EVALUATIONS OF BEEF TENDERNESS BY WARNER-BRATZLER SHEAR FORCE, A DESCRIPTIVE-TEXTURE PROFILE SENSORY PANEL, AND A DESCRIPTIVE ATTRIBUTE SENSORY PANEL

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Summary

This study examined interrelationships among Warner-Bratzler shear force (WBSF), evaluation by a highly trained descriptive-texture-profile (DTP) sensory panel, and evaluation by a trained descriptive attribute (DA) sensory panel as affected by muscle fiber orientation of samples. Eighteen longissimus lumborum and 18 semitendinosus muscles from Choice and Select carcasses were cut into 1-inch steaks and cooked to 150EF. Cores were obtained by two methods (parallel to the muscle fiber orientation and perpendicular to the cut steak surface) for WBSF determinations. Cubes ½ × ½ × 1 in. were presented to the DTP and DA sensory panels. Cores taken parallel to the longissimus muscle fiber orientation had a 1.4 lb. higher (P<.05) mean WBSF than cores taken perpendicular to the cut steak surface. Both panels detected carcass differences; however, a panelist × carcass effect (P<.05) occurred for the DA panel. Both panels detected differences (P<.05) between muscle fiber orientations for attributes related to tenderness. Muscle fiber orientation of samples may need to be parallel for WBSF but perpendicular to the steak surface for sensory panel evaluation.

(Key Words: Tenderness, Shear Force, Sensory Panels, Muscle Fiber Orientation.)

Introduction

Controversy has existed concerning the method of removing cores from cooked steaks for Warner-Bratzler shear force (WBSF) testing. Guidelines published by the American Meat Science Association (1995) recommended that cores be taken parallel to the muscle fiber orientation instead of perpendicular to the cut steak surface as previously recommended (1978). However, the recommendation for meat samples for sensory evaluation has not changed; samples should be cut into cubes perpendicular to the steak surface, but muscle fiber orientation is not mentioned.

The relationship between shear force and sensory texture data is of major concern in evaluating the relevance and significance of tenderness research data. The two most common types of sensory panels for research are: 1) semitrained and 2) highly trained, experienced panels. How well either interprets meat palatability data and how well either relates to WBSF values are unanswered questions.

Our objective was to elucidate the effects of muscle fiber orientation on tenderness as evaluated by WBSF, a highly trained, descriptive-texture-profile (DTP) panel, and a trained, descriptive attribute (DA) panel. We also evaluated the effects of muscle fiber orientation of samples on WBSF results.

Experimental Procedures

Short loins and eye of rounds from 12 Choice and six Select grade carcasses were obtained from a commercial processor. The two muscles were not likely to have been

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from the same sides. At 3 to 5 days postmortem, subprimal cuts were frozen (-40EF) and cut into 1-inch-thick steaks with individual subprimal identification maintained. Each steak was vacuum packaged. Steaks from each subprimal for both the longissimus lumborum (LL) (shortloin) and semitendinosus (ST) (eye of round) muscles were assigned randomly to the following WBSF treatment groups: one steak cored parallel to the muscle fiber orientation and sheared, and one steak cored perpendicular to the steak surface and sheared. All steaks were frozen (!40EF) until thawing at 0EF for 48 hr prior to cooking in a Blodgett modified broiling oven to 150EF internally.

After cooking, steaks were cooled for 2 hr at room temperature, cores were made either perpendicular to the steak cut surface or parallel to the muscle fiber orientation using a 1/2-inch-diameter core on a drill. WBSF values were measured using an Instron Universal testing machine with a 50 kg compression load cell and a cross head speed of 100 in/min.

The DTP sensory analyses were conducted on the 18 replications of each muscle using a six-member, highly trained, experienced panel from the Sensory Analysis Center at Kansas State University. The same procedures for thawing, cooking, and cooling were used for sensory analysis as for WBSF determination. DTP panelists had over 120 hr of training by professional sensory analysts in the evaluation of texture characteristics, over 2,000 hr of sensory testing experience, and extensive experience in testing meat products.

Three texture attributes were assessed: firmness, fibrousness, and chewiness. All attributes, descriptions, and references were generated by the DTP panelists. They had access to reference samples during each test session. Three cooked steaks from each subprimal were cut into 1 in.× ½ in.×1/2 in. cubes either perpendicular to the cut surface or parallel to muscle fiber orientation. Panelists placed each sample horizontally on their molars for evaluation. Panelists scored the three texture attributes using a structured 15-point scale (0 = none to 15 = very intense).

Descriptive attribute (DA) sensory evaluations were conducted for all replications of each muscle using a 10-member panel trained according to AMSA (1995) guidelines. Three attributes were assessed: myofibrillar tenderness, connective tissue amount, and overall tenderness. Two cooked steaks from each subprimal were cut into 1 in. × ½ in. × ½ in. cubes either perpendicular to the cut surface or parallel to muscle fiber orientation. Panelists placed each sample (parallel or perpendicular) horizontally on their molars to evaluate the three texture attributes using an 8-point number scale.

The statistical design was a type of split plot. Statistical analyses for WBSF data and DA and DTP panel data were performed by using a SAS PROC MIXED ANOVA procedure. Pearson correlation coefficients were calculated for WBSF data with DA or DTP panel data with the same sample orientation.

Results and Discussion

The mean WBSF value for LL cores taken parallel with the muscle fiber orientation was higher ($P<.05$) than the mean for those sheared perpendicular to the cut steak surface (4.08 vs 3.42 lb.) (Figure 1). No difference ($P>.05$) occurred for ST cores, because cores taken perpendicular to the cut steak surface are also parallel to the muscle fibers. The mean WBSF value was higher for the ST muscle than for the LL muscle.

A mix of Choice and Select grade carcasses was utilized to provide variation, but grade differences were not of interest. The DTP sensory panel detected differences ($P<.05$) among replications (carcass source) for each muscle (LL and ST) for each attribute (chewiness, fibrousness, and firmness). No differences occurred among DTP panelists for any of the three attributes ($P>.05$) (panelist effect), and no ($P>.05$) panelist by replication interaction occurred. These results suggest that the panelists could detect differences consistently.

The DA sensory panel also detected differences (P<.05) among replications for each muscle (LL and ST) for each of the three attributes (myofibrillar tenderness, connective tissue amount, and overall tenderness. However, some differences (P<.05) occurred among panelists for each of the three attributes (panelist effect). In addition, a panelist by replication interaction (P<.05) suggests that DA panelists were somewhat inconsistent in their evaluations. This could be partly due to the 7-wk evaluation period versus a 3-wk period for the DTP panel.

Our results also indicate that, in terms of reproducibility, extent of training may be more important than experience. Both panels were experienced in sensory testing of meat; however, the DTP panel was more highly trained. The DTP panel detected differences (P<.05) between samples taken parallel to the muscle fiber orientation and samples taken perpendicular to the cut steak surface in the LL muscle for the attributes of chewiness, fibrousness, and firmness (Table 1). The DA panel scored LL samples lower (P<.05) (less tender) for myofibrillar tenderness and overall tenderness when they were taken parallel to the muscle fiber orientation than when taken perpendicular to the cut steak surface (Table 1).

For both panels, the correlations between sensory scores and WBSF values were relatively low (P>.05) for LL samples taken parallel to the muscle fiber orientation (Table 2). On the other hand, correlations were meaningful between WBSF and DA panel scores of myofibrillar tenderness (r = -.59), connective tissue amount (r = -.58), and overall tenderness (r = -.55) when LL cores were removed perpendicular to the steak surface.

With LL samples, relationships between scores for tenderness-related attributes and WBSF values were better for the DA panel than for the DTP panel. With ST samples, scores of tenderness-related attributes by the two panels had similar relationships with WBSF values. However, muscle fiber orientation was less important for the DA panel than for the DTP panel.

Tenderness-related attributes, such as myofibrillar tenderness, connective tissue amount, overall tenderness, firmness, and chewiness, can be correlated significantly (Table 2) to WBSF values, but not all with the same muscle fiber orientation. Our results did not show higher correlations between sensory attributes and WBSF values when cores were removed parallel to the muscle fibers rather than perpendicular to the cut steak surface.

Both panels were effective in detecting differences in tenderness that were related to WBSF values. Overall, relationships between tenderness scores and WBSF values were somewhat higher for the DA panel than for the DTP panel. DTP attributes of fibrousness and chewiness may relate to characteristics that are not measured by WBSF. A highly trained DTP sensory panel might detect more subtle differences among treatments because panelist variation is less. Scores for attributes evaluated by the DA sensory panel showed higher correlations with WBSF values than those for attributes evaluated by a DTP sensory panel, regardless of muscle fiber orientation of samples. The appropriate type of panel should be selected to meet research objectives. Cores should be removed parallel with muscle fiber orientation for WBSF determinations, but cubes for sensory evaluation should be removed perpendicular to the steak surface.

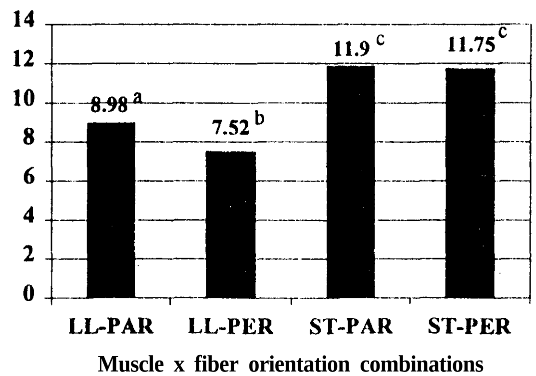

Figure 1. Mean WBSF Values for LL and ST Muscles Using Parallel (PAR) and Perpendicular (PER) Cores. Means are displayed at the top of each treatment. Means with different superscript letters within a muscle are different (P<.05).

Table 1. Descriptive-Texture-Profile (DTP) and Descriptive-Attribute (DA) Sensory Panel Interaction Means between Parallel and Perpendicular Samples for Each Attribute within Each Muscle (Longissimus, LL; and Semitendinosus, ST)

	Treatments			
Attribute	LL Parallel	LL Perpendicular	ST Parallel	ST Perpendicular
DTP panel[a]				
Chewiness	7.9 [c]	7.6[d]	8.3. [e]	8.4 [e]
Fibrousness	9.3 [c]	8.9 [d]	9.4 [e]	9.4 [e]
Firmness	7.6 [c]	7.3 [d]	8.4 [e]	8.4 [e]
DA panel[b]				
Myofibrillar tenderness	6.1 [c]	6.3 [d]	5.6 [e]	5.8 [f]
Connective tissue amount	6.6 [c]	6.7 [c]	5.4 [e]	5.5 [e]
Overall tenderness	6.3 [c]	6.5 [d]	5.4 [e]	5.6 [f]

[a]DTP scale: 0 = none to 15 = very intense.
[b]DA scale: 1 = extremely tough, abundant connective tissue, or extremely tough; 5 = slightly tender, moderate amount of connective tissue, or slightly tender; 8 = extremely tender, no connective tissue, or extremely tender.
[c,d]Means in the same row within a muscle lacking a common superscript letter differ (P<.05).
[e,f]Means in the same row within a muscle lacking a common superscript letter differ (P<.05).

Table 2. Correlations of Descriptive-Texture-Profile (DTP) and Descriptive-Attribute (DA) Sensory Panel Scores for Individual Attributes to Warner-Bratzler Shear Force (WBSF) Values when Samples Were Removed with the Same Fiber Orientation for Both Sensory Panels and WBSF Determinations for Longissimus (LL) and Semitendinosus (ST) Muscles

	Treatments	
Panel and attribute	LL - Parallel	LL - Perpendicular
DTP panel	r	r
Firmness	.28	.49
Fibrousness	.14	-.07
Chewiness	-.02	.47
	LL - Parallel	LL - Perpendicular
DA panel	r	r
Myofibrillar tenderness	-.42	-.59 [a]
Connective tissue amount	-.18	-.58 [a]
Overall tenderness	-.35	-.55 [a]
	ST - Parallel	ST - Perpendicular
DTP panel	r	r
Firmness	.65 [a]	.54 [a]
Fibrousness	-.02	.18
Chewiness	.18	.32
	ST - Parallel	ST - Perpendicular
DA panel	r	r
Myofibrillar tenderness	-.64 [a]	-.53 [a]
Connective tissue amount	-.43	-.31
Overall tenderness	-.60 [a]	-.46

[a]Correlation values are significant (P<.05).