Increasing tenderness of beef round and sirloin muscles through prerigor skeletal separations[1]

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ABSTRACT: Crossbred steers ($n = 30$) were used to explore and compare tenderness improvements in beef round and sirloin muscles resulting from various methods of prerigor skeletal separations. Animals were slaughtered according to industry procedures, and at 60 min postmortem one of six treatments was applied to each side: A) control, B) saw pelvis at the sirloin-round junction, C) separate the pelvic-femur joint, D) saw femur at mid-point, E) combination of B and C, and F) combination of B and D. After 48 h, the following muscles were excised from each side: semimembranosus, biceps femoris, semitendinosus, and adductor from the round; vastus lateralis and rectus femoris from the knuckle; and gluteus medius, biceps femoris and psoas major from the sirloin. Following a 10-d aging period, samples were removed from each muscle to determine the effect of treatment on sarcomere length and Warner-Bratzler shear force. Most skeletal separation treatments resulted in longer sarcomeres than controls for semimembranosus, adductor, semitendinosus, and gluteus medius muscles. All skeletal separation treatments yielded shorter sarcomeres for the psoas major as compared with controls. Warner-Bratzler shear force differed among treatments for rectus femoris, semitendinosus, and psoas major. For rectus femoris, treatments C, D, E, and F resulted in lower ($P < 0.05$) shear values than for controls. Treatments B, D, and F increased shear force of the semitendinosus relative to controls ($P <$ J. Anim. Sci. 2002. 80:123–128

Introduction

The National Beef Tenderness Survey (Morgan et al., 1991), conducted in 1990, identified problems with tenderness in beef rounds and top sirloin steaks. A follow-up study, the National Beef Tenderness Survey-1998 (Brooks et al., 2000), revealed that improvements in tenderness of cuts from the round were still needed. In an effort to improve tenderness, some researchers have centered on physically stretching or controlling the shortening of sarcomeres during rigor development.

Two methods of prerigor muscle stretching that have been considered and extensively investigated include alternative suspension of carcasses, first studied by Herring et al. (1965) and Hostetler et al. (1970b), and applying tension to muscles with weights or mechanical devices (Buege and Stouffer, 1974; Sonaiya and Stouffer, 1982). Even hind leg "twisting" (Odusanya and Okubanjo, 1983) has been attempted. However, these procedures have not been readily adopted by the industry.

More recently, researchers at Virginia Polytechnical Institute and State University (Wang et al., 1994; 1996; Ludwig et al., 1997) and later in a commercial setting (Claus et al., 1997) and at the University of Arkansas (Beaty et al., 1999) have examined prerigor skeletal cuts (separations) to improve beef tenderness. This procedure, sometimes referred to as the "Tendercut Process," has been tested on the longissimus muscle and on sirloin and round cuts. Researchers have found tenderness improvements in the longissimus muscle, round, and sirloin; but the greatest improvement has been shown in the longissimus muscle. Furthermore, these researchers have only reported results for one cut location in the round/sirloin region, and tenderness improvements have not been reported on all of the major round and sirloin muscles. Therefore, this study was

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[1] Published with the approval of the director of the South Dakota Agric. Exp. Sta. as publ. no. 3260 of the journal series. This research was funded in part by a grant from the South Dakota Beef Industry Council.

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Received January 8, 2001.

Accepted August 21, 2001.

Table 1. , ,

Trait	Mean	SD	Minimum	Maximum
Live weight, kg	560	14	539	581
Hot carcass wt, kg	346	10	330	363
Adjusted fat thickness, cm	1.22	0.36	0.64	2.29
Longissimus muscle area, cm^2	80.6	7.7	69.0	98.7
Actual kidney, pelvic, and heart fat, %	3.5	0.7	2.4	5.1
USDA yield grade	3.3	0.7	2.0	4.9
Overall maturity[a]	154	11	130	180
Marbling score[b]	413	57	330	570

[a] 100 = A^{00}, 200 = B^{00}, etc.
[b] 300 = $Slight^{00}$, 400 = $Small^{00}$, etc.

Results and Discussion

Mean carcass trait values (Table 1) were generally representative of the population sampled in the 1995 NBQA (Boleman et al., 1998). However, less variation (lower SD) existed among carcasses in this project than in the 1995 NBQA. Therefore, this group of carcasses was an excellent test sample because they were: a) representative of the industry average, and b) consistent.

Table 2 presents least squares means for initial and total 24-h carcass length drop of treated and control sides. Treatment F resulted in the greatest initial carcass length drop (7.4 cm); treatments B, D, and E were intermediate; and treatment C resulted in the least amount of initial carcass length drop (3.2 cm). Subsequently, sides subjected to treatment F had the largest amount of total carcass length drop at 24 h (10.6 cm).

Sarcomere lengths differed among treatments for the SM, AD, ST, GM, and PM muscles (Table 3). In general, either treatments B and C individually or combined (treatment E) were the most effective at lengthening sarcomeres. For the SM, treatments B, C, E, and F resulted in longer sarcomeres than controls. For the AD, treatments B, C, D, and E resulted in longer sarcomeres than controls. For the ST, treatment C resulted in longer sarcomeres than controls. For the GM, only treatments B and E resulted in longer sarcomeres than controls. Correspondingly, Beaty et al. (1999) found that the Tendercut process, which is analogous to treatment B in the current study, increased sarcomere length in the SM and ST muscles. Apparently, longer sarcomeres observed in the current study for the SM, AD, ST, and GM were due to stretching that resulted from the skeletal separations. Differences in the magnitude of response for sarcomere length among muscles subjected to different treatments were probably influenced by the proximity of the individual muscle in relation to skeletal separation point and by muscle fiber orientation in relation to tension.

All treatments yielded shorter sarcomeres in the PM muscle as compared with controls (Table 3). Herring et al. (1965) observed similar outcomes; they discovered that horizontal placement vs conventional suspension of carcasses resulted in lengthened sarcomeres for several muscles, but considerably shortened sarcomeres for the PM. In the current study, control sides had an average sarcomere length of 3.52 µm, vs 2.41 µm for the average of treatments B through F. Treatment D resulted in a lesser degree of sarcomere shortening as compared with the other treatments, which was likely due to the greater linear distance between the point of skeletal separation (midpoint of the femur) and the PM muscle. Thus, with treatment D, intact connective tissue and tendons associated with the PM muscle may have maintained adequate resistance, hence keeping sarcomeres from shortening as much as with other treatments. In contrast to treatment D, the posterior insertion of the PM muscle was in close proximity to the site of treatment application for B, C, E, and F. Therefore, shorter sarcomeres found in the PM for treatments B, C, E, and F were probably a result of tension release, which probably occurred when connective tissue and tendons associated with the PM muscle were severed during treatment application.

Table 2. ( ) -
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	Treatment[a]							
Trait	A	B	C	D	E	F	*P*-value	RMSE
Initial carcass length drop	0.0^b	4.3^{cd}	3.2^c	4.1^{cd}	4.9^d	7.4^e	0.0001	1.5
Total 24-h carcass length drop	4.3^b	7.1^c	7.2^c	6.1^{bc}	7.9^c	10.6^d	0.0001	2.3

[a] A = control; B = saw pelvis at the sirloin-round junction; C = separate the pelvic-femur joint; D = saw femur at the mid-point; E = combination of B and C; F

Table 3. ( )

Muscle	Treatment[a]						*P*-value	RMSE
	A	B	C	D	E	F		
Round								
Semimembranosus (top round)	1.82^{b}	2.00^{ed}	1.91^{cd}	1.88^{cb}	2.04^{e}	1.96^{cde}	0.0002	0.10
Adductor (top round)	1.88^{bde}	2.02^{cde}	2.13^{dd}	2.03^{cd} Adductor (top	2.02^{cd88}			

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