plastic bags at 70°C in an 80-L waterbath. From each block 5 sub-samples with a cross-sectional area of 1cm^2 were cut parallel to the muscle fibres and peak force measured using a Lloyd (Model LRX, Lloyd Instruments, Hampshire, UK) with a Warner-Bratzler shear blade fitted. After cooking the samples were cooled in cold running water for 30 minutes, dried with paper towel and weighed and cooking loss was calculated.

Statistical analysis: pH, colour measures, shear force and cooking loss data were analysed using an analysis of variance procedure (Genstat 5.4.2, 2000) which contained fixed effects for group (second cross suckers, second cross lambs, first cross lambs, first cross hoggets or Merino), slaughter day (1 or 2), slaughter time within day (1 or 2) and the first order interaction.

Results

Meat from sucker lambs was the lightest in colour, with hogget meat the darkest ($P < 0.001$), but there was no difference between groups for the colour parameters a^* or b^* (Table 1). Animals slaughtered on the second day had darker, less red and yellow meat ($P < 0.05$). There was a consistent pattern for pH with meat from first cross lambs and Merino lambs exhibiting a higher pH than meat from other types ($P < 0.001$). Lambs slaughtered in the second group on each day had a higher pH in each of the three muscles ($P < 0.05$) than those slaughtered in the first group. For the m. *semitendinosus* there was also a significant interaction ($P < 0.05$) between group and the slaughter day. This was such that the pH was lower on the second slaughter day for meat from second cross lambs compared to the first slaughter day, but for Merino lambs the change was in the opposite direction. There were no other differences between groups. Differences between groups for L^* were independent of pH. A lesser number of samples were available for shear force testing (Table 1), but there was no difference between groups, nor any effect of slaughter day or time. Hogget loin had the least cooking loss and that from the suckers the greatest and the effect did not appear to be related to differences in pH.

Table 1. Predicted means (av. s.e.d.) of colour parameters (*L**, *a**, *b**), ultimate pH for m. *longissimus thoracis et lumborum* (LL), m. *semimembranosus* (SM), and m. *semitendinosus* (ST), shear force (SF) and cooking loss (CL) for the LL for animals according to group

Group	*L**	*a**	*b**	pH (LL)	pH (SM)	pH (ST)	SF (LL)	CL (LL)
Number	115	115	115	116	116	116	85	85
Second cross, sucker	38.5a	19.9a	10.3a	5.56b	5.57b	5.78b	2.75a	29.9a
Second cross, lamb	37.6ab	21.6a	10.7a	5.56b	5.62b	5.83b	2.82a	28.6ab
First cross, lamb	36.6b	20.0a	9.8a	5.68a	5.68a	6.10a	3.15a	28.1bc
First cross, hogget	34.2c	21.8a	10.6a	5.58b	5.59b	5.86b	2.74a	26.8c
Merino	36.4b	20.3a	9.9a	5.68a	5.70a	6.04a	2.78a	28.4abc
Av s.e.d.	0.72	0.85	0.49	0.04	0.02	0.06	0.25	0.80

Means followed by a different letter in a column (a, b, c) are not significantly different ($P < 0.05$).

Discussion

There was a clear effect of age on the lightness/darkness (*L**) of loin meat with meat from hoggets being darker than meat from other groups of animals which could reflect the increasing concentration of myoglobin in muscle as sheep become older *(Ledward & Shorthose, 1971)*. The higher *L** values for loin meat from suckers supports this conclusion. The differences were independent of pH with no difference in loin pH between the hoggets and the two groups of second cross lambs. Given that there is only a low correlation between pH and *L** values in sheep meat *Menzies & Hopkins (1996)* this result is not surprising. Some consumers would be deterred from purchasing hogget meat due its darkness, because meat colour is a very important influence on such decisions as it is used as a cue to indicate freshness *(Issanchou, 1996)*, whereas they would be attracted to meat from suckers. If we use an *L** value of less than 34 as the cut-off point below which the meat is considered unacceptably dark *(Hopkins, 1996)* then 43% of the hogget loins were in this category, compared with 15% of the lamb loins and none of the sucker loins.

A higher muscle pH for first cross (BLM) and Merino lambs compared to second cross lambs has been reported *previously (Gardner, et al., 1997; Hopkins & Fogarty, 1998)*. In the current experiment this difference was consistent across 3 different muscles, but the effect cannot be ascribed to an increasing proportion of Merino genes as the pH levels for the BLM and Merino animals were similar and the BLM hoggets had similar levels to the second cross lambs. This conclusion is supported by the data presented by *Hopkins & Fogarty (1998)*. In a New Zealand experiment where various types of terminal sires were joined to Merino ewes it was reported that loin meat from Merino lambs had a significantly higher pH than that from BLM lambs and Poll Dorset lambs which had similar pH levels *(Young et al., 1993)*. Overall these results indicate that "genotype" effects are not always consistent, but there is a tendency for Merino meat to produce a higher pH, even when the Merinos are run and handled together with other types of lambs. From the results of *Gardner et al. (1997)* it seems that Merinos respond differently to the slaughter process and even when well fed pre-slaughter this expresses itself in reduced glycogen and higher pH's. It is probable that the tendency for a higher pH could reduce the bacteriological stability of such meat that is transported as chilled vacuum packed product, given that above a pH of 5.8 stability declines *(Egan & Shay, 1988)*.

The fact that there was no difference between the lamb groups for loin shear force is not surprising given the results of *Hopkins & Fogarty (1998)* as they found no difference between lamb loin meat from 6 different genotypes when the meat had been aged for 7 days. The fact that hogget loin had a similar shear force to that of the lamb groups is in line with the suggestion of *Wenham et al. (1973)* that with changes to processing, meat from older sheep could be used as table meat. The use of high voltage stimulation and ageing for 5 days in the current experiment are indicative of the changes that would be needed.

Conclusions

It is apparent that hogget meat will be less acceptable at the point of sale, due to a darker colour, although this will not translate into loin meat that has a higher shear force. The higher muscle pH for Merino and BLM lambs reinforces the need for strategies in these types of animals to reduce the impact of pre-slaughter stress.

Acknowledgments

The assistance of Briana Daly and Andrew Blakely (UNE), Frank Shaw (CSIRO), Bernie Munro, David Stanley and Jayce Morgan (NSW Ag.) in the conduct of this experiment is noted with appreciation. The co-operation of Darby Stein, who fed the animals, Clive Anderson who agisted the animals and Cowra abattoir staff was also appreciated. Meat & Livestock Australia provided support for this work.

References

Anon. (1992). AUS-MEAT language (4th ed.). Sydney: Authority for Uniform Specification Meat and Livestock.
Egan, A. F., & Shay, B. J. (1988). Proc. 34th ICoMST, (pp. 476-481), Brisbane, Australia.
Ellis, M., Webster, G. M., Merrell, B. G., & Brown, I. (1997). Anim. Sci. **64**, 77-86.
Gardner, G. E., Kennedy, L., Milton, J. W., & Pethick, D. W. (1997). In J. L. Corbett, M. Choct, J. V. Nolan, & J. B. Rowe (Eds.), *Recent Advances in Animal Nutrition in Australia.* (pp. 256-257). University of New England, Armidale, Australia.
Genstat (2000). *Genstat 5 release 4.2.* (5th Ed.), Lawes Agricultural Trust (Rothamsted Experimental Station).
Hopkins, D. L. (1996). Meat Focus Inter. **5**, 400-401.
Hopkins, D. L., & Fogarty, N. M. (1998). Meat Sci. **49,** 477-488.
Issanchou, S. (1996). Meat Sci. **43,** S5-S19.
Ledward, D. A., & Shorthose, W. R. (1971). Anim. Prod. **13**,193-195.
Menzies, D. J., & Hopkins, D. L. (1996). Proc. Aust. Soc. of Anim. Prod. **21**, 353.
Wenham, L. M., Fairburn, S. J., McLeod, K., Carse, W. A., Pearson, A. M., & Locker, R. H. (1973). *J. Anim. Sci.,* **36,** 1081-1087.
Young, O. A., Reid, D. H., & Scales, G. H. (1993). NZ J. of Agric. Res. **36,** 363-370.
Young, O, A., Agnew, M.P., & Fraser, T.J. (1997). Proc. 43rd ICoMST, (pp. 632-633), Auckland, New Zealand.