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Effects of low voltage electrical stimulation on quality characteristics of young bulls fed to 14, 16 and 18 months of age.

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Abstract
Low voltage electrical stimulation of young bulls at 30 to 45 min after bleeding resulted in a lower muscle pH, higher marbling score, lighter cherry red color and reduced incidence of heat ring formation when compared to non-stimulated controls. Ribeye steaks from electrically stimulated sides were more tender than non-stimulated controls, but bottom round steaks were not different. Our results indicate that low voltage electrical stimulation, incorporated into a continuous slaughter operation as late as 30 to 45 min after bleeding, can improve USDA quality characteristics and tenderness of meat from young bulls.

Keywords
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Effects of Low Voltage Electrical Stimulation on Quality Characteristics of Young Bulls Fed to 14, 16 and 18 months of Age.

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Summary

Low voltage electrical stimulation of young bulls at 30 to 45 min after bleeding resulted in a lower muscle pH, higher marbling score, lighter cherry red color and reduced incidence of heat ring formation when compared to non-stimulated controls. Ribeye steaks from electrically stimulated sides were more tender than non-stimulated controls, but bottom round steaks were not different.

Our results indicate that low voltage electrical stimulation, incorporated into a continuous slaughter operation as late as 30 to 45 min after bleeding, can improve USDA quality characteristics and tenderness of meat from young bulls.

Introduction

Electrical stimulation accelerates the rate of pH decline (measure of acidity), reduces the incidence of cold toughening and heat ring formation, increases marbling score and produces a brighter, more youthful colored ribeye muscle. Low voltage electrical stimulation (ES) has been introduced because it is safer and cheaper than high voltage electrical stimulation.

Young bulls for slaughter gain faster and grow more efficiently than steers, but have more variable carcass and meat quality. Our study was designed to find if ES would minimize these problems.

Experimental Procedure

Fifty-four high percentage Simmental bulls were allotted to three slaughter groups of 14, 16 and 18 months of age. Bulls were fed an 85% concentrate ration from weaning (8 mo) until slaughter at a commercial packing plant.* At 30 to 45 min after bleeding (post-mortem), one side of each carcass was stimulated, using low voltage electrical stimulation (ES) consisting of 50 volts of 60 Hz pulsating (1 sec on and 1 sec off for 1 min) current. Carcasses were chilled at 33-37° F. Temperature and pH measurements of ribeye (longissimus, RE) and bottom round (biceps femoris, BR) muscles were taken at 1, 3, 6 and 24 hr after bleeding. Carcass quality measurements were taken at 24 and 48 hr post-mortem.

Wholesale rounds and ribs were stored at 35-39° F. RE and BR steaks were removed at 7 days after death and stored at -4° F until Warner-Bratzler shear force determinations were made.

*Appreciation is extended to Roode Packing Co., Fairbury, Nebraska for their cooperation in slaughtering these bulls.

Results and Discussion

Rates of cooling of the ribeye (RE) and bottom round (BR) muscles were similar (P>.05) for ES and control (C) sides. pH values were lower (P<.05) in ES sides through 6 hr, but by 24 hrs after death pH's were similar (P>.05, Table 3.1). These data indicate a slight increase in pH decline rate due to ES.

At 24 hr after death, ES sides displayed more marbling, a lighter cherry red color and less heat ring than C (P<.05, Table 3.2). ES sides also had a lighter cherry red color, softer lean, and a lower incidence of heat ring than C sides at 48 hr after death (P<.05, Table 3.2). ES improved tenderness (P<.05) for the RE muscle as indicated by a lower Warner-Bratzler shear force (Table 3.3). Overall, ES sides had equal or improved quality characteristics when compared to C sides.

Marbling increased (P<.05) with slaughter age at both 24 and 48 hr evaluation times (Table 3.4). Lean color at 48 hr became darker cherry red with increased slaughter age (P<.05). Also, at 48 hr, bulls slaughtered at 18 mo had (P<.05) a softer and coarser textured lean than bulls slaughtered at 14 and 16 months of age. In addition, bulls slaughtered at 18 mo had greater (P<.05) shear values (less tender) for the BR muscle than bulls slaughtered at 14 mo (Table 3.3). In agreement with other researchers, these results indicate that the optimum slaughter age for young bulls is approximately 14-16 mo of age.

Table 3.1. pH Values of Ribeye (RE) and Bottom Round (BR) Muscle for ES[a] and Control (C) Bull Carcass Sides at 1, 3, 6 and 24 hr After Death.

Hours after death	RE		BR	
	ES	C	ES	C
1[b]	6.7[c]	7.0[d]	6.6[c]	6.8[d]
3	6.3[c]	6.6[c]	6.3[c]	6.5[d]
6	6.0[c]	6.3[d]	6.2[c]	6.3[d]
24	5.7	5.7	5.7	5.7

[a]Low Voltage Electrical Stimulation

[b]pH at 1 hr was taken only on carcasses slaughtered at 14 and 18 mo.

[cd]Means in the same row for each muscle bearing different superscripts are different (P<.05).

Table 3.2. Quality Characteristics at 24 and 48 hr After Death of ES[a] and Control (C) Bull Carcass Sides

Characteristic	24 hr		48 hr	
	ES	C	ES	C
Marbling	Slight[64c]	Slight[58d]	Slight[69]	Slight[69]
Lean Color[b]	3.6[c]	4.0[d]	3.4[c]	3.7[d]
Lean Firmness[b]	4.8	5.0	4.5[c]	4.8[d]
Lean Texture[b]	4.5	4.3	4.6	4.4
Heat Ring[b]	4.9[e]	3.8[f]	4.9[c]	3.9[d]

[a]Low Voltage Electrical Stimulation

[b] Scores: 3 = light cherry red, moderately soft, moderately coarse or moderate; 4 = cherry red, slightly soft, slightly coarse or slight; 5 = slightly dark red slightly firm, slightly fine, or none.

[cd]Means in the same row for either 24 or 48 hr bearing different superscripts are different ($P \leq .05$).

[ef]Treatment x slaughter group interaction resulted from ES having less ($P < .05$) heat ring with each successive slaughter group.

Table 3.3. Warner-Bratzler Shear Force Values (Lbs) for Ribeye (RE) and Bottom Round (BR) Muscles of ES[a] and Control (C) Carcass Sides and Bulls Slaughtered at 14, 16 and 18 Months of Age

Muscle	Treatment		Months of age		
	ES	C	14	16	18
RE	6.0[b]	7.0[c]	6.4	6.2	6.9
BR	10.1	10.0	9.3[b]	10.2[bc]	10.7[c]

[a]Low Voltage Electrical Stimulation

[bc]Means in the same row bearing different superscripts are different ($P < .05$).

Table 3.4. Quality Characteristics at 24 and 48 hr After Death of Bulls Slaughtered at 14, 16 and 18 Months of Age

Characteristic	24 hr			48 hr		
	14 mo	16 mo	18 mo	14 mo	16 mo	18 mo
Marbling	Slt^{34b}	Slt^{64c}	Slt^{84d}	Slt^{44b}	Slt^{77c}	Slt^{87d}
Lean Color[a]	3.3	4.0	4.1	3.2^{b}	3.6^{c}	3.9^{d}
Lean Firmness[a]	4.5	5.2	5.0	4.8^{b}	5.0^{b}	4.1^{c}
Lean Texture[a]	4.5	4.5	4.2	4.7^{c}	5.1^{b}	3.7^{d}

[a]Scores: 3 = light cherry red, moderately soft, or moderately coarse; 4 = cherry red, slightly soft, or slightly coarse; 5 = slightly dark red, slightly firm or slightly fine.

[bcd]Means in the same row for either 24 or 48 hr bearing different superscripts are different ($P<.05$).

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Why Electrical Stimulation Works with Hot Boning

Muscle cells contain a reserve energy source called glycogen. When an animal is killed, the muscle cells continue to metabolize for several hours, converting the glycogen to lactic acid. That causes muscles to become slightly acid (the pH drops), and normal rigor mortis occurs. If a carcass is hot-boned soon after slaughter and the meat chilled rapidly before rigor mortis occurs, a less tender product can result. However, if the carcass is electrically stimulated at slaughter, the resulting muscle contractions cause a quick conversion of glycogen to lactic acid, rigor mortis occurs rapidly, and a tender product results, even though the carcass was hot-boned, chilled and boxed without the usual 48 hours of initial cooling before cutting.

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