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Steven C. Seideman
Bryan Meats

H. Russell Cross
Texas A & M University

John D. Crouse
U.S. Meat Animal Research Center

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Introduction

Numerous studies have shown that meat from bulls is less tender than meat from steers of comparable age and feeding regimen. Collagen crosslinking has been reported to be more extensive in bulls than in steers of similar age and has been implicated as a potential cause of toughness in meat from bulls.

Several studies have shown that blade tenderization improved the tenderness of beef and decreased the amount of sensory panel-detectable connective tissue. Also, it has been reported that blade tenderization of bull muscles resulted in steaks which required less time to cook, had decreased amounts of detectable connective tissue, and had increased tenderness, flavor, and overall palatability ratings. The objectives of this study were to: (1) determine if mechanical tenderization would increase the tenderness of bull beef to a level equal to that of steer beef; and (2) determine the number of passes through a mechanical tenderizer needed to achieve this desired effect.

Procedure

Ten bulls and ten steers of the same breed (Brown Swiss) and age (13 mo) were slaughtered. After a 24-hr chill, carcasses were evaluated for muscle firmness (8 = very firm; 1 = very soft); lean color (8 = light grayish red; 1 = black); lean texture (8 = very fine; 1 = very coarse); lean maturity (100-199 = A; 200-299 = B); skeletal maturity (100-199 = A; 200-299 = B); overall maturity (100-199 = A; 200-299 = B); marbling (000-100 = devoid; 900-1000 = abundant); fat thickness; adjusted fat thickness; percent kidney, pelvic, and heart fat; and ribeye area. The round semimembranosus (SM), biceps femoris (BF), and longissimus dorsi (LD) muscles were removed from both right and left sides (24 hr postmortem), vacuum packaged, and aged for 1 wk. Muscles were then cut into two equal portions perpendicular to fiber direction, and the four half-muscle sections were randomly assigned to one of four treatments to include control (OX), one pass through a Ross TC-700 mechanical tenderizer (1X), two passes (2X), or three passes (3X). Steaks (1.2 in thick) were cut from the LD muscle while all other muscles remained as roasts and were wrapped in polyethylene-coated freezer paper and frozen for 2 wk. Roasts and steaks were thawed and either broiled on Farberware grills (LD) or in convection ovens (SM and BF). Internal temperatures were monitored by iron/constantan thermocouples attached to a recorder. The difference between thawed and cooked wt determined cooking loss.

Sensory panelists were asked to evaluate juiciness (8 = extremely juicy, 1 = extremely dry), ease of fragmentation (8 = extremely easy, 1 = extremely difficult), amount of detectable connective tissue (8 = none, 1 = abundant), overall tenderness (8 = extremely intense, 1 = extremely bland), and off-flavor (4 = none, 1 = intense). In addition, six 1.3 cm diameter cores from each muscle (LD, BF, and SM) were removed parallel to fiber direction and sheared twice each on a Warner-Bratzler shear device attached to an Instron Universal Testing Instrument.

Results

Mean values for carcass characteristics of bulls and steers are presented in Table 1. Bull carcasses had significantly lower mean values for adjusted fat thickness; kidney, pelvic, and heart fat; marbling; and USDA quality grade. The fact that bulls deposit less carcass fat than steers has been reported in numerous studies.

Table 1—Carcass characteristics of bulls and steers

Carcass characteristic	Sex condition[e] Bulls	Steers
Lean firmness[a]	5.6	5.6
Lean color[b]	4.2	4.9
Lean texture[a]	5.5	5.0
Skeletal maturity[c]	A^{24}	A^{20}
Lean maturity	A^{25}	A^{29}
Overall maturity[c]	A^{24}	A^{24}
Hot carcass wt (lb)	600	611
Fat thickness (in)	.12	.18
Adjusted fat thickness (in)	.11	.16
Ribeye area (in^2)	12.4	12.2
Kidney, pelvic, & heart fat (%)	1.80	2.45
Marbling[d]	T^{83}	SL^{70}
Quality grade	ST+	G+

[a]Means according to an 8-point scale (8 = very firm or very fine; 1 = very soft or very coarse).
[b]Means according to an 8-point scale (8 = light grayish red; 1 = black).
[c]Means according to an open scale (A = 100-199; B = 200-299).
[d]Means according to an open scale (000-100 = devoid; 900-1,000 = Abundant).
[e]Means underscored by a common line are different ($P < .05$).

Effects of multiple passes through a mechanical tenderizer on cooking characteristics and textural and sensory properties are shown in Table 2. Cooking loss of all three muscles generally increased with additional passes through the mechanical tenderizer. However, this difference was not always consistent enough for statistical significance. Passing the SM and LD muscles through a mechanical tenderizer one or more times generally decreased peak load.

Effects of multiple passes through a mechanical tenderizer on sensory properties are shown in Table 2. These means represent the average of both sex conditions. Each pass through a mechanical tenderizer generally increased sensory panel ease of fragmentation rating, improved amount of detectable connective tissue (e.g., reduced detection of connective tissue), improved overall tenderness ratings, and improved off-flavor ratings.

Sensory panel attributes of mechanically tenderized LD steaks from bulls and steers are shown in Table 2.

[1]Seideman is employed by Bryan Meats, West Point, Mississippi (formerly a research food technologist, MARC); Cross is a professor of animal science, Texas A&M University (formerly the meats research leader, MARC); and Crouse is the research leader, Meats Unit, MARC.

[2]The full report of this work was published in J. Food Quality 9:49-56, 1986.

Table 2—The effect of multiple passes through a mechanical tenderizer on cooking characteristics and textural and sensory properties

Muscle	Cooking characteristics, textural, or sensory properties	Passes through mechanical tenderizer[e] OX	1X	2X	3X
Textural properties					
Biceps femoris					
	Cooking loss (%)	28.75[c]	30.25[bc]	32.02[ab]	32.86[a]
	Cooking time (min)	2.12[a]	2.09[a]	1.80[b]	1.63[b]
	Peak load (lb)	7.5[ab]	6.7[bc]	8.0[a]	6.3[c]
Semimembranosus					
	Cooking loss (%)	33.94[c]	36.09[ab]	36.35[a]	34.81[bc]
	Cooking time (min)	2.07[a]	2.18[a]	2.09[a]	1.92[a]
	Peak load (lb)	8.8[a]	7.0[b]	7.1[b]	7.3[b]
Longissimus dorsi					
	Cooking loss (%)	28.76[a]	28.88[a]	32.60[a]	31.06[a]
	Cooking time (min)	0.58[ab]	0.48[c]	0.60[a]	0.53[bc]
	Peak load (lb)	10.7[a]	7.8[b]	7.2[b]	6.8[b]
Sensory properties					
Longissimus dorsi					
	Juiciness	5.5[a]	5.3[a]	5.5[a]	5.5[a]
	Ease of fragmentation	5.0[d]	5.3[c]	5.7[b]	6.0[a]
	Amount of connective tissue	4.9[c]	5.3[b]	5.7[a]	5.9[a]
	Overall tenderness	5.0[d]	5.4[c]	5.7[b]	6.0[a]
	Flavor intensity	5.8[a]	5.7[a]	5.8[a]	5.8[a]
	Off-flavor	2.4[c]	2.7[b]	2.6[b]	2.8[a]

[abcd]Means within the same row followed by a different superscript are different ($P < 0.05$).
[e]Means represent the average of both sex conditions.

The original objective of this study was to determine if mechanical tenderization would increase the tenderness of bull beef to the level of steer beef. However, the meat from bulls was only 0.3 sensory tenderness units less tender than meat from steers (4.9 *vs* 5.2). This small tenderness difference may have been attributed to the age of the bulls at slaughter (13 mo) but does tend to reinforce the contention that meat from bulls is less tender than meat from steers. Passing of bull beef once (1X) through a mechanical tenderizer improved the sensory tenderness ratings to those observed in untenderized meat from steers. Increasing the number of passes through the mechanical tenderizer generally increased sensory tenderness ratings by 0.3 units of meat from both bulls and steers.

Based on the results of this study, it can be concluded that the passing of the SM and LD muscles through a mechanical tenderizer one or two times will decrease peak load. Passing of beef through a mechanical tenderizer will improve tenderness rating and will probably increase the tenderness of bull beef to a comparable level to steer beef if the bull beef is initially tough.