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Effect of liveweight gain or loss on lamb meat quality

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ABSTRACT

An experiment was undertaken to compare the palatability and muscle pH of meat from around 30 lambs per group that had over a 7-week period in early winter either gained 11 kg live weight, held weight, or lost 11 kg live weight. The cooked longissimus muscle from the gain and loss groups was tested for shear force value using 10 samples from each lamb in a MIRINZ tenderometer. Mean values of 15.5 and 14.2 force score units were recorded for the two groups respectively on a scale where a value of 40 is bordering on tough. A consumer panel rated roast leg meat for overall score, tenderness and flavour and the meat from all treatments was rated highly satisfactory. Mean ultimate pH values from the lambs on all treatments were low. The results indicate that lamb weight loss *per se* had no adverse effect on the quality of meat. Weight loss did not differentially remove carcass fat compared with other tissues but the tendency was in this direction.

Keywords Lamb; weight loss; meat quality; weight gain; pH; tenderness; flavour; tenderometer

INTRODUCTION

The meat industry sometimes argues that lambs stressed before slaughter are more likely to produce tougher, poorer quality meat (Bray, 1988). There is often no attempt to distinguish between the longer term components mainly under farmer control such as those resulting from substantial liveweight losses (Bray, 1988) and the short term stress resulting from transport (Hails, 1978), washing and being moved by dogs in the yards of slaughter plants immediately before slaughter (Kilgour and de Langen, 1970; Pearson *et al.*, 1977).

Weight loss can reduce carcass fat cover compared with similar groups that have gained weight. As a result, the weight loss animals can be tougher because their carcasses are more susceptible to cold shock in the absence of a thick insulating layer of fat, where post-mortem processing is unsatisfactory (Tatum, 1981). Historically this has often been the case in New Zealand slaughter plants. In addition, it is sometimes claimed that, at least for beef, tenderness decreases as muscle pH increases from 5.5 to 6.0 and then increases again with higher pH values (Lawrie, 1979).

The purpose of this experiment was to investigate the longer term contribution to lamb stress of reduced feed availability which results in liveweight loss. The experiment was undertaken under conditions where the short term contributions to stress were minimised and where carcasses were not toughened by unsatisfactory post-mortem processing.

MATERIALS AND METHODS

Animals and Treatments

Treatments were applied separately to three groups of lambs of similar average age (numbers specified in Table 1) over the seven week period from 20 May 1987 to 9 July 1987 (late autumn to mid-winter) as described by Thorrold *et al.* (1988). Border Leicester x Romney cryptorchid lambs were allocated to final treatments on 21.5.87 on the basis of weight on 20.5.87, with one third fed to gain weight, one third to maintain weight and one third to lose weight. The maintenance and loss groups were selected from lambs that had been well fed until 21 May while the group allocated to the gain treatment came from another group of continuously growing lambs which had been slightly less well fed up to 21 May. Although the data in Table 1 appear to indicate that the maintenance group held weight, the mean weights of the lambs in this group over the treatment

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TABLE 1 Effect of nutritional treatment on hot carcass weight gain and loss in Border Leicester x Romney cryptorchid lambs.

Treatment	No. lambs	20.5.87 Full live weight (kg)	20.5.87 Hot carcass weight[1] (kg)	9.7.87 Full live weight (kg)	9.7.87 Hot carcass weight[2] (kg)	Carcass change (kg)	GR (mm)
Growth	28	47.5	21.3	58.7	26.7	+5.6	20.0
Maintenance	31	52.8	24.9	56.1	25.4	+0.5	18.4
Loss	28	52.8	24.9	41.6	19.3	-5.6	9.0

[1] Carcass weights from an additional sample slaughtered in May (Thorrald *et al.*, 1988; their L2 group = "Growth", H3 = "Maintenance" and "Loss")
[2] Treatment groups in July described by Thorrold *et al.* (1988) as L3, M3 and R3.

period were 52.8 kg (20 May), 45.3 kg (4 June), 47.7 kg (18 June) and 56.1 kg (9 July). Thus they initially lost weight and then regained it over the last three weeks.

Slaughter and Post-Mortem Treatment

The lambs were not washed before slaughter and dogs were not involved in the handling of the lambs while at the Ruakura abattoir. Lambs were slaughtered and dressed after electrical stunning using conventional inverted dressing methods. The carcasses were stored for 24 hr in a chiller set at 9 °C and then for 5 days at 1 °C . They were then cut into long loin samples for freezing prior to tenderometer analysis and into legs and half-legs for taste panel analysis.

Carcass Analysis

Eighteen carcasses from the gain treatment and 18 carcasses from the loss treatment covering the range of carcass weights available were selected and the left sides were ground and sampled for duplicate analysis by ether-extract using Soxhlet extraction after oven drying.

Muscle pH (Ultimate)

Twenty four hours after slaughter, the pH of the *M. longissimus dorsi* was measured with an Orion pH meter in the region of the 10-12th rib. The longissimus muscle is also known as the eye muscle and is the main muscle in the chop.

Tenderometer

Twenty eight carcasses from each treatment were used for tenderometer and taste panel evaluation. Frozen loins were thawed, and then cooked in a water bath (99°C) until the internal temperature reached 75°C. The eye muscle was then dissected out and placed in ice to cool. When cool, 10 identical sized samples from each loin were prepared by cuts parallel to the muscle fibres. Each sample was then tested for shear force in a MIRINZ tenderometer with shear force measurements taken across the muscle fibres. Measurements of kg/F were converted to the more normally quoted force score units by the formula

$$\text{Force score} = \text{kg/F} \times 3.44 + 2.37$$

On the force score scale, a value of 20 represents a tender product, a score of 40 is borderline between tender and tough and a score of 80 is produced by an inedibly tough product.

Taste Panel

Right legs were removed from all carcasses and prepared for distribution to families acting as volunteer taste panelists. Where family size comprised two tasters, large legs were halved before distribution and such families received two butts and a shank or one butt and two shanks.

Eighteen families (with more than two tasters per family) received whole legs and 20 families received half legs. Ninety eight tasters commented overall on the 28 legs from each of the three treatments. They were asked to cook and taste the legs in a specified order that was allocated at random to families.

Families were given 4 weeks to cook and taste the legs or half legs. In practice it took 6 weeks to get all forms returned. Families were asked to cook the legs in a specified manner and score the meat for overall preference, tenderness and flavour on the 9-point hedonic scale of Peryam and Pilgrim (1957). The higher the score the more the meat is preferred (tender, tasty).

Statistical

The taste panel, tenderometer and pH and carcass fatness measurements were analysed by standard statistical methods.

RESULTS AND DISCUSSION

TABLE 2 Effect of nutritional treatments on ultimate pH of lamb muscle.

Treatment	No Lambs	Mean pH	Standard deviation
Growth	28	5.55	0.05
Maintenance	31	5.55	0.06
Loss	25[1]	5.63	0.06

[1] Values of 5.88, 6.03 and 6.14 from the loss group are omitted from this table.

From the full live weights and carcass weights in July and from an additional sample slaughtered in May (Table 1), it can be calculated that lambs in the growth treatment gained just over 110 g carcass weight per day over the 7-week period and the loss group lost over 110 g/d over the same period. The 5.5 kg carcass weight gain or weight loss for the respective treatments are reasonably large and should reveal treatment differences in carcass quality if such on-farm effects occur. The treatments resulted in considerable differences in GR measurement (total tissue depth at the 12th rib) which could not be explained solely by differences in carcass weight (Thorrold *et al.*, 1988).

Ultimate pH values of muscle are given in Table 2. Omission of three high outlier values from the loss treatment, gave a mean pH value 5.63; a value 0.08pH units higher ($P<0.05$) than that of the remaining groups. All values were well within the normal range. The inclusion of the 3 outlier values in the low treatment raised the mean to 5.67 which is still a relatively low value. Such results need to be seen in the context that 6 out of 30 control lambs in an earlier stage of the Thorrold *et al.* (1988) experiment produced pH values of 6.0 or higher. The results show that while undernutrition in itself has little effect on lamb pH at slaughter, such a treatment may predispose lambs to produce higher pH meat if triggered by other factors such as stress caused by dogs or repeated washing (Petersen, 1983) before slaughter. Overseas results tend to show that experimentally planned treatments (transport, resting) have small effects on the ultimate pH of

TABLE 3 Effect of nutritional treatment on palatability of lamb as measured by tenderometer and taste panel.

	No. lambs	Tenderometer force score	Taste panel score		
			Overall	Tenderness	Flavour
Growth	28	15.5	7.40	7.16	7.28
Maintenance	28	-	7.14	7.08	6.91
Loss	28	14.2	7.20	7.04	6.97
Standard error of difference		0.99	0.17	0.24	0.22
Significance of difference		NS	NS	NS	NS

TABLE 4 Effect of nutritional treatment on carcass fatness.

	No. carcasses	Hot carcass weight (kg)	Mean fat Weight (kg)	Mean fat %	Mean adjusted fat[1] Weight (kg)	Mean adjusted fat[1] %
Growth	18	26.8	7.33	27.1	6.19	26.0
Loss	18	19.3	4.16	21.3	5.29	22.4
Standard error of difference					0.55	2.3
Significance of difference					NS	NS

[1] Adjusted by covariance to the same carcass weight.

the muscles in carcasses of slaughtered animals compared with other unplanned effects (eg. chain stoppage).

The effects of treatments on palatability of the meat (tenderometer values on loin muscle of growth and loss groups, taste panel results on the leg of all groups) are reported in Table 3. Tenderometer results show that the meat from both treatments was exceptionally tender. The tenderness results from leg roasts as reported by members of 38 families averaged slightly higher than moderately tender (7.0) for all treatments, normally about the upper limit of meat scored by this type of panel. These results show that weight loss produced no adverse effect on tenderness. However, the lower fat cover of the loss treatment lambs, as indicated by the GR values in Table 1, would make such carcasses more susceptible to toughening by cold shortening where post-mortem carcass treatment is unsatisfactory, as has often been the case in New Zealand slaughter plants.

Taste panel results for overall meat score, tenderness and flavour showed a lack of effect of nutritional treatment on these attributes. Panel results are similar to those obtained previously from a similar trial with younger, lighter lambs (Kirton *et al.*, 1981) except that all mean panel scores from all treatments were lower than in the present trial. Similarly, shear force values were higher than in the present trial indicating that the post-mortem protocol was more satisfactory in the present trial.

The effects of the nutritional treatments on the carcass fat content are shown in Table 4. Associated with the marked reduction in carcass weight, was a marked reduction in fat in the loss treatment. After adjustment for differences in carcass weight, fat content (weight and percent) of the loss carcasses was not lower ($P > 0.10$) than fat content of the gain carcasses. However, the GR values were significantly lower (Thorrold *et al.*, 1988).

The present experiment examined longer term factors, largely under producer control, that may nutritionally stress lambs prior to slaughter. This study has shown that the nutritional effect alone is likely to have a minimal effect on the quality of carcasses from such a system. These results, together with those from other experiments (Tatum, 1981; Petersen, 1983; Kilgour and de Langen, 1970; Pearson *et al.*, 1977; Hails, 1978), suggest that the major causes of animal stress which may adversely affect meat quality are more likely to be the treatment the animals receive beyond the farm gate.

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