

# VALUE ADDED MEAT PRODUCTS UTILIZING BEEF CHUCK AND ROUND MUSCLES FROM VARIOUS USDA QUALITY GRADES

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**Abstract:** Eight muscles representing various USDA quality grades (Choice, Select, and Standard) were evaluated to assess their potential as a value-added steak from underutilized beef muscles. 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 marination treatments (treated or negative control). Steaks were evaluated for sensory characteristics via consumer panel (USDA Choice only) and trained sensory panel, as well as, Warner-Bratzler shear force. Infraspinatus, rectus femoris, and teres major received the highest ( $P < 0.05$ ) overall acceptability and tenderness ratings, whereas the vastus lateralis had the lowest overall acceptability scores among all muscles evaluated. The vastus lateralis, biceps femoris, semimembranosus, and supraspinatus received the lowest ( $P < 0.05$ ) tenderness ratings among all steaks evaluated by consumers. Treated steaks from the eight muscles ranked significantly higher for all sensory attributes when compared to their non-treated control ( $P < 0.01$ ). Trained sensory panel evaluations varied greatly by grade and treatment, with a grade by treatment interaction evident for several muscles. Generally speaking, treated steaks received more favorable ratings than their non-treated counterparts for all sensory attributes. Grade effects varied, with USDA Choice muscles receiving higher scores in most instances. For muscles with quality grade by treatment interactions, treated steaks from USDA Choice carcasses generally received the most favorable ratings. Among steaks with a significant main effect for treatment, treated steaks from the semimembranosus, triceps brachii, and vastus lateralis had the lowest shear force values ( $P < 0.05$ ). Among steaks with a significant grade effect, USDA Choice infraspinatus, triceps brachii, and biceps femoris showed the lowest shear force values ( $P < 0.01$ ). 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 rectus femoris and teres major muscles that had been treated, exhibited the lowest ( $P < 0.01$ ) shear force values. Finally, neither treatment nor USDA quality grade had an effect on supraspinatus Warner-Bratzler shear force values. These data show that treated USDA Choice steaks, especially those isolated from the infraspinatus, rectus femoris, and teres major, exhibited the most potential for producing palatable value-added steaks.

## Introduction

The wholesale beef chuck and round represents a large percentage of a beef carcass. Unfortunately, cuts from the chuck and the round have traditionally been of low value. Typically, the chuck and the round are 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 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, trained sensory panel evaluations, and consumer ratings of steaks produced from individual muscles coming from the chuck and the round.



Consumer Panel



Teres Major Steaks



Steak Fabrication

## Materials and Methods

### Sub-primals

Beef chuck and round sub-primals consisting of the shoulder clod (IMPS #114; n = 35 per grade), chuck tender (IMPS #116B; n = 35 per grade), knuckle (IMPS #167A; n = 30 per grade), inside round (IMPS #169A; n = 20 per grade) and outside round (IMPS #171B; n = 20 per grade) 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. Upon arrival, the sub-primals were fabricated into individual muscles and completely denuded. Fabrication time and yields were measured.

### Fabrication, Marination and Tenderization of Steaks

Muscles were randomly segregated into a treated group and a control group. The treated muscles were mechanically tenderized (twice), cut into 0.2 kg steaks by expert cutters and marinated (two, 6-minute cycles) in a vacuum tumbler with a marinade consisting of water, *Aspergillus oryzae*, and salt. Fabrication time and yield data was obtained from the control steaks. All steaks were allowed to reach 21 days of aging (combined age for sub-primal and steak) before further analysis.

### Consumer Panel

Consumer panel evaluations were held in a restaurant setting, at Taylor Dining (Human Environmental Science Building, on the Oklahoma State University Campus). Only USDA Choice steaks were evaluated. All steaks were cooked to 70°C (medium degree of doneness) on a commercial flame-broil grill. The steak samples consisted of a treated portion, a non-treated portion of the same muscle, and a portion of untreated Certified Angus Beef® top loin steak that had been aged for 21 d postmortem. Panelists ranked the steaks using a nine-point scale for overall like, flavor, juiciness, tenderness, and a five-point scale for purchase intent.

### Shear Force Determination

Thawed, 0.2 kg 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). Samples were then allowed to cool to room temperature (26°C) 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.

### Trained Sensory Panel

Trained sensory panel evaluations took place over an eight-day period. During this time two separate trained panel groups (consisting of six to eight panelists) evaluated samples twice daily. Panelists were asked to evaluate samples for tenderness, juiciness, connective tissue amount, and overall acceptability using an eight-point scale, and uncharacteristic flavor using a four-point scale. Steaks were cooked to an internal temperature of 70°C (medium degree of doneness) on a commercial flame-broil grill and served warm.

### Statistical Analysis

Data were analyzed using least squares analysis of variance (PROC GLM; SAS Institute, Cary, NC). Models included muscle, treatment, and/or quality grade, as well as, interactions to evaluate their effect on sensory attributes and shear force values. Means were separated using least significant difference.

## Results and Discussion

### Warner-Bratzler Shear Force

Among steaks with a significant main effect for treatment (Table 1), treated semimembranosus, triceps brachii, and vastus lateralis steaks had the lowest shear force values ( $P < 0.01$ ). Among steaks with a significant grade effect (Table 2), USDA Choice infraspinatus, triceps brachii, and biceps femoris steaks had the lowest shear force values ( $P < 0.01$ ). 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 ( $P < 0.01$ ) shear force values (Table 3). Finally, neither treatment nor USDA quality grade had an effect on supraspinatus Warner-Bratzler shear force values (data not shown).

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

Muscle	Treatment	
	Control	Treated
Semimembranosus	4.98 <sup>a</sup> ± 0.09	4.55 <sup>b</sup> ± 0.09
Triceps brachii	4.44 <sup>a</sup> ± 0.06	3.61 <sup>b</sup> ± 0.06
Vastus lateralis	5.22 <sup>a</sup> ± 0.08	4.80 <sup>b</sup> ± 0.08

<sup>a,b</sup>Within a row means without a common superscript letter differ ( $P < 0.01$ )

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

Muscle	USDA Quality Grade		
	Choice	Select	Standard
Biceps femoris	5.24 <sup>a</sup> ± 0.19	6.03 <sup>b</sup> ± 0.19	6.12 <sup>b</sup> ± 0.19
Infraspinatus	2.68 <sup>a</sup> ± 0.06	2.88 <sup>a</sup> ± 0.06	2.98 <sup>a</sup> ± 0.06
Triceps brachii	3.60 <sup>a</sup> ± 0.07	4.26 <sup>b</sup> ± 0.07	4.22 <sup>b</sup> ± 0.07

<sup>a,b</sup>Within a row means without a common superscript letter differ ( $P < 0.01$ )

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

Muscle	USDA Quality Grade			
	Choice	Select	Standard	
Rectus femoris	Control	3.48 <sup>a</sup> ± 0.16	3.01 <sup>ab</sup> ± 0.17	4.46 <sup>b</sup> ± 0.17
	Treated	2.99 <sup>ab</sup> ± 0.16	3.33 <sup>ab</sup> ± 0.16	2.80 <sup>a</sup> ± 0.16
Teres major	Control	4.73 <sup>a</sup> ± 0.14	3.78 <sup>b</sup> ± 0.10	4.13 <sup>b</sup> ± 0.11
	Treated	3.33 <sup>b</sup> ± 0.13	3.70 <sup>b</sup> ± 0.10	3.40 <sup>b</sup> ± 0.10

<sup>ab</sup>Means without a common superscript differ ( $P < 0.01$ )

## Consumer Panel

The infraspinatus, rectus femoris, and teres major received the highest ( $P < 0.05$ ) consumer overall acceptability and tenderness ratings, whereas the vastus lateralis had the lowest overall acceptability scores among all muscles evaluated (Table 4). The vastus lateralis, biceps femoris, semimembranosus, and supraspinatus received the lowest ( $P < 0.05$ ) tenderness ratings among all steaks evaluated by consumers (Table 4). Treated steaks from the eight muscles ranked significantly higher ( $P < 0.01$ ) for all consumer sensory attributes when compared to their non-treated control (data not shown).

**Table 4.** Least squares means for consumer responses by muscle

Item	Triceps <sup>1</sup>	Intra <sup>2</sup>	Teres <sup>3</sup>	Biceps <sup>4</sup>	Semi <sup>5</sup>	Vastus <sup>6</sup>	Rectus <sup>7</sup>	Supra <sup>8</sup>
Overall <sup>1</sup>	5.7 <sup>a</sup>	7.0 <sup>b</sup>	6.1 <sup>b</sup>	5.0 <sup>c</sup>	5.7 <sup>b</sup>	4.8 <sup>c</sup>	6.4 <sup>b</sup>	6.0 <sup>b</sup>
Flavor <sup>2</sup>	5.5 <sup>ab</sup>	6.7 <sup>b</sup>	6.0 <sup>bc</sup>	6.0 <sup>bc</sup>	5.5 <sup>bc</sup>	5.1 <sup>c</sup>	6.2 <sup>bc</sup>	5.9 <sup>b</sup>
Juiciness <sup>3</sup>	5.6 <sup>b</sup>	7.0 <sup>c</sup>	5.6 <sup>b</sup>	5.8 <sup>b</sup>	5.6 <sup>b</sup>	4.3 <sup>a</sup>	5.7 <sup>b</sup>	5.9 <sup>b</sup>
Tenderness <sup>4</sup>	5.2 <sup>ab</sup>	7.1 <sup>c</sup>	6.2 <sup>bc</sup>	5.3 <sup>c</sup>	5.2 <sup>c</sup>	4.8 <sup>c</sup>	6.4 <sup>b</sup>	5.6 <sup>bc</sup>
Purchase <sup>5</sup>	3.0 <sup>ab</sup>	3.8 <sup>b</sup>	3.2 <sup>b</sup>	3.0 <sup>b</sup>	3.0 <sup>b</sup>	2.6 <sup>a</sup>	3.4 <sup>bc</sup>	3.1 <sup>b</sup>

<sup>1-5</sup>Within a row, means without a common superscript letter differ ( $P < 0.01$ )  
<sup>1</sup>Overall: 4=slightly dislike; 5=neither like nor dislike; 6=slightly like; 7=like  
<sup>2</sup>Flavor: 4=neither like nor dislike; 6=slightly like  
<sup>3</sup>Juiciness: 4=moderately dry; 5=slightly dry/slightly juicy; 6=moderately juicy; 7=very juicy  
<sup>4</sup>Tenderness: 4=moderately tough; 5=slightly tough/slightly tender; 6=moderately tender; 7=very tender  
<sup>5</sup>Purchase: 2=Probably would not buy if this steak were offered on foodservice menu; 3=Might or might not buy if this steak were offered on a foodservice menu  
<sup>1</sup>Triceps=Triceps brachii; <sup>2</sup>Intra=Infraspinatus; <sup>3</sup>Teres=Teres major; <sup>4</sup>Biceps=Biceps femoris; <sup>5</sup>Semi=Semimembranosus; <sup>6</sup>Vastus=Vastus lateralis; <sup>7</sup>Rectus=Rectus femoris; <sup>8</sup>Supra=Supraspinatus

## Trained Sensory Panel

Trained sensory panel evaluations varied greatly by grade and treatment, with a grade by treatment interaction evident for several muscles. Generally, treated steaks received more favorable ratings than their non-treated counterparts for all sensory attributes. Grade effects varied, with USDA Choice muscles receiving higher scores in most instances. For muscles with quality grade by treatment interactions, treated steaks from USDA Choice carcasses generally received the most favorable ratings. Trained sensory panel scores for tenderness are presented in Table 5. Biceps femoris steaks had a significant treatment effect for tenderness with treated steaks receiving a "slightly tender" rating. Teres major steaks had a significant grade effect for tenderness, with USDA Standard steaks receiving higher ratings than USDA Select steaks. However, all teres major steaks received a tenderness score of "moderately tender". Infraspinatus, rectus femoris, semimembranosus, supraspinatus, triceps brachii, and vastus lateralis had a grade by treatment interaction for tenderness. Non-treated USDA Choice, Select, and Standard semimembranosus and triceps brachii; and non-treated USDA Choice supraspinatus and vastus lateralis averaged "slightly tough" tenderness ratings. All other muscles with a grade by treatment interaction received a mean tenderness rating of "slightly" or "moderately tender".

**Table 5.** Main effect and treatment interaction least squares means for trained sensory tenderness scores<sup>1</sup>

Muscle	Treatment			Grade			Interaction			
	Con <sup>2</sup>	Tr <sup>3</sup>	Std <sup>4</sup>	Ch <sup>5</sup>	St <sup>6</sup>	Sl <sup>7</sup>	Con	Tr	Std	
Biceps femoris	4.9 <sup>a</sup>	5.6 <sup>b</sup>	ns							
Infraspinatus	-	-	-	6.0 <sup>a</sup>	6.4 <sup>b</sup>	6.1 <sup>b</sup>	6.7 <sup>a</sup>	6.8 <sup>a</sup>	6.4 <sup>b</sup>	6.4 <sup>b</sup>
Rectus femoris	-	-	-	5.6 <sup>a</sup>	6.4 <sup>b</sup>	5.8 <sup>b</sup>	5.6 <sup>a</sup>	5.7 <sup>a</sup>	5.5 <sup>a</sup>	5.5 <sup>a</sup>
Semimembranosus	-	-	-	4.7 <sup>a</sup>	6.3 <sup>b</sup>	4.8 <sup>b</sup>	5.3 <sup>a</sup>	4.7 <sup>a</sup>	5.5 <sup>a</sup>	5.5 <sup>a</sup>
Supraspinatus	-	-	-	4.5 <sup>a</sup>	5.5 <sup>b</sup>	5.4 <sup>b</sup>	5.5 <sup>a</sup>	5.1 <sup>a</sup>	5.3 <sup>a</sup>	5.3 <sup>a</sup>
Teres major	ns	6.2 <sup>b</sup>	6.0 <sup>b</sup>	6.4 <sup>b</sup>	ns	ns	ns	ns	ns	ns
Triceps brachii	-	-	-	4.4 <sup>a</sup>	6.4 <sup>b</sup>	4.0 <sup>b</sup>	5.4 <sup>a</sup>	4.8 <sup>a</sup>	6.0 <sup>b</sup>	6.0 <sup>b</sup>
Vastus lateralis	-	-	-	4.8 <sup>a</sup>	5.8 <sup>b</sup>	5.0 <sup>b</sup>	5.2 <sup>a</sup>	5.0 <sup>a</sup>	6.3 <sup>b</sup>	6.3 <sup>b</sup>

<sup>1</sup>ns=not significant  
<sup>2</sup>Con=Control; <sup>3</sup>Tr=Treated  
<sup>4</sup>Ch=USDA Choice; <sup>5</sup>St=USDA Select; <sup>6</sup>Sl=USDA Standard

## Fabrication Time and Yield Data

The supraspinatus had the highest yields of all sub-primals sampled. While the infraspinatus and teres major produced very well in sensory and tenderness evaluations, these muscles represent a relatively small portion of the shoulder clod. The denuded muscle yield of all muscles from the shoulder clod were markedly lower when compared to other sub-primals. The semimembranosus produced the highest mean number of 0.2 kg steaks, as well as, the highest percentage yield of steaks. The teres major produced the lowest mean number of 0.2 kg steaks, while the triceps brachii had the lowest percent yield of steaks. Sub-primal fabrication time varied, with the shoulder clod generally taking the longest to fabricate. The biceps femoris and semimembranosus took the longest time to fabricate into 0.2 kg steaks, but produced the highest number of 0.2 kg steaks. Data not presented in tabular form.

## Conclusion

While more research needs to be done to explore consumer and industry acceptance of these muscles, the 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 and consumer/sensory 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.

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