DIFFERENCES IN MUSCLE : BONE RATIOS BETWEEN
ZEBU CROSS AND BRITISH BREED STEERS

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Summary

Differences were found in the ratio of the weight of four large muscles to
the weight of total side bone in 67 British and Zebu cross steers. The Zebu
cross steers had the higher muscle: bone ratio. Corrections for carcass weight did
not remove this difference, but correction for slaughter age did.

I. INTRODUCTION

Genetic studies designed to establish parameters in beef cattle on which
selection can be made require the definition of inherited carcass characteristics to
allow selection either in the live animal or on the carcasses of progeny.

With a clear understanding of the relationships of muscle, bone and fat tissue
and an appreciation of the effects of environment and genetic influences on these
tissues, independently as well as proportionately, it should be possible to establish
a basis for comparison of carcass composition of breed groups and of cattle from
various treatments (Berg and Butterfield 1966). Breed differences in muscle:bone
ratios were found by Hankins, Knapp and Phillips (1943), Carroll, Clegg and
Kroger (1964) and Berg and Butterfield (1966). The animals used by Berg and
Butterfield (1966) were drawn from diverse origins and differed widely in live-
weight and age. Using contemporary experimental animals, Williams, Butterfield
and Dettmann (1968) found little difference between progeny groups in muscle:
bone ratios of Aberdeen Angus bulls.

As part of a larger programme designed to study morphological and physio-
nological differences between British and Zebu cattle (Kennedy and Turner 1959),
it was possible to dissect part of the carcasses of 67 steers and to make comparisons
between breeds in the ratio of weights of four large muscles to bone. These data
are reported.

II. MATERIALS AND METHODS

(a) Animals

The Zebu steers used were Africander and Brahman cross Shorthorn and
Africander and Brahman cross Hereford, and the British breed steers were Short-
horns and Herefords and their crosses. These animals were bred and reared

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together (Kennedy and Turner 1959). Steers born in one year were slaughtered to provide information for these studies. Preliminary studies using carcass appraisal techniques (Yeates 1952) on small numbers of animals indicated that there were large differences in carcass measurements of animals of the same age, but that these differences were eliminated if allowances were made for differences in carcass weights (Hewetson, unpublished data). In this study, to remove differences in liveweight as a confounding influence, all steers were killed at approximately the same liveweight (450 kg).

Because of different growth rates, the British breed steers were on average older than the Zebu crosses at the time of slaughter. Animals were weighed after being run in from the paddock in the late afternoon and transported to the meatworks early next morning. They were killed approximately 24 h later. Growth rates were calculated by dividing liveweight gain from birth to slaughter by slaughter age.

(b) Dissections

The animals were slaughtered at the Rockhampton meatworks in batches of eight. Usually, all breeds were represented, but never by equal numbers of animals. Hot carcass weights were obtained on the floor within an hour of death. After chilling for 48 h at 34°C, the carcasses were quartered at the 10/11 rib and two measures of subcutaneous fat thickness were made using the technique of Yeates (1952). The left sides of the carcasses were dissected at room temperature and after being freed of dissectable fat, the weights of the **Mm. biceps femoris**, **longisimus dorsi**, **quadriceps femoris** and **semitendinosis** were recorded to the nearest 60 g.

The validity of using one side of the carcass only had previously been established. (Hewetson, unpublished data; Butterfield private communication).

The bone from the half carcass was removed by a butcher and weighed to the nearest 60 g.

Pooled and within breed relationships between muscle, bone and fat and muscle:bone ratio respectively, and carcass weight and age, and growth rate were calculated by correlation techniques (Snedecor 1956). The results were analysed by analysis of variance and covariance.

III. RESULTS

Correlation coefficients between the important pooled and within breed independent and dependent variables are shown in Table 1. Carcass weight was very highly significantly correlated to muscle weight, bone weight and fat thickness (P <0.01) even though differences in carcass weight were relatively small. There was a significant (P<0.05) correlation between pooled carcass weight and muscle: bone ratio, highly significant negative correlations (P <0.01) between muscle : bone ratio and slaughter age and a highly significant correlation (P <0.01) between muscle: bone ratio and growth rate. The correlation between bone weight and slaughter age was not significant. There was a significant (P<0.05) correlation between muscle weight and fat thickness in the Zebu steers and a significant
TABLE 1

Pooled and within breed correlations between the main independent and dependent variables

<table>
<thead>
<tr>
<th></th>
<th>Pooled Correlations</th>
<th>Within Breed Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle: bone ratio</td>
<td>.27*</td>
<td>British steers — .34*</td>
</tr>
<tr>
<td>and carcass weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and slaughter age</td>
<td>— .35**</td>
<td></td>
</tr>
<tr>
<td>and growth rate</td>
<td>.38**</td>
<td></td>
</tr>
<tr>
<td>Muscle weight</td>
<td>.83**</td>
<td></td>
</tr>
<tr>
<td>and carcass weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and slaughter age</td>
<td>.70**</td>
<td></td>
</tr>
<tr>
<td>Bone weight</td>
<td>— .12</td>
<td></td>
</tr>
<tr>
<td>and carcass weight</td>
<td>.72**</td>
<td>Zebu steers .38*</td>
</tr>
<tr>
<td>Fat thickness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and carcass weight</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td>and muscle weight</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* P<0.05  
** P<0.01  

(P<0.05) correlation between muscle: bone ratio and growth rate in the British steers.

Means and standard deviations for carcass characteristics are shown in Table 2. The Zebu steers had significantly (P<0.01) heavier carcasses, muscle weights and higher muscle:bone ratios than the British breed steers. The British breed steers were significantly older and had lower growth rates, but had significantly thicker fat measurements (P<0.01) when adjustment was made for carcass weight. Bone weight adjusted for differences in carcass weight was not significantly different. The analyses of covariance are shown in Table 3.

IV. DISCUSSION

The results reported here are similar to those reported by Berg and Butterfield (1966) in that breed differences in muscle: bone ratios have been observed. However, the studies differ greatly in the type of cattle used and, of course, also in the completeness of the dissection technique. Berg and Butterfield (1966) obtained their experimental animals from a wide source of origins and Africander crosses were not represented in their breeds. Our steers were bred from a random sample of Hereford and Shorthorn dams of similar genetic origin and were run together until slaughter. Berg and Butterfield’s (1966) dissections were complete (Butterfield 1963) whilst ours were limited to four large muscles. However Butterfield (1965) has shown that the four large muscles dissected by us (Belmont group) were highly correlated (r = 0.99) with total muscle.

In our results there were, however, large differences in the time taken by the two breeds to reach slaughter age. The animals used by Berg and Butterfield (1966) were of diverse origin, weights and ages and did not receive contemporary treatment before slaughter.

Breed differences in muscle:bone ratios in our results were removed by adjustment by covariance analysis for slaughter age and growth rate. There was a highly significant negative correlation between muscle:bone ratio and slaughter
TABLE 2

Means and standard deviations for production and carcass measurements of Zebu crossbred and British breed steers, slaughtered at approximately 450 kg liveweight

<table>
<thead>
<tr>
<th>Cattle Type</th>
<th>No.</th>
<th>Carcass Wt. (kg)</th>
<th>Muscle (kg)</th>
<th>Bone (kg)</th>
<th>Fat Thickness X (cm)</th>
<th>Y (cm)</th>
<th>Growth Rate (kg/week)</th>
<th>Slaughter Age (weeks)</th>
<th>Muscle: Bone Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>British</td>
<td>31</td>
<td>242.7±3.2</td>
<td>15.68±3</td>
<td>17.41±3</td>
<td>0.9±0.07*</td>
<td>1.1±0.07*</td>
<td>2.5±0.02</td>
<td>184±0.85**</td>
<td>9016±0.0092</td>
</tr>
<tr>
<td>Zebu Cross</td>
<td>36</td>
<td>263±2.9**</td>
<td>17.24±5.5**</td>
<td>18.82±5</td>
<td>0.8±0.06</td>
<td>0.9±0.08</td>
<td>3.2±0.05**</td>
<td>153±3.0</td>
<td>.9440±0.0096</td>
</tr>
</tbody>
</table>

* Fat is significantly thicker (P<0.05) in the British steers if correction is made for difference in carcass weight.

** P<0.01. Bone weights not different at same carcass weight.
age and a highly significant correlation between muscle:bone ratio and growth rate. In correcting our muscle:bone ratios for fat thickness, an assumption has been made that increases in fat thickness in the steers would be accompanied by increases in intra-muscular fat which would increase muscle weight (Tayler 1954). This assumption was supported by a muscle weight and fat thickness correlation of 0.38 in the Zebu steers and 0.26 in the British steers. The pooled correlation \((r = 0.1)\) only approached significance but the slope of the regressions of muscle weight on fat thickness was different for the two breeds.

If the assumption was correct, then had the British breed steers reached slaughter weight as soon as the Zebu crossbreds, they may have had similar muscle:bone ratio. There was a significant correlation of 0.34 between growth rate and muscle:bone ratio in the British breed steers and a significant correlation of 0.38 in the pooled results.

If no correction was made for fat thickness, the Zebu steers still have a highly significantly higher muscle:bone ratio, but the effect of growth, rate and slaughter age was removed.

When statistical adjustment is made for the small but significant differences in carcass weight, the Zebus have the same proportion of bone, but more muscle and less fat, so that at the same carcass weight their carcasses are less mature than the British breed steers. This could be a true breed difference and indicate a heavier mature weight for the Zebu crossbreds. Berg and Butterfield’s (1966) results show that the \(\frac{1}{2}\) and \(\frac{3}{8}\) Brahman crossbreds have the highest per cent muscle in their carcasses at the same mean level of fatness and, except for the Aberdeen Angus which were much fatter and had much less bone, the highest muscle:bone ratio, but there preslaughter treatment was not contemporary.
Williams, Butterfield and Dettmann (1968) in a single Angus herd were able to find only small differences between animals in muscle: bone ratios and no significant sire differences in muscle: bone ratios. Their animals were, however, killed at a constant age and not at a constant weight, and individual ages were not recorded.

In further muscle: bone studies, it would seem worth while to examine more animals from progeny groups, within breeds which differ greatly in the age at which they reach market weight, or which differ greatly in their final mature size. In the meantime, there appears to be no incompatability between rapid growth and a high muscle : bone ratio.

V. ACKNOWLEDGMENTS

I am indebted to Mr. J. F. Kennedy and the staff of the National Cattle Breeding Station, “Belmont”, Rockhampton for care of the animals to slaughter age and to the C.Q.M.E. Company in Rockhampton for use of slaughtering facilities. Mr. B. J. Thompson assisted with the dissections and the compilation of the results.

VI. REFERENCES


