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GROWTH RATE AND MUSCLE BONE RATIO IN CATTLE

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Summary

The effect of growing Angus steers from 300 to 440 kg along three different growth paths on muscle-bone ratio is described. The growth rates studied were:- High (H):-0.8 kg/day; Low (L):-0.4 kg/day and High-Maintenance (HM):-0.8 kg/day followed by a period during which liveweight was maintained constant. Muscle-bone ratio (MBR) was determined by complete dissection of one side of the carcass of each animal.

MBR increased with dissected side weight (DSW) only in the H group. The slope of this relationship was significantly greater in the H than in the HM group but not different from that in the L group. The average MBR in L animals (4.55) was not significantly less than that in the H group (4.70). Although MBR was lower in the HM and L groups than in the H group, the analyses of the relationship between total side muscle (TSM) and MBR indicated that at the same MBR, the weight of TSM was significantly lower in the H group than in the HM and L groups.

I. INTRODUCTION

The effect of growth rate on muscle-bone ratio is not clear. In a review, Berg (1968) cites experiments where increased growth rate was found to increase this ratio (Guenther *et al.* 1965) and others where no such effect was observed (Callow 1961; Henrickson, Pope and Hendrickson 1965). The contrary results of these workers may be explained, in part, by variations in experimental procedure.

Guenther et *al.* (1965) calculated the "lean" content of their carcasses by adding the weights of protein, water and ash determined from chemical analyses of the boned-out carcass joints. Thus, no allowance was made for intra-muscular fat nor for non-muscular sources of protein, water or ash. The results of Callow (1961) were based on data of Brooks and Vincent (1950) who varied the feeding level of their cattle during the winter period when the animals were housed. During the summer period, the animals were all pasture fed and, consequently, the growth rates of the treatment groups were not controlled during this period of each year. Finally, the overall growth rates of the animals studied by Henrickson, Pope and Hendrickson (1965) varied by only 0.16 kg/day which may have been insufficient to elicit any interaction between muscle-bone ratio and growth rate.

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This paper describes the muscle-bone ratio of cattle whose growth was controlled along three markedly different paths, and in which the ratio of muscle to bone was assessed by complete dissection of a whole carcass side.

II. MATERIALS AND METHODS

(a) *Experimental design and animals*

A complete description of the experimental design and slaughtering procedure has been reported elsewhere (Murray 197 1). After reaching 300 kg, 29 Angus steers were allotted to the following treatments:—

High growth rate (H): 0.8 kg/day (11 animals)

Low growth rate (L): 0.4 kg/day (9 animals)

High-maintenance (HM): a period of high growth rate (H) followed by a period of constant liveweight until such time as the corresponding animals in the L treatment reached the same weight (9 animals).

Two animals were killed at 300 kg and, within each treatment, two animals were killed at the following liveweights: 330, 363, 400 kg. At a final killing weight of 440 kg, three animals were killed in each treatment. The data from the animals killed at 300 kg were pooled with those from the H group. This was considered appropriate as their growth' rate from around 270 to 300 kg was also 0.8 kg/day.

(b) *Animals and management*

At the first killing weight (300 kg), the animals were on average, 13-14 months old. Each day, they were individually fed a diet of 0.9 kg hammer-milled oaten straw together with a ration of commercial cattle pellets*, which was adjusted to maintain the required growth rates.

(c) Dissection techniques

Animals were slaughtered and dressed according to commercial practice. The right side of each carcass was dissected into muscle, bone, fat and connective tissue by the method of Butterfield (1963).

(d) *Statistical analyses*

Muscle-bone ratios were related to dissected side weight and dissected muscle weight by linear regression. Differences between treatments were assessed by a. paired comparison of (i) the slopes (***b*** values) of the regression lines, and (ii) the intercepts (***a*** values) of the regression lines. If the two slopes were not statistically different, the common slope was calculated and fitted to both sets of data. The resultant intercepts were then compared. The notations indicating differences between the a intercepts in the table, therefore, refer to group differences rather than to differences in the tabulated ***a*** intercepts per se.

III. RESULTS

The regression constants from the analyses of covariance for the interrelationships between muscle-bone ratio (MBR) and dissected side weight (DSW) and total side muscle weight (TSM) are presented in Table 1.

* "Hutmill beef fattener", Tomlins Simmie, 87 Charleston Road, Bendigo, Victoria. Mean crude protein 13.0 per cent of dry matter.

TABLE 1

Constants in the regression equations from the analyses of covariance for the inter-relationships between muscle-bone ratio (MBR) and dissected side weight (DSW) (kg) and weight of total side muscle (TSM) (kg)

Equations are of the form: $y = a + bx$

Independent variate (x)	Dependent variate (y)	*a*			*b* ± S.E.		
		H	HM	L	H	HM	L
					d	e	de
DSW	MBR	3.71	5.15	3.30	0.0093 ± 0.0026	—0.0058 ± 0.0055	0.0126 ± 0.0082
MBR	TSM	—27.21[s]	67.55[r]	—1.11[r]	18.90 ± 8.12	2.40 ± 9.79	14.94 ± 7.34

Within rows, within triplets values with different letters are significantly different ($P < 0.05$).

Arithmetic means, excluding H animals killed at 300 kg, for all treatments:—

D.S.W.: 111.0 kg; TSM: 66.1 kg; MBR: 4.58.

(a) *Muscle-bone ratio and dissected side weight*

There was no significant difference between the H and L groups in either the a or ***b*** values in the regression of MBR against DSW. However, a comparison of the regression equations for the H and HM groups showed that the ***b*** value was significantly greater in the former group.

(b) *Total side muscle and muscle-bone ratio*

The regression of TSM against MBR was significant only in the H group. There were no significant differences between groups in the slopes of the regression. However, at the same MBR, the weight of TSM in both the HM and L groups was significantly greater- than in the H group (significantly different ***a*** values).

IV. DISCUSSION

The similarity of the regression of MBR against DSW in the H and L groups suggests that, if cattle are grown to the same slaughter weights at different growth rates, then muscle-bone ratios will be similar. Average MBR and their standard errors in the H (excluding the data from the two animals killed at 300 kg) and the L groups were 4.75 ± 0.09 and 4.55 ± 0.11, respectively. Although the ***b*** values were not significantly different between the H and L groups, the MBR showed a significant increase as DSW increased only in the H group.

While the animals in the HM group were held at constant weight, MBR fell relative to that in the H group (see Table 1). Although the absolute fall of MBR in the HM group was not significant (b = -0.0058 ± 0.0055) it is a result similar to that reported by Trowbridge, Moulton and Haigh (19 18) who dissected two steers which had been held at constant weight. Verbeek (1961), using 3-rib dissections from groups of steers in comparable treatments, also reached similar conclusions. The decrease in MBR appears due to the fact that, although muscle tissue increased during maintenance of Iiveweight (Murray 1971), this rate of increase was relatively slower than that of bone. The results reported here do not support the statement of Butterfield, Pryor and Berg (1966) that, "if genetically identical animals are slaughtered at specific weights, it may be expected from the findings of Berg and Butterfield (1966) that their muscle : bone ratios will be similar irrespective of nutritional history or age".

The regression analyses of TSM against MBR showed that, at the same MBR, the weight of TSM was significantly greater in the HM and L groups than in the H group (Table 1). This difference represented an advantage of 2-3 kg of muscle in favour of the HM and L groups (Murray 1971).

Muscle-bone ratio appears to be of limited use in assessing the economic value of a carcass unless carcasses are compared at the same muscle weight. This implies that, before MBR can be useful, it is necessary to know carcass composition.

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