Shear Force Determination Of Value Added Beef From The Chuck And The Round

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Story in Brief

Individual beef chuck and round muscles representing various USDA quality grades were evaluated to assess their potential as a value-added foodservice steak from underutilized beef muscles. Four chuck muscles and four round muscles were utilized in this study. Individual muscles were trimmed free of visible connective tissue and further processed into 0.2 kg portion sized steaks. Steaks were then subjected to one of two treatments (treated or negative control). Treated muscles were mechanically tenderized twice, using a needle tenderizer, and their steaks were marinated for two 6-min cycles in a vacuum tumbler utilizing a marinade consisting of water, Aspergillus oryzae, and salt. Steaks were then allowed to reach a combined age of 21 days before further analysis. Steaks were evaluated for tenderness via Warner-Bratzler shear force determination. Treated steaks from the semimembranosus, triceps brachii, and vastus lateralis had lower shear force values than their non-treated counterparts. Among steaks with a significant grade effect, USDA Choice infraspinatus, triceps brachii, and biceps femoris had the lowest shear force values. USDA Standard and Choice steaks from rectus femoris and teres major muscles that had been treated, exhibited the lowest shear force values among steaks with a significant grade by treatment interaction. These data suggest that treated USDA Choice steaks, especially those isolated from the infraspinatus, rectus femoris, and teres major, exhibit the most potential for producing palatable steaks based on their overall shear force values.

Key Words: Beef, Muscle Profiling, Shear Force

Introduction

The wholesale beef chuck and round represent a large percentage of a beef carcass. Unfortunately, cuts from the chuck and the round have traditionally been of low value and fabricated into low-priced roasts, steaks, and or ground beef. The objective of this study was to evaluate the potential for developing palatable steaks from underutilized beef muscles. To carry out this study, four chuck muscles (infraspinatus, triceps brachii, teres major, and supraspinatus) and four round muscles (rectus femoris, vastus lateralis, biceps femoris, and semimembranosus) were identified. USDA quality grades (Choice, Select, and Standard) were sampled to determine the effect of mechanical tenderization and marination on the Warner-Bratzler shear force of steaks produced from individual muscles coming from the chuck and the round.

Materials and Methods

Sub-primals. Beef chuck and round sub-primals consisting of the shoulder clod, Institutional Meat Purchase Specifications (IMPS) #114 (NAMP 1997); chuck tender, IMPS #116B (NAMP 1997); knuckle, IMPS #167A (NAMP1997); inside round, IMPS #169A (NAMP1997); and outside round, IMPS #171B (NAMP1997) were obtained from a federally inspected beef processing plant in Dodge City, Kansas and shipped to the Food and Agricultural Products

Center (FAPC) at Oklahoma State University. Sample sizes consisted of: shoulder clod, n=35 per grade; chuck tender, n=35 per grade; knuckle, n=30 per grade; inside round, n=20 per grade; and outside round, n=20 per grade. Upon arrival, the sub-primals were fabricated into individual muscles and completely denuded of fat and connective tissue using a Townsend® skinner (Townsend Engineering Co., Des Moines, IA). Individual muscles were then vacuum packaged and stored in a 4ºC cooler until transport to National Steak and Poultry (NSP) in Owasso, Oklahoma for further processing.

Fabrication, Marination and Tenderization of Steaks. Muscles were randomly segregated into two groups (a treated group and a control group) to obtain an equal representation of each muscle and grade per treatment. The treated muscles were mechanically tenderized twice, utilizing a ROSS® needle tenderizer (Ross Industries, Inc., Midland, VA). The treated muscles were then cut into 0.2 kg (7 oz) steaks by expert cutters and marinated for two 6-min cycles in a vacuum tumbler utilizing a marinade consisting of water, Aspergillus oryzae (tenderizer), and salt. The control muscles were fabricated into 0.2 kg steaks and vacuum packaged. All steaks were then individually vacuum-packaged and allowed to reach 21 d of aging (combined age for sub-primal and steak) in a 4ºC cooler before being frozen at -30°C. After the samples were completely frozen they were stored at -10ºC.

Shear Force Determination. Warner-Bratzler shear force was evaluated for all muscles, grades, and treatment groups. Thawed, 0.2 kg (7 oz) steaks were cooked to an internal temperature of 70°C (medium degree of doneness) on a commercial flame-broil grill (Model RB-846-C, Rankin Inc., Whittier, CA) within the FAPC. Samples were then allowed to cool to room temperature (26ºC) before coring and shearing. Cores (approximately six per sample) were taken parallel to the muscle fiber and then sheared perpendicular to the muscle fiber orientation on a Universal Instron Testing Machine with a Warner-Bratzler head attachment.

Data were blocked by muscle and analyzed using least squares analysis of variance (PROC GLM; SAS Institute, Cary, NC). The model included treatment, quality grade, and interaction to evaluate their effect on shear force. Means were separated using least significant difference.

Results and Discussion

Among steaks with a significant main effect for treatment, treated steaks had the lowest shear force values (Table 1), indicating improved tenderness. Treated steaks from both the semimembranosus and triceps brachii had mean shear force values of less than 4.6 kg and 3.9 kg, respectively (Table 1). This indicates that these steaks should have a 50% and 68% chance, respectively, of being rated as “slightly tender” or higher according to tenderness threshold values reported by Shackelford et al. (1991). While values of less than or equal to 3.9 kg are considered acceptable, mean shear force values obtained in this study are slightly higher than values for clod and top round steaks reported in the National Beef Tenderness Survey-1998 (Brooks et al., 2000).

Table 1. Least squares means and standard errors for Warner-Bratzler shear force values (kg) of steaks from muscles with a significant main effect for treatment

	Treatment

Muscle	Control	Treated
Semimembranosus	$4.98^{a} \pm .09$	$4.55^{b} \pm .09$
Triceps brachii	$4.44^{a} \pm .06$	$3.61^{b} \pm .06$
Vastus lateralis	$5.22^{a} \pm .08$	$4.80^{b} \pm .08$
^{a,b}Within a row, means without a common superscript letter differ ($P<.01$)		

Among steaks with a significant grade effect, USDA Choice steaks showed the lowest shear force values (Table 2). There was no significant difference for Warner-Bratzler shear force between USDA Select and USDA Standard steaks, within a muscle. Steaks isolated from the infraspinatus and triceps brachii had mean shear force values below the threshold of 4.6 kg, regardless of USDA quality grade, while biceps femoris steaks had shear force values well above 4.6 kg (Table 2). Infraspinatus steaks had the lowest mean shear force values of all muscles sampled, with values ranging from 2.68 kg for USDA Choice to 2.98 kg for USDA Standard (Table 2). According to Miller et al. (1998), shear force values of less 3.0 kg should result in 100% consumer satisfaction for tenderness.

Table 2. Least squares means and standard errors for Warner-Bratzler shear force values (kg) of steaks form muscles with a significant main effect for USDA quality grade

	USDA Quality Grade		
Muscle	Choice	Select	Standard
Biceps femoris	$5.24^{a} \pm .19$	$6.03^{b} \pm .19$	$6.12^{b} \pm .19$
Infraspinatus	$2.68^{a} \pm .06$	$2.88^{b} \pm .06$	$2.98^{b} \pm .06$
Triceps brachii	$3.60^{a} \pm .07$	$4.26^{b} \pm .07$	$4.22^{b} \pm .07$
^{a,b}Within a row, means without a common superscript letter differ ($P<.01$)			

The rectus femoris and teres major muscles had a significant grade by treatment interaction for Warner-Bratzler shear force. USDA Standard and Choice steaks from treated rectus femoris and teres major muscles exhibited the lowest ($P<.01$) shear force values (Table 3). All mean values, excluding USDA Choice non-treated teres major, had a shear force value of less than 4.6 kg, while all treated muscles had a shear force value of less than 3.9 kg (Table 3).

Table 3. Least squares means and standard errors for Warner-Bratzler shear values (kg) of steaks with a grade x treatment interaction

	USDA Quality Grade		
Muscle	Choice	Select	Standard
Rectus femoris			
Control	$3.48^{c} \pm .16$	$3.01^{ab} \pm .17$	$4.46^{d} \pm .17$
Treated	$2.99^{ab} \pm .16$	$3.33^{bc} \pm .16$	$2.80^{a} \pm .16$
Teres major			
Control	$4.73^{d} \pm .14$	$3.78^{b} \pm .10$	$4.13^{c} \pm .11$
Treated	$3.33^{a} \pm .13$	$3.70^{b} \pm .10$	$3.40^{a} \pm .10$
^{a,b,c,d}Means without a common superscript differ ($P<.01$)			

Neither treatment nor USDA quality grade had a significant effect on supraspinatus shear force values (Table 4). Mean shear force values for the supraspinatus ranged from 4.35 kg for treated-USDA Choice steaks, to 5.01 kg for treated-USDA Standard steaks (Table 4).

Table 4. Least squares meansa and standard errors for Warner-Bratzler shear values (kg) of steaks from the Supraspinatus			
	USDA Quality Grade		
Treatment	Choice	Select	Standard
Control	4.76 ± .39	4.38 ± .39	4.63 ± .39
Treated	4.35 ± .39	4.47 ± .39	5.01 ± .41
[a]None of the means were statistically different (P>.05)			

Conclusions

While more research is needed to explore consumer and industry acceptance of these muscles, data show several muscles have potential as foodservice steaks. These data suggest that treated USDA Choice steaks, especially those isolated from the infraspinatus, rectus femoris, and teres major, exhibit the most potential for producing palatable value-added steaks, based on their overall shear force values. Ultimately the value of these muscles will, to some extent, be based on packer's willingness to isolate these muscles. Labor cost, excess trimmings, and purge loss are factors which must be weighed and considered. Consideration of these factors, along with the palatability ratings and shear force values, will determine which muscles truly add value to beef carcasses.

Literature Cited

Brooks, J.C. et al. 2000. J. Anim. Sci. 78:1852-1860.

Miller, M. F. et al. 1998. Paper presented at AMSA Annu. Recip. Meat Conf, Storrs, CT.

NAMP. 1997. The Meat Buyers Guide. 1st ed. North American Meat Processors Assoc, Reston, VA.

Shackelford, S.D. et al. 1991. J. Muscle Foods 2:289-296.

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