

Table 2. Predicted yield grade and dressing percentage from hypothetical data on Angus, Hereford and Hereford-Angus cross steers

Days on feed	Hypothetical data		Predicted	
	Average daily gain (lb)	Final weights (lb)	Dressing percentage	Yield grade
84	3.26	946	60.5	1.6
112	3.19	1029	61.4	2.8
140	3.09	1105	62.2	3.6
168	2.98	1173	62.9	4.2
181	2.92	1201	63.2	4.4

The Growth of Three Fiber Types in Beef Longissimus Muscle as Influenced by Breed and Age

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Story in Brief

Changes in the areas of α -white, α -red and β -red fibers from the Longissimus dorsi muscles of Angus and Charolais calves slaughtered at 25, 240 and 650 days of age were determined. At 25 days all three fiber types from the Angus calves were notably larger than those from the Charolais. This size difference was maintained throughout the growing periods. For the α -white fibers, however, the breed difference lessened with increased age. In the Angus, the β -red fibers were slightly larger at 25 days than the α -reds; yet as the growing period was extended, the α -reds became significantly larger than the β -reds. These findings may explain how the musculature of beef animals maintains its increased energy need during growth. There was a progressive increase, favoring the Charolais, in percent fiber area, the α -reds of both breeds showing the greatest percent increase. The α -white fibers of the Charolais had a greater net increase per day, suggesting a faster overall muscle growth rate for this breed. During the latter part of the growth phase (240 to 650 days), the β -red fibers of the Angus enlarged at a significantly faster rate per day, which could be related to the Angus' capacity to "marble."

Introduction

The ultimate muscle size or mass in beef animals may be due largely to the extent of radial growth or increase in area of the basic structural units of muscle, the individual muscle fibers.

Beef muscle is not uniform in its fiber composition; rather, it is believed to contain a heterogenous mixture of at least three types of fibers, which may be distinguished by their different metabolic characteristics. Research data to determine the influence of breed type on the extent and rate of enlargement of the different muscle fiber types during growth is limited. Thus, the present study was conducted to evaluate changes occurring in the size of three types of muscle fibers, α -white, α -red and β -red, taken from the Longissimus dorsi of Angus and Charolais calves at three stages of maturity.

Materials and Methods

A total of 15 Angus and 15 Charolais calves were used for this study. Six calves (three Angus and three Charolais) were slaughtered at 25 days of age, 12 (six Angus and six Charolais) at 240 days and 12 (six Angus and six Charolais) at 650 days. All calves were selected from the same herds and calving groups.

Immediately after each calf was slaughtered, a section of the right Longissimus dorsi (12th rib to the 4th lumbar vertebra) was removed, trimmed of external fat, wrapped in aluminum foil, frozen in liquid nitrogen and stored at -20°C until sectioning was accomplished. From each muscle a transverse section (approximately 1 cm wide) was removed at a location 50 percent of the long axis of the muscle. This section was visually divided into quadrants, and a core 6.35 mm in diameter was removed, at random, from one of the quadrants. The core was thawed in buffered saline, fixed to a microtome chuck and refrozen. Two sections were cut (12 microns thick) from each core, affixed to separate glass slides and stained via an alkaline ATPase procedure.

The stained fibers were projected onto an A/O Visopan screen. The periphery of 5 α -white, α -red and β -red fibers (from each of the two sections), selected at random, was traced onto transparent paper strips. The inner area was made opaque with white liquid paper fluid and the area of all fiber tracings was determined with a LiCor meter.

Results and Discussion

The average areas for three fiber types, α -white, α -red and β -red, determined on the Longissimus dorsi muscles of Angus and Charolais calves at 25, 240 and 650 days of age are presented in Table 1. These data show that at all age groups and for all three fiber types, the Angus calves had larger fiber areas than the Charolais. At 25 days

Table 1. Effect of breed and age on fiber area of Longissimus dorsi muscle

Age ¹	Breed	Fiber type		
		α - White	α - Red	β - Red
25	Angus	.717 ^{2,3}	.415	.430
	Charolais	.513	.263	.283
240	Angus	1.147	.657	.542
	Charolais	1.043	.532	.503
650	Angus	2.210	1.930	1.490
	Charolais	2.120	1.380	1.250

¹Days.

²Average of ten measurements, units in cm².

³Values are uncorrected for magnification.

Table 2. Effect of breed and growth phase on the percent increase in fiber area of Longissimus dorsi muscle

Growth phase ¹	Breed	Fiber type		
		α - White	α - Red	β - Red
25-240	Angus	60.0 ²	58.3	26.0
240-650		92.7	122.1	174.9
25-650		208.2	365.1	246.5
25-240	Charolais	92.1	102.3	77.7
240-650		103.3	159.4	148.5
25-650		290.4	424.7	325.8

¹Days.

²Percent increase during indicated intervals.

of age the average fiber area (across all fiber types) was 1.4 times greater for the Angus. This advantage in fiber area for the Angus was maintained throughout the entire growing period, though the difference between the two breeds became smaller with increased age in the α -white fibers, suggesting that the more numerous muscle fibers of the Charolais (reported previously) were "catching-up" in size as the growth period was extended.

For both breeds and at each age period, the α -white fibers were considerably larger in area than either the α -red or β -red fibers. This difference did not lessen until the animals reached market weight. Conversely, at 25 days of age the β -red fibers of the Angus and Charolais were slightly larger than their respective α -red fibers; however as age was increased, the α -red fibers became notably larger than the β -red fibers. These observations, particularly the latter, might be due to the muscles' increased need to maintain oxidative and ATPase activity during growth and may suggest a possible mechanism for these events.

The influence of breed and growth phase or increasing age on the percent change in fiber area are given in Table 2. These results show a progressive increase in percent fiber area with age. While the Angus had larger fiber areas in all cases (Table 1), the Charolais' muscle fibers showed a greater percentage increase, except in the β -red comparison during the 240-650 day growth phase, suggesting an overall advantage in rate of muscle growth in the Charolais calves. The largest percent increase in fiber area occurred during the 240-650 day period (weaning-market weight).

When the increase in fiber area was expressed on the basis of net change per day (Table 3), a somewhat different picture was obtained. For the α -white fibers, the largest increase in area occurred during the 240-650 day growth phase (post-weaning). The net area increase per day of the α -white fibers was significantly lower during the 25-240 day period (pre-weaning), as well as for the 25-650 day period (overall). In each case, however, the net change in α -white fiber area was greater for the Charolais, indicative of a faster muscle growth rate for these calves.

The net increase in area per day of the α -red and β -red fibers for the two breeds followed a different course than that of the α -whites. During the 25-240 day period, the Charolais showed a larger net increase in fiber area than the Angus. However, during the 240-650 day growth phase, the Angus' β -red fibers enlarged at a significantly faster rate per day. Also, the overall increase in size per day in these fibers was greater for the Angus calves (25-650 day period). These findings may be related to the Angus calves' ability to deposit intra-muscular or "marbling fat" at an earlier age and lighter weight than the Charolais.

Table 3. Effect of breed on increase in fiber area per day of age

Growth phase ¹	Breed	Fiber type		
		α - White	α - Red	β - Red
25-240	Angus	2.00 ^{2,3}	1.12	0.52
240-650		2.59	3.10	2.31
25-650		2.39	2.42	1.70
25-240	Charolais	2.32	1.25	1.02
240-650		2.63	2.07	1.82
25-650		2.52	1.79	1.55

¹Days.

²Average of ten measurements, units in $\text{cm}^2 \times 10^{-3}$

³Values are uncorrected for magnification.