EFFECT OF COMPENSATORY GROWTH ON
MEAT QUALITY IN SHEEP

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Summary

The effect on meat quality of bodyweight loss followed by compensatory gain was studied in Corriedale wethers. There were four treatment groups - a continuous growth group, two intermittent growth groups differing in the level of bodyweight loss prior to compensatory gain, and a maintenance group.

Animals were slaughtered over a range of bodyweights within each group and the Mm. longissimus dorsi and semimembranosus were removed for assessment of tenderness and proximate analysis.

No significant treatment effect on tenderness was found with either muscle. As bodyweight increased, tenderness decreased in the M. semimembranosus but remained unchanged in the M. longissimus dorsi.

The proximate composition of the muscle was not affected by treatment. However, as bodyweight increased, fat content of the muscles increased, water content decreased and protein content remained unchanged.

I. INTRODUCTION

Tenderness is the one character of meat which predominates in assessment of quality (Yeates 1965).

Tayler (1964) reviewed the effect of growth rate and periods of retarded growth on tenderness and found that slow growth adversely affected tenderness in sheep, whereas with cattle the effects of different growth rates were unpredictable. However, there appears to be no work which records the effect of bodyweight loss followed by subsequent compensatory gain on meat quality in sheep. This paper reports an investigation of this type.

II. MATERIALS AND METHODS

(a) Animals and Experimental Design

The experimental animals were 42 eight-month old Corriedale wethers selected for uniformity of bodyweight. By stratified randomization based on bodyweight, they were allocated to four experimental treatments and within treatments to various slaughter weights. From the initial bodyweight of 36 kg, all animals were individually fed to appetite. At 48 kg bodyweight, the following treatments were imposed:—

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Group I: ad libitum food intake.
Group II and III: food intake was restricted in order to achieve a bodyweight loss of 0.9 kg/week until bodyweights were reduced to 38.5 kg and 34.5 kg respectively, whereupon ad libitum feeding was resumed.
Group IV: food intake was adjusted to maintain bodyweight at 48 kg.

The growth curves and slaughter weights for each treatment are shown in Figure 1. Within treatments, two animals were killed at each slaughter weight except in Group IV where four animals were killed. Throughout the experiment, the sheep were fed a standard commercial ration of sheep pellets* with a crude protein content of 16.5 per cent and a crude fibre content of 14.0 per cent on a dry matter basis.

![Growth curves and slaughter weights](image)

Fig. 1. — Mean growth patterns of four groups of sheep — ○ group I, continuous growth; • group II and ● group III, intermittent growth, and ⋄ group IV, maintenance growth. Each point represents the slaughter weight of two animals in groups I, II and III and four animals in group IV.

* Barastoc (sheep cubes) Barastoc sheep products, 143 Queen Street, Melbourne, Victoria.
(b) Quality Assessment

(i) Muscle samples

After slaughtering the animals, the carcasses were stored at 2-3°C for 24 h. The *M. longissimus dorsi* and *semimembranosus* were then removed from the right side of each carcass, sealed in polyethylene bags (thickness 0.1 mm) and stored at -20°C until required for quality tests. Determination of tenderness of the *M. semimembranosus* was carried out by C.S.I.R.O., Division of Food Preservation, Meat Research Laboratory, Cannon Hill, using a shearing device similar to a Warner-Bratzler Shear. Measurements on samples from the *M. longissimus dorsi* were made in our own laboratory. Three medial sections 2.5 cm thick were sawn from each frozen muscle. After thawing, each section (steak) had a Cu-Con thermocouple probe positioned in its approximate geometric centre and was then cooked in vegetable oil at 185°C until it reached an internal temperature of 60°C. Nine to 12 longitudinal cores (along the line of the muscle fibres) from each muscle, 1.25 cm in diameter, were each sheared once with a Warner-Bratzler Shear.

(ii) Proximate analyses and pH measurement

A medial section 2.5 cm thick was cut from the *M. longissimus dorsi* and used for proximal chemical analyses (nitrogen, ether extract, water) using methods described by A.O.A.C. (1960).

Muscle pH was determined by homogenizing a 5g sample of muscle with 10 ml of distilled water in a Bühler Blender, measurements being made with a Radiometer glass electrodes pH meter.

III. RESULTS

(a) Tenderness

The mean shear forces for both muscles are plotted against empty bodyweight* in Figure 2, empty bodyweight being the weight of the animal at slaughter less the weight of the contents of the digestive tract and of the bladder. The standard deviations of shear force means for samples from the individual animals ranged from 0.23 to 0.90 kg for the *M. longissimus dorsi*, and 0.83 to 3.32 kg for the *M. semimembranosus*.

Statistical analysis of the *M. longissimus dorsi* data showed no significant regression of shear force against empty bodyweight for either individual groups or the pooled data. The sub-group shear force means of Group IV (maintenance periods of 66 and 120 days respectively) were not statistically different from each other or, when pooled, from any other group means. The mean shear force of the *M. longissimus dorsi*, for the four groups was 3.45 kg ± S.E. 0.99 (Figure 2b).

There were no significant differences between treatments in tenderness for the *M. semimembranosus* (Figure 2a). However, when the results for all treatments were pooled, a significant regression (*P<0.01*) of shear force *Y* (kg), with empty bodyweight *X* (kg), was found viz:

\[ Y = 1.44 + 0.155X \] (SEb ± 0.045)

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Results shown in Table 1 are mean values for the animals slaughtered at each of the empty bodyweights within groups I, II, III and IV. Regression analysis
<table>
<thead>
<tr>
<th>Slaughter E.B. W. (kg)</th>
<th>M. longissimus dorsi Weight (g)</th>
<th>%</th>
<th>Water Weight (g)</th>
<th>%</th>
<th>Protein (gx6.25) Weight (g)</th>
<th>%</th>
<th>Fat Weight (g)</th>
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</table>

* Ash content remained constant at approximately 1%.

† E.B.W.: Empty bodyweight.
of the data comparing empty bodyweight with muscle weight and chemical components showed no significant differences between treatments. The weight of the *M. longissimus dorsi* was significantly related to empty bodyweight (*r* = 0.71, *P* < 0.01). On a percentage basis, there were significant relationships between empty bodyweight and water content of the muscle (*r* = -0.83, *P* < 0.01) and with fat (ether extract) content of the muscle (*r* = 0.78, *P* < 0.01), whereas protein (*N x 6.25*) content remained constant.

A significant (*P* < 0.01) negative correlation (*r* = -0.84) was found between water and fat in the muscle. In group IV, the longer maintenance period produced significantly heavier (*P* < 0.01) *M. longissimus dorsi* than those of the shorter maintenance period. However, the composition was not different and in fact was no different to other muscles from animals of comparable empty bodyweight.

### IV. DISCUSSION

In this experiment, loss of bodyweight followed by compensatory gain had no significant affect on tenderness of both the *Mm. Longissimus dorsi* and *semimembranosus* of sheep when comparisons were made with muscles from continuously grown animals. Although these growth patterns had no affect on tenderness, there is good evidence that the morphology of muscles changes as growth patterns change (Joubert 1954, 1956; Tuma et al. 1962; Yeates 1964, 1965; Suzuki 1965; Asghr and Yeates 1968).

There appear to be no comparable experiments with sheep. However, Winchester and Howe (1955) and Winchester and Ellis (1956) found that the tenderness of cattle, which had been restricted for six months and subsequently returned to the same bodyweight, was not adversely affected. Matthew and Bennett (1962) found no effect of differing growth patterns on the tenderness of the *M. longissimus dorsi* in cattle, although their treatments were compared at similar ages rather than at similar weights. A similar experiment with cattle by Houston, Bryce-Jones and Harries (1962), however, showed that a fast growth rate enhanced tenderness.

In group IV, a period of maintenance of up to 120 days had no significant effect on muscle tenderness.

The *M. longissimus dorsi* showed no depression of tenderness with increasing bodyweight, but decreased tenderness was found in the *M. semimembranosus*. These findings are comparable with the findings of Weller, Galpan and Jacobson (1962) and Batcher et al. (1962). With sheep, they found an adverse effect of increasing bodyweight on the tenderness of the *M. longissimus dorsi* but no effect on the *M. semimembranosus*. However, the results of Weller, Galpan and Jacobson (1962) are not strictly comparable because they cooked their muscles as roasts rather than as steaks (as done here). The significant effect on the *M. longissimus dorsi* reported by Batcher et al. (1962) was obtained with a taste panel but, in the same experiments, shear tests showed no significant bodyweight effects on tenderness of either the *M. longissimus dorsi* or *M. semimembranosus*. 

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It does appear that in sheep, increasing bodyweight may be associated with decreasing tenderness of certain muscles. The effects of growth rate and bodyweight may be quite separate. In the present experiment, a favourable effect of high growth rate during compensatory gain may have partly obscured increasing toughness normally associated with increasing bodyweight and age.

In spite of the different growth patterns used in this experiment, changes in the proximate composition of the *M. longissimus dorsi* reflect changes in bodyweight rather than differences between treatments. The protein content of the muscle remained extraordinarily constant although water and fat appeared to be interchangeable -depending on growth pattern and bodyweight. This result is similar to that reported by Batcher et al. (1962). This experiment gives some indication of the rates at which these changes in composition occur over a wide range of bodyweights. During weight loss, comparable changes in composition have been obtained in pigs by Widdowson, Dickerson and McCance (1960). After examining weight-loss and subsequent recovery to the same weight in sheep, Hight and Barton (1965) and Bassett (1960) reported similar effects.

Results from this experiment indicate that a period of intermittent growth may not adversely affect meat quality. They also suggest that the practice of holding sheep in sale condition to wait for a more favourable market trend may not involve any deterioration in quality.

V. ACKNOWLEDGMENTS

This work forms part of a research programme financed by the Australian Meat Research Committee and the Reserve Bank of Australia (Rural Credits Development Fund). The author wishes to thank the CSIRO Division of Food Preservation, Meat Research Laboratory, Cannon Hill, Brisbane for their quality assessments, Dr. N. M. Tulloh for his patience and guidance, Mrs. M. Tanner for her assistance in the laboratory and Messrs. R. Thomas and H. Moog for the care and slaughter of the animals.

VI. REFERENCES


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