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The Effects of Carcass Electrical Stimulation and Cooler Temperature on the Quality and Palatability of Bull and Steer Beef

John D. Crouse, Steven C. Seideman, and H. Russell Cross¹

Introduction

The advantages of producing bulls as opposed to steers in production efficiency, performance, and carcass leanness have been well documented. However, it also has been observed that bulls have darker colored lean and lower carcass quality grades than steers. In all studies summarized in a literature review, meat obtained from bulls was less tender when compared with meat from steers. Consequently, the superiority of bulls over steers in performance and carcass cutability have been largely countered by the inferior carcass quality of bulls. Production of beef by bulls, therefore, has not been widely undertaken in the United States.

Recent technological advances in meat 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. Improvement in tenderness by electrical stimulation was greatest when control samples had higher shear force requirements.

High temperature, early postmortem carcass conditioning may also improve palatability characteristics of meat from bulls.

Improvement in visual appeal and palatability of bull beef would certainly be in the best interest of the beef industry. The objective of this study was to examine postmortem treatments that could lead to improved meat quality of beef obtained from bulls. Methods studied were carcass electrical stimulation and high temperature conditioning.

Procedures

Animals. Carcasses were obtained from Hereford bulls (44 head) and Hereford steers (27 head) that were born in March or April, weaned at 8 months of age, and fed a corn silage diet until 15 months of age. Animals were then fed, until slaughter, an 84 percent total digestible nutrient corn-corn silage diet supplemented with soybean meal and minerals. Bulls were fed in one pen as a group, and steers were fed in another pen as a group.

Slaughter. Steers were slaughtered when the average 12th rib fat thickness for all steers was .5 in (17 mo of age), as evaluated by visual appraisal. Bulls were slaughtered when the average 12th rib fat thickness for all bulls was .3 in (18 mo of age), as evaluated by visual appraisal. Bulls were selected with less fat thickness than steers because it was considered unreasonable to feed bulls to weights required to attain fat thicknesses equivalent to those of fed market weight steers. It was also considered that one of the competitive advantages of bulls for beef production was leanness.

Postmortem Treatments. Carcasses were split, each side weighed, and the right side electrically stimulated (ES) within 1 h postmortem. The ES consisted of 17 impulses at 550 volts (AC), 2 to 2.5 amps and 60 Hz for a 1.8-sec duration with a 1.8-sec pause between impulses. The left sides were used as controls (Cn). All carcasses were held at a cooler temperature of 60°F for 1 h post-stimulation. Thirty-six bull and steer carcasses were then moved to a 33°F cooler. Thirty-five bull and steer carcasses remained in the 60°F cooler for an additional 12 h postmortem, after which time they were placed in the 33°F cooler.

Carcass Evaluation. Intact longissimus (ribeye) muscle tem-

perature and pH of each side were measured at stimulation and at 1, 2, 3, 6, 12, 18, and 48 h post-stimulation.

Carcasses were evaluated for quality and yield at 48 h post-mortem. Lean color of the longissimus muscle at the 12th rib was scored from 1 = light cherry red through 8 = very dark red after at least a 30-min bloom period.

Sensory Panel. A descriptive attribute panel was used. Panelists evaluated each sample according to differences in juiciness (1 = extremely dry, 8 = extremely juicy), ease of fragmentation (1 = extremely difficult, 8 = extremely easy), amount of connective tissue (1 = abundant, 8 = none), overall tenderness (1 = extremely tough, 8 = extremely tender), and flavor intensity (1 = extremely bland, 8 = extremely intense).

Results

Sex Effects. Bulls had a slower rate of carcass temperature decline than steers. Differences between bulls and steers in carcass temperature diminished with time in the cooler resulting in a significant sex x time interaction. The two groups of carcasses reached equilibrium after being in the cooler for a 48-h period, as would have been expected over this time period. Evidently, heavier carcass weights and thicker longissimus muscles of bulls resulted in a slower chill rate than that of steers.

The longissimus muscles of bulls had higher pH values than steers. Differences between bulls and steers in pH were maintained during the 48-h cooler period.

Means for carcass traits are given in Table 1. Bull beef was darker in color and possessed more advanced lean maturity ratings than steers. Bulls were about 1 month older than steers.

Bulls had less marbling and lower quality grades than steers (Table 1). Bulls also had heavier side weights, larger 12th-rib longissimus muscle areas, and were trimmer than steers.

Cooler Temperature. Least-squares means and standard errors for high (60°F) and low (33°F) temperature treatments are given in Table 2. Lean meat (12th rib) of the 60°F temperature carcasses was slightly less mature in appearance than lean meat from the 33°F temperature treatment. Although 60°F 12th-rib longissimus lean color tended to be lighter in color than that of 33°F 12th-rib lean, the difference was not statistically significant. The practical importance of differences observed in lean maturity are questionable.

With the exception of kidney, pelvic, and heart fat (KPH), variation in the remainder of the traits observed in the cooler was not associated with temperature conditions. There is no explanation apparent to the authors for reduced amounts of KPH fat in the 33°F group.

Electrical Stimulation. Electrical stimulation had no effect on carcass temperature. Electrical stimulation did, however, result in a more rapid pH decline. The more rapid pH decline of ES sides was not associated with improved tenderness. Ultimate pH values for the ES and control sides were similar at 48 h.

Electrically stimulated sides were lighter in color and exhibited more youthful 12th-rib longissimus muscle lean maturity scores than control sides (Table 3). However, no differences in quality grades were observed between sides. Heavier weights of electrically stimulated sides (right side) are likely due to splitting errors and/or variation in KPH fat distribution. Carcasses were graded after a 48-h chill; therefore, lack of improved quality grades due to electrical stimulation was not unexpected. Previous research indicated that ES could be utilized to improve certain quality-indicating characteristics when carcasses were ribbed after a 24-h chill.

Sex condition x ES interactions for palatability traits (except

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lavor) were the only statistically significant interactions. Sensory panel means for sex x ES subclasses are presented in Table 4. Electrical stimulation improved palatability characteristics about one-half a panelist score within the steer group. However, no improvement in palatability characteristics was observed in the bulls. Steers had lower pH and carcass temperatures than bulls. The lower pH of bulls may have been associated with decreased antemortem glycogen levels of bulls. Lower glycogen levels may have prevented violent contraction required for muscle fiber disruption or lysosomal enzyme release described. However, another very likely explanation for the sex x ES interaction was that variation in tenderness in bulls is primarily related to variation in connective tissue and not variation in the myofibrillar component.

Effects of cooler temperature (CT) and sex were important for sensory characteristics. The lack of a meaningful interaction would indicate that CT affected bull and steer carcasses equally. Of interest, however, is whether or not high temperature con-

ditioning (60°F) improved palatability of meat obtained from bull carcasses to approximate meat obtained from steer carcasses under normal chilling conditions (33°F). Means for meat from 60°F bulls for fragmentation ease, amount of connective tissue, and tenderness are generally within one-half a palatability score of meat from 33°F steers. This compared with a difference of one unit in taste panel scores for 33°F bulls vs 33°F steers.

It was concluded that high temperature carcass conditioning and ES were not adequate treatments to improve the palatability of meat obtained from bulls to equal meat obtained from steers. Sensory panel perceived connective tissue was highly associated with panel scores for tenderness, which suggests that variation in tenderness was affected primarily by connective tissue. Consequently, subsequent studies of the effects of sex on connective tissue and the relationship of connective tissue to palatability are recommended.

Table 1.—Means of carcass traits for bulls and steers

Trait	Bulls	Steers
Number (sides).....	88	54
Color ^a	5.82	5.30
Lean maturity ^b	2.00	1.89
Marbling ^c	6.94	8.91
USDA quality grade ^d	7.11	8.39
Side weight, lb.....	387	316
Fat thickness, in.....	.3	.5
Longissimus area, in ²	13.6	10.8
KPH fat, pct.....	1.98	2.58
USDA yield grade.....	2.60	3.44

^aScored: 1 = light to 8 = very dark.

^bScored: 1 = A-, 2 = A, 3 = A+.

^cScored: 6 = traces+, 7 = slight-, 8 = slight+, 9 = slight+.

^dScored: 7 = Good-, 8 = Good, 9 = Good+.

Table 2.—Means of traits for high and low cooler temperatures

Trait	High (60° F)	Low (33° F)
Number.....	70	72
Color.....	5.51	5.60
Lean maturity.....	1.88	2.00
Marbling.....	7.68	8.17

Table 3.—Least-squares means of traits for electrically stimulated and control sides

Trait ^a	Stimulated	Control
Number.....	71	71
Color.....	5.33	5.78
Lean maturity.....	1.89	2.00
Marbling.....	7.97	7.88
USDA quality grade.....	7.82	7.69

^aSee Table 1 for a description of traits.

Table 4.—Least-squares means of sensory panel traits for sex x electrical stimulation subclasses

Trait ^{a, b}	Bull		Steer	
	ES	Control	ES	Control
Number.....	43	43	27	25
Fragmentation ease ^a	5.30	5.41	6.56	6.03
Amt. connective tissue ^b	5.02	5.14	6.33	5.82
Tenderness ^c	5.25	5.36	6.57	6.06
Flavor ^d	5.27	5.51	5.73	5.46

^aScored: 1 = extremely difficult to 8 = extremely easy.

^bScored: 1 = Abundant to 8 = none.

^cScored: 1 = extremely tough to 8 = extremely tender.

^dScored: 1 = extremely bland to 8 = extremely intense.