

Trained Sensory Evaluation 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 (sub-primal and steak) age of 21 days before sensory evaluations. Steaks were evaluated for sensory characteristics via a 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. 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 sensory values.

Key Words: Beef, Muscle Profiling, Sensory Evaluation

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 trained sensory panel evaluations 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 (NAMP 1997); inside round, IMPS #169A (NAMP 1997); and outside round, IMPS #171B (NAMP 1997) 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 4°C 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 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 4°C cooler before being frozen at -30°C. After the samples were completely frozen they were stored at -10°C.

Trained Sensory Panel. Trained sensory panel evaluations took place over an eight d 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. The evaluations took place at the FAPC sensory test room in individual sensory booths under red lights. Panelists were given unsalted crackers and water to cleanse their pallets between each sample.

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

Results and Discussion

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 rating 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.

Biceps femoris steaks had a significant treatment effect for tenderness with treated steaks receiving a “slightly tender” rating (Table 1). 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” (Table 1).

Infraspinatus, rectus femoris, semimembranosus, supraspinatus, triceps brachii, and vastus lateralis steaks had a grade by treatment interaction for tenderness.

Table 1. Main effect and treatment interaction least squares means for trained sensory tenderness scores^e

| Muscle | Treatment | | Grade | | | Interaction | | | | | |
|------------------|------------------|------------------|-------------------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|------------------|-------------------|
| | Con ¹ | Trt ² | Ch ³ | Sel ⁴ | St ⁵ | Ch:Con | Ch:Trt | Sel:Con | Sel:Trt | St:Con | St:Trt |
| Biceps femoris | 4.9 ^a | 5.6 ^b | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Infraspinatus | - | - | - | - | - | 6.0 ^a | 6.4 ^{bc} | 6.1 ^{ab} | 6.7 ^{cd} | 6.8 ^d | 6.4 ^{bc} |
| Rectus femoris | - | - | - | - | - | 5.6 ^a | 6.4 ^b | 5.8 ^a | 5.6 ^a | 5.7 ^a | 5.5 ^a |
| Semimembranosus | - | - | - | - | - | 4.7 ^a | 6.3 ^c | 4.8 ^a | 5.3 ^b | 4.7 ^a | 5.5 ^b |
| Supraspinatus | - | - | - | - | - | 4.5 ^a | 5.5 ^b | 5.4 ^b | 5.5 ^b | 5.1 ^b | 5.3 ^b |
| Teres major | ns | ns | 6.2 ^{ab} | 6.0 ^a | 6.4 ^b | ns | ns | ns | ns | ns | ns |
| Triceps brachii | - | - | - | - | - | 4.4 ^{ab} | 6.4 ^d | 4.0 ^a | 5.4 ^c | 4.8 ^b | 6.0 ^d |
| Vastus lateralis | - | - | - | - | - | 4.8 ^a | 5.8 ^b | 5.0 ^a | 5.2 ^a | 5.0 ^a | 6.3 ^c |

^{a,b,c,d}Within a row, means without a common superscript letter differ ($P<.05$)
^eTenderness: 4=slightly tough; 5=slightly tender; 6=moderately tender.
 ns=not significant
¹Con=Control; ²Trt=Treated
³Ch=USDA Choice; ⁴Sel=USDA Select; ⁵St=USDA Standard

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 1).

Sensory panel scores for juiciness are presented in Table 2. Supraspinatus steaks had a significant treatment effect for juiciness, with treated steaks receiving higher scores. Among steaks with a significant grade effect, mean scores for all muscles, excluding USDA Standard rectus femoris, were rated as “slightly juicy” or higher ($P<.05$), regardless of USDA quality grade. Among steaks with a significant grade by treatment interaction for juiciness, treated USDA Choice and Standard steaks, excluding the biceps femoris, received the highest ($P<.05$) mean juiciness scores.

Table 2. Main effect and treatment interaction least squares means for trained sensory juiciness scores^e

| Muscle | Treatment | | Grade | | | Interaction | | | | | |
|------------------|------------------|------------------|------------------|------------------|------------------|-------------------|------------------|------------------|-------------------|------------------|-------------------|
| | Con ¹ | Trt ² | Ch ³ | Sel ⁴ | St ⁵ | Ch:Con | Ch:Trt | Sel:Con | Sel:Trt | St:Con | St:Trt |
| Biceps femoris | - | - | - | - | - | 4.4 ^a | 6.0 ^c | 5.4 ^b | 5.7 ^{bc} | 4.6 ^a | 5.3 ^b |
| Infraspinatus | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Rectus femoris | ns | ns | 5.9 ^a | 5.6 ^a | 4.7 ^b | ns | ns | ns | ns | ns | ns |
| Semimembranosus | - | - | - | - | - | 4.6 ^a | 5.4 ^b | 4.7 ^a | 4.6 ^a | 4.5 ^a | 5.7 ^b |
| Supraspinatus | 4.8 ^a | 5.3 ^b | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Teres major | ns | ns | 6.1 ^a | 5.8 ^b | 5.7 ^b | ns | ns | ns | ns | ns | ns |
| Triceps brachii | - | - | - | - | - | 4.1 ^a | 5.8 ^d | 4.6 ^b | 5.4 ^c | 4.6 ^b | 5.4 ^{cd} |
| Vastus lateralis | - | - | - | - | - | 5.2 ^{ab} | 5.9 ^c | 5.5 ^b | 5.4 ^b | 4.9 ^a | 6.0 ^c |

^{a,b,c,d}Within a row, means without a common superscript letter differ ($P<.05$)
^eJuiciness: 4=slightly dry; 5=slightly juicy; 6=moderately juicy.
 ns=not significant
¹Con=Control; ²Trt=Treated

³Ch=USDA Choice; ⁴Sel=USDA Select; ⁵St=USDA Standard

USDA quality grade and treatment had no effect on the flavor scores of the infraspinatus and vastus lateralis. Treated semimembranosus and teres major steaks received more favorable ratings than their non-treated counterparts. USDA Standard biceps femoris and rectus femoris steaks had significantly more desirable scores than USDA Choice steaks. While significant differences exist among data for uncharacteristic flavor, the mean score for all muscles was 3, indicating a “slight” amount of uncharacteristic flavor (Table 3). However, frequency data among treated and non-treated steaks revealed that 74% of biceps femoris, infraspinatus, and rectus femoris steaks received flavor scores of “no uncharacteristic flavor”, while 71% of semimembranosus steaks, 66% of supraspinatus steaks, 70% of triceps brachii steaks, 76% of teres major steaks, and 67% of vastus lateralis steaks also received flavor scores of “no uncharacteristic flavor”.

Table 3. Main effect and treatment interaction least squares means for trained sensory uncharacteristic flavor scores^c

| Muscle | Treatment | | Grade | | | Interaction | | | | | |
|------------------|------------------|------------------|------------------|-------------------|------------------|------------------|------------------|------------------|-------------------|------------------|------------------|
| | Con ¹ | Trt ² | Ch ³ | Sel ⁴ | St ⁵ | Ch:Con | Ch:Trt | Sel:Con | Sel:Trt | St:Con | St:Trt |
| Biceps femoris | ns | ns | 3.6 ^a | 3.7 ^b | 3.8 ^b | ns | ns | ns | ns | ns | ns |
| Infraspinatus | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Rectus femoris | ns | ns | 3.6 ^a | 3.7 ^{ab} | 3.8 ^b | ns | ns | ns | ns | ns | ns |
| Semimembranosus | 3.5 ^a | 3.7 ^b | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Supraspinatus | - | - | - | - | - | 3.2 ^a | 3.8 ^b | 3.7 ^b | 3.7 ^b | 3.6 ^b | 3.6 ^b |
| Teres major | 3.6 ^a | 3.8 ^b | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Triceps brachii | - | - | - | - | - | 3.5 ^a | 3.8 ^b | 3.6 ^a | 3.6 ^{ab} | 3.8 ^b | 3.5 ^a |
| Vastus lateralis | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |

^{a,b}Within a row, means without a common superscript letter differ ($P < .05$)

^cUncharacteristic flavor: 3=slight.

ns=not significant

¹Con=Control; ²Trt=Treated

³Ch=USDA Choice; ⁴Sel=USDA Select; ⁵St=USDA Standard

Among those steaks with a significant treatment effect for connective tissue amount, treated steaks received higher mean scores, indicating lower amounts of detectable connective tissue (Table 4). Among those steaks with a significant grade effect, USDA Choice and Standard received the highest scores, indicating the least amount of detectable connective tissue (Table 4). Responses varied greatly among muscles with a significant grade by treatment interaction for connective tissue. Nevertheless, infraspinatus steaks received the highest ratings while supraspinatus steaks received the lowest ratings (Table 4).

Table 4. Main effect and treatment interaction least squares means for trained sensory connective tissue amount scores^e

| Muscle | Treatment | | Grade | | | Interaction | | | | | |
|----------------|------------------|------------------|-----------------|------------------|-----------------|------------------|--------------------|-------------------|------------------|-------------------|-------------------|
| | Con ¹ | Trt ² | Ch ³ | Sel ⁴ | St ⁵ | Ch:Con | Ch:Trt | Sel:Con | Sel:Trt | St:Con | St:Trt |
| Biceps femoris | 4.7 ^a | 5.0 ^b | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Infraspinatus | - | - | - | - | - | 5.6 ^a | 6.0 ^{abc} | 5.7 ^a | 6.4 ^c | 6.3 ^{bc} | 5.9 ^{ab} |
| Rectus femoris | - | - | - | - | - | 5.2 ^a | 6.2 ^c | 5.6 ^{ab} | 5.2 ^a | 5.8 ^{bc} | 5.4 ^{ab} |

| | | | | | | | | | | | |
|------------------|------------------|------------------|-------------------|------------------|------------------|-------------------|-------------------|--------------------|--------------------|--------------------|-------------------|
| Semimembranosus | 5.0 ^a | 5.5 ^b | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| Supraspinatus | - | - | - | - | - | 4.6 ^a | 5.5 ^d | 5.1 ^{bcd} | 5.4 ^{cd} | 4.9 ^{abc} | 4.8 ^{ab} |
| Teres major | - | - | - | - | - | 6.1 ^{bc} | 5.6 ^{ab} | 5.7 ^{ab} | 5.8 ^{abc} | 5.6 ^a | 6.2 ^c |
| Triceps brachii | 4.6 ^a | 5.6 ^b | 5.4 ^a | 4.7 ^b | 5.3 ^a | ns | ns | ns | ns | ns | ns |
| Vastus lateralis | 4.9 ^a | 5.4 ^b | 5.1 ^{ab} | 4.9 ^a | 5.4 ^b | ns | ns | ns | ns | ns | ns |

^{a,b,c,d}Within a row, means without a common superscript letter differ ($P < .05$)

^eConnective tissue amount: 4=moderate; 5=slight; 6=traces.

ns=not significant

¹Con=Control; ²Trt=Treated

³Ch=USDA Choice; ⁴Sel=USDA Select; ⁵St=USDA

Standard

Overall acceptance scores, as determined by sensory analysis, are present in Table 5. Semimembranosus steaks had both a significant grade and treatment effect for overall acceptability. Treatment greatly improved mean acceptability scores for semimembranosus steaks from “slightly undesirable” to “slightly desirable”. While there were grade differences in overall acceptability scores for semimembranosus steaks, all three quality grades received mean scores of “slightly undesirable”. Among steaks with a significant grade by treatment interaction for overall acceptability, all infraspinatus and teres major steaks received a mean score of “slightly desirable” or higher. Other muscles varied greatly by treatment and grade. The triceps brachii received a mean score of “undesirable” for USDA Select non-treated steaks, and a mean score of “desirable” for USDA Choice treated steaks.

Table 5. Main effect and treatment interaction least squares means for trained sensory overall acceptability scores^e

| Muscle | Treatment | | Grade | | | Interaction | | | | | |
|------------------|------------------|------------------|------------------|-------------------|------------------|-------------------|--------------------|------------------|-------------------|-------------------|-------------------|
| | Con ¹ | Trt ² | Ch ³ | Sel ⁴ | St ⁵ | Ch:Con | Ch:Trt | Sel:Con | Sel:Trt | St:Con | St:Trt |
| Biceps femoris | - | - | - | - | - | 4.0 ^a | 5.2 ^c | 4.6 ^b | 4.9 ^{bc} | 4.0 ^a | 5.0 ^{bc} |
| Infraspinatus | - | - | - | - | - | 5.6 ^a | 5.8 ^{ab} | 5.6 ^a | 6.4 ^c | 6.3 ^{bc} | 5.7 ^a |
| Rectus femoris | - | - | - | - | - | 4.9 ^a | 5.8 ^b | 5.2 ^a | 4.9 ^a | 4.8 ^a | 4.9 ^a |
| Semimembranosus | 4.2 ^a | 5.1 ^b | 4.9 ^a | 4.6 ^{ab} | 4.4 ^b | ns | ns | ns | ns | ns | ns |
| Supraspinatus | - | - | - | - | - | 3.9 ^a | 5.3 ^c | 4.7 ^b | 5.0 ^{bc} | 4.6 ^b | 4.6 ^b |
| Teres major | - | - | - | - | - | 5.9 ^{cd} | 5.8 ^{bcd} | 5.1 ^a | 5.7 ^{bc} | 5.4 ^{ab} | 6.1 ^d |
| Triceps brachii | - | - | - | - | - | 4.4 ^b | 6.0 ^d | 3.9 ^a | 5.2 ^c | 4.6 ^b | 5.3 ^c |
| Vastus lateralis | - | - | - | - | - | 4.3 ^a | 5.3 ^b | 4.6 ^a | 4.8 ^a | 4.5 ^a | 5.6 ^b |

^{a,b,c,d}Within a row, means without a common superscript letter differ ($P < .05$)

^eOverall acceptability: 3=undesirable; 4=slightly undesirable; 5=slightly desirable; 6=desirable. ns=not significant

¹Con=Control; ²Trt=Treated

³Ch=USDA Choice; ⁴Sel=USDA Select; ⁵St=USDA

Standard

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 (Elam et al., 2002) 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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