EFFECT OF DIETARY PROTEIN AND SLAUGHTER WEIGHT ON SKELETAL MUSCLE FIBERS OF BEEF

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Introduction

The aim of this study was to reduce the protein intake while at the same time retaining all the essentials of efficient feeding to insure proper growth and an acceptable meat product. This nutritional treatment may help producers reduce the high cost of feeding. The effect of undernutrition, however, may result in alteration of muscle cellularity which prompted this investigation to examine the effect on animal growth and development in longissimus dorsi muscle.

Materials and Methods

Forty Angus beef steers were used in this study with initial live weight ranged from 256 to 278 Kg. The cattle were randomly divided equally into two groups. Group A received a protein deficient diet (8.48% crude protein on a dry matter basis), while group B received adequate protein (12.20% crude protein on a dry matter basis). The diets fed contained 20% cottonseed hulls and 80% concentrate, the soybean meal was used as the source of supplemental protein. The animals were slaughtered at about one-month intervals in groups of eight (4 animals from each group at specific times). Samples of longissimus dorsi (LD) were collected from all animals 48 h after slaughter. The muscle tissues were rolled in talcum powder prior to freezing in liquid nitrogen and after left inside the cryostat for about an hour to equilibrate to -20° C. Cross sections 10 mm in thickness were cut and mounted on glass microscopic slides and were reacted with myofibrillar ATPase at alkaline pH (Guth et al. 1970) in order to differentiate muscle fiber type according to their glycolytic capability. Reciprocal slides were also reacted with NADH-Tr to differentiate muscle fibers base on their oxidative capability (Engel and Broke, 1966). Fiber were classified into bR (Red), aR (Intermediate) and aW (White) according to Ashmore and Doerr (1971). Sections from previously mentioned muscle were stained with Oil-Red-O and hematoxylin according to the procedure outlined by Lillie (1965) in order to stain fat cells in the intercellular space. Fiber size and fat cell size were determined using a Zeiss particle size analyzer. The data were analyzed using the statistical analysis system (SAS, 1985), using the general linear model and least square means procedures. The Duncan' s new multiple range test by Snedecor and Cochran (1976), using the SAS was used to test for differences among treatment means.

Results and discussion

Least square means for longissimus fiber type percentages and diametr for each dietary group within slaughter time are shown in table 1. Inadequate dietary protein (treatment A) did not affect muscle fiber size in general; however, there was a significant effect ($P < 0.05$) on the fiber size of red and white muscle fibers after cattle had been on feed 98 and 167 days feed, respectively. Days on feed did not influence fiber types except between 63 and 98 days where a significant reduction ($P < 0.05$) in diameter of aW fibers occurred (59.2 mm to 53.1 mm; table 2).This was likely due to animal variation since the study did not reflect a continuos sampling biopsy procedure to observe muscle from the same animal over time. The aW fibers tended to be larger in diameter than aR (intermediate) and bR (Red) fibers (51.9 mm compared to 45.0 mm and 44.3 mm, respectively). This trend agreed with results reported by Padykula and Gauthier (1970); Johnston et al. (1975); May et al. (1977); Nicastro et al.(1991); Nicastro and Maiorano (1994). A significant increase in fiber diameter with increasing age as reported by Nicastro and Maiorano (1994) was not observed in our study.Although dietary protein did not show a significant effect on muscle fiber type percentage (Table 1) it is interesting to note that the percent of white fibers in group A in all five slaughter groups tended to be higher than in group B. The percentage of intermediate fibers was lower whereas red fibers tended to fluctuate without any clear pattern. This variation in fiber type within a specific area adds further evidence that fiber transformation may be influenced by animal nutrition. The most likely path of fiber conversion is the shift in intermediate fiber type toward white fibers. Chronological age did not influence the distribution of fiber types proportionally throughout the 167 days on feed (Table 1). However, a significant ($P < 0.05$) decrease in percentage of aW fibers was noted between the 4th and 5th slaughter period while an increase occurred in percent of bR (Red) fibers.

Figure 1, shown the trend for intrafascicular fat cell diameter. Protein level in the diet did not have a significant effect on fat cell size, except for group B where adipocytes were larger ($P < 0.05$) than group A after 144 days on feed. However as cattle grew older and heavier, fat cells were not altered significantly.

Conclusions

We can conclude that under the conditions of our experiment neither muscle fiber nor intramuscular fat cell size from the muscle studied contributed significantly to overall animal growth. Therefore, in order to determine more fully the possible contribution of these factors to true growth, future research should involve younger animals and muscle from different impetus groups within the body.

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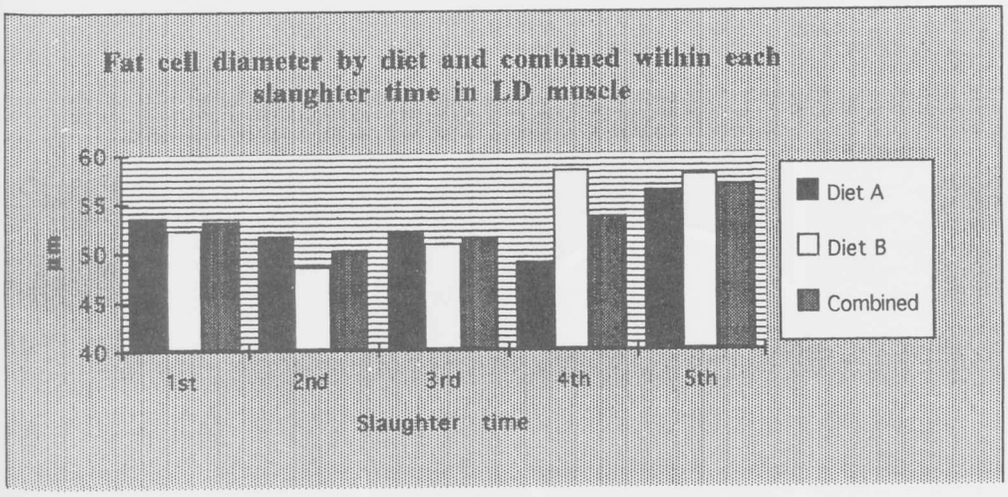

Table 1 - Least squares means for fiber type percentages and diameters of Red, Intermediate and White in Longissimus Thoracis muscle fibers for each treatment within each slaughter time

Slaughter time		Fiber Type, %			Fiber Diameter, µm		
		Red	Intermed	White	Red	Intermed	White
1	Diet A	28.5	21.0	49.3	47.1	43.0	56.3
	Diet B	27.3	34.0	38.8	52.9	46.3	62.1
		27.9	28.0	44.0	50.0**c**	44.6	59.2**c**
2	Diet A	20.8	24.4	54.8	45.9	47.6	52.9
	Diet B	22.9	46.0	31.1	43.7	45.7	53.4
		21.9	35.2	42.9	44.8	46.6	53.1**d**
3	Diet A	21.5	30.9	47.6	46.7**a**	44.0	51.6
	Diet B	19.4	34.5	46.0	36.9**b**	40.8	47.2
		20.4	32.7	46.8	41.8**d**	42.4	49.4**d**
4	Diet A	20.4	26.8	52.7	40.8	43.5	48.4
	Diet B	24.4	29.3	46.3	41.2	48.2	49.3
		22.4	28.1	49.5**c**	41.0**d**	45.8	48.8**d**
5	Diet A	35.8	24.3	39.9	44.9	42.9	45.3**a**
	Diet B	26.1	37.1	36.8	42.8	48.8	52.6**b**
		30.9	30.7	38.3**d**	43.9**d**	45.9	49.0**d**

a,b Means in the same column with different superscripts differ for each treatment (P< .05).
c,d Means in the same column with different superscripts differ for each slaughter time (P< .05).