1985

Effects of Dietary Stress on Dark-Cutting Beef

John D. Crouse
MARC

Stephen B. Smith
Texas A & M University

Effects of Dietary Stress on Dark-Cutting Beef

John D. Crouse and Stephen B. Smith[1]

Introduction

The advantages of bulls compared with steers in production efficiency, performance, and carcass leanness have been well documented. However, it has also been well documented that meat obtained from bulls is darker in color and less tender than meat produced by steers. It may be concluded that the superiority in production performance of bulls over steers has not been exploited largely due to meat characteristics that differ from those of steers.

Postmortem (after slaughter) muscle color is directly associated with antemortem (pre-slaughter) muscle glycogen content, postmortem muscle pH decline, and ultimate muscle pH, which, in turn, is affected by live animal physiological stress. In several mammalian species, depletion of muscle glycogen by exercise was followed by repletion to greater content of muscle glycogen than observed before exercise. In a lab study, starvation for 48 h followed by 48 h of refeeding rats a 65 percent glucose diet resulted in an increase and "overshoot" in the activities of muscle glucose 6-phosphate dehydrogenase, malic enzyme, and muscle glycogen content. The objective of the present study was to determine the effects of fasting on bull muscle glycogen content and repletion rates.

Procedure

Animals and Diet. Four Simmental, six Hereford, and two Angus bulls were randomly assigned within breeds in equal numbers to a fasted or control group and individually penned and fed. Bulls were about 12 months of age and weighed 1,000 lb. Bulls were fed to appetite a diet (84 pct TDN) containing corn silage, corn, soybean meal, and urea for 2 months before and during the experiment.

Fasting. After having been fed the diet for 2 months, six bulls were fasted for 96 h with access to water. The six fasted animals were gradually returned to full feed over a 5-day period.

Biopsy and Glycogen Assay. All bulls were biopsied 11 days before the fast period (time period = -15 days), at the end of the fast (time period = 0 days), and 3, 7, 10, and 14 days postfasting. A needle biopsy procedure was used to obtain longissimus muscle samples on the right and left sides of the animals between the first and fifth lumbar vertebrae about 12 cm off the midline. Local anesthesia was used at time of biopsy. Glycogen was assayed by an accepted procedure.

Results

Bulls adapted well to their new environment and diet over the 2-month period before the first biopsy. Bulls also remained relatively calm when moved and handled for biopsy.

No significant interactions among breed, treatment, period, or biopsy location were observed in variation in glycogen content. Glycogen values were also similar among sampling sites within the longissimus muscle.

Fasted and control bulls had similar muscle glycogen content at days -15, 7, 10, and 14 (Table 1). Fasting for 96 h reduced muscle glycogen from 77 to 50 mol glycogen-glucose/g of tissue by day 0. Depressed muscle glycogen levels persisted through day 3 while animals were developing normal feed consumption patterns.

The repletion rate of 3 μmol glycogen-glucose·g^{-1}·day^{-1} observed in the present study from days 3 to 7 was very low. It is possible that muscle glycogen was not adequately depleted by fasting to trigger a more rapid repletion rate. Or, repletion rates in cattle are lower than those in laboratory animals. Muscle glycogen repletion rates within the fasted group were similar between days 3 to 7 and 10 to 14. Muscle glycogen-glucose content in both groups of bulls declined slightly at day 10, possibly due to undefined environmental stress incurred on that day. By day 7, muscle glycogen-glucose content of the fasted group was 9 to 12 μmol/g less than the control group; however, this difference was relatively small as compared with experimental residual error, and the values for fasted and control groups were considered equal.

Recent technological advances in postmortem processing may enhance bull beef quality. A review indicates that electrical stimulation of prerigor carcasses will improve tenderness and enhance lean color and marbling of beef. It must be noted, however, that the process is muscle energy dependent. Previously reported research indicates that electrical stimulation of prerigor bull carcasses failed to result in an improvement in meat color or tenderness. One plausible explanation for the lack of an electrical stimulation effect is that muscle glycogen reserves were not adequate to promote the desirable effects of electrical stimulation.

Results indicate that fasting to reduce muscle glycogen content and refeeding to attain a muscle glycogen "overload" is not feasible. The procedure will not serve as a management tool to attain a muscle condition that will enhance meat quality by increasing quantities of antemortem muscle glycogen. Given very low muscle glycogen repletion rates, management systems designed to prevent muscle glycogen depletion prior to slaughter appear more promising.

Table 1.—Least-squares means of glycogen by treatments over time[a]

	Time, day[b]						Residual
	-15	0	3	7	10	14	SD
Control (C).....	86	77	77	77	69	78	11
Fasted (F)	82	50	53	65	58	68	11
C minus F	4	27	24	12	11	10	

[a]μmol glycogen-glucose/g of sample reported.

[b]Length of time fed before refeeding (-15 days) and length of time after refeeding (3, 7, 10 and 14 days). Animals were fasted 96 h before day 0 (-4 to 0 days).

[1]Crouse is the research leader, Meats Unit, MARC; and Smith is an associate professor of animal science, Texas A&M University (formerly a research chemist, Meats Unit, MARC).