SURVEILLANCE OF RETAIL BEEF TENDERNESS IN THE UNITED STATES

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Abstract - The purpose of this study was to obtain beef top loin steaks (*n* = 1,613) from retail stores in four cities across the United States for Warner-Bratzler shear force (WBSF), slice shear force (SSF) and consumer sensory determinations. Personnel at four universities (California Polytechnic State University, Colorado State University, University of Missouri and Texas A&M University) conducted the study over a 12-month period. Enhanced/blade tenderized top loin steaks had the lowest (*P* < 0.05) WBS and SSF values, whereas non-enhanced top loin, bone-in had the highest (*P* < 0.05) WBS and SSF values. Enhanced/blade tenderized top loin steaks received the highest (*P* < 0.05) ratings by consumers for palatability scores whereas non-enhanced top loin, bone-in steaks had the lowest (*P* < 0.05) consumer panelist ratings. USDA quality grade did have an effect (*P* < 0.05) on the tenderness of the non-enhanced steaks. The WBS values and consumer sensory values for top loin steaks were comparable to the 2010 National Beef Tenderness Survey, signifying that no drastic changes in tenderness have occurred due to changes in antemortem or postmortem conditions.

I. INTRODUCTION

Consumer satisfaction is an important factor influencing the amount of beef that is purchased by households in the United States [1]. The Beef Consumer Satisfaction Study showed that tenderness is a highly influential attribute that affects a consumers' eating experience [2]. Additional research shows that consumers are willing to pay a premium for guaranteed tender beef products [3].

In 1990, the first National Beef Tenderness Survey [4] was conducted to determine the tenderness of beef in retail cases across the U.S. based on Warner-Bratzler shear (WBS) force values and trained sensory panels. Morgan et al. [4] solely focused on the retail sector and showed tenderness concerns for the round, and chuck subprimals. The 1991 National Beef Tenderness Survey also served as a benchmark for tenderness at the retail level. In the 2010 National Beef Tenderness Survey [5], the collection period was adjusted to 12-months to account for seasonal changes of product in retail and foodservice markets. There is a continuous need for monitoring tenderness of beef products, and these surveys have allowed the beef industry to make comparisons and improve beef tenderness. The objective of the current project was to evaluate top loin steaks from four U.S. cities for Warner-Bratzler shear force, sliced shear force, and sensory evaluations, and to compare the findings to the 2010 National Beef Tenderness Survey.

II. MATERIALS AND METHODS

A. Product selection

Personnel at four universities (California Polytechnic State University, Colorado State University, University of Missouri, and Texas A&M University) selected steaks (*n* = 1,613). Collaborators sampled four metropolitan areas chosen to represent a broad geographical range, and to maintain some historical linkage with cities that have been utilized in past National Beef Tenderness Surveys. U.S. metropolitan areas included: Los Angeles, California; Denver, Colorado; Kansas City, Missouri, and Houston, Texas. Each city was sampled four times from July 2012 to May 2013. In each metropolitan area, approximately 20 supermarket or wholesale club stores were sampled. Steak packages were selected from various locations within each retail case and represented the various programs and brands offered

by each retailer.

B. Retail sale parameters

Information gathered during in-store steak collection included U.S. Quality Grade, enhanced/non-enhanced, brand name, and other items not reported here. Collected steak packages were bagged, placed in insulated coolers with refrigerant, and transported to respective universities.

C. Sample processing

Steaks collected by personnel at universities other than Texas A&M University, then were frozen and shipped via overnight courier in insulated containers with refrigerant to ensure products arrived at Texas A&M University in a frozen state.

D. Warner-Bratzler shear force

Steaks were cooked on a grated, non-stick electric grill (Hamilton Beach™ Indoor/Outdoor Grill, Southern Pines, NC). All steaks were turned upon reaching 35˚C, and removed from the grill upon reaching an internal temperature of 70˚C. Internal temperature was monitored with a thermocouple (Omega™ HH501BT, Stamford, CT) using a 0.02 cm diameter, copper constantan Type-T thermocouple wire. Steaks were then cooled for approximately 16 hours at 2 to 4˚C.

After cooling, steaks were trimmed of visible fat and heavy connective tissue to expose muscle fiber orientation. At least six 1.3 cm cores were removed from each steak at locations from the medial, middle and lateral portions. Cores were removed parallel to the muscle fibers and sheared once, perpendicular to the muscle fibers, on a United Testing machine (United SSTM-500, Huntington Beach, CA) at a cross-head speed of 500 mm/min using an 226.8 kg load cell, and a 1.02 cm thick V-shape blade with a 60° angle and a half-round peak. The peak force (N) needed to shear each core was recorded, and the mean peak shear force of the cores was used for statistical analysis.

E. Slice shear force

Steaks were cooked in the same manner previously described. After cooking, each steak was trimmed of visible fat and connective tissue. A cut was made across the width of the *M. longissimus lumborum* at a point about 1 to 2 cm from the lateral end of the muscle. Using the sample-sizing box, a second cut was made across the width of the *M. longissimus lumborum* parallel to and at a distance of 5 cm from the first cut. A 1 cm × 5 cm slice was removed from the lateral end of the steak at a 45˚ angle parallel to the muscle fibers. The slice shear force was performed on the United Testing machine, as previously described, and the peak force (N) needed to shear each slice was recorded, and used for statistical analysis.

F. Consumer sensory panel

Steaks were assigned randomly to panelists for evaluation. Each panelist received two 1.27 cm cubes of each sample and evaluated four random samples during the session. Samples were characterized using 10-point hedonic scales for overall like (10 = like extremely; 1 = dislike extremely), overall like of tenderness (10 = like extremely; 1 = dislike extremely), intensity of the tenderness (10 = extremely tender; 1 = extremely tough), overall like of flavor (10 = like extremely; 1 = dislike extremely), level of beef flavor (10 = extremely intense; 1 = extremely bland/no flavor), overall like of juiciness (10 = like extremely; 1 = dislike extremely), and level of juiciness (10 = extremely juicy; 1 = extremely dry).

F. Statistical analysis

Data were analyzed as analysis of variance using PROC GLM of SAS (SAS Institute, Inc., Cary, NC). Least squares means were generated for main effects and separated using PDIFF option when appropriate with an alpha-level ($P < 0.05$).

III. . RESULTS AND DISCUSSION

A. Warner-Bratzler shear force

Top loin steaks had lower ($P < 0.05$) WBS values compared to top loin bone-in steaks (Table 1). Guelker et al. [5] found similar least squares means for WBS values of top loin steaks. When comparing our data to those from studies by Morgan et al. [4] and Brooks et al. [6] WBS values have decreased. However, an increase in WBS values can be seen when comparing data from our study to those from Voges et al. [7]. It should be noted that when stratified by enhancement/blade tenderization, WBS values were significantly lower ($P < 0.05$) for enhanced, top loin steaks compared to either of the non-enhanced steak groups (data not shown in tabular form).

Table 1 Least squares means and standard errors for Warner-Bratzler shear values (N) and slice shear values (N) of retail steaks

	Warner-Bratzler Shear, N		Slice shear values, N	
Steak	Mean	SE	Mean	SE
Top loin	24.5a	0.36	152.0	2.00
Top loin, bone-in	27.2b	0.89	160.1	4.75
P-value	0.0063		0.0091	

Belew et al. [8] and Shackelford et al. [9] developed tenderness categories based on WBS values. These categories were to be used stratify retail steaks into tenderness classes. The percentage of top loin steaks across tenderness categories four our study can be seen in Table 2. These values are similar to data reported by Guelker et al. [5] and Emerson et al. [10]. Although enhanced and/or blade tenderized steaks are not eligible for tenderness claims, all of the enhanced/blade tenderized top loin steaks would have had shear values needed to be eligible for the very tender class.

Table 2 Percentage (%) distribution of retail steaks stratified into tenderness categories

Steak	"Very Tender" WBS < 31.4 N	"Tender" 31.4 N < WBS < 38.3	"Intermediate" 38.3 < WBS < 45.1	"Tough" WBS > 45.1 N
Top loin	80.9	10.8	5.1	3.2
Top loin, bone-in	76.3	12.7	6.8	4.2

B. Slice shear force

In the current study, SSF values for top loin steaks were similar to top loin bone-in steaks (Table 1). When stratified by enhancement, enhanced/blade tenderized top loin steaks were lower ($P < 0.05$) in SSF values (data not shown in tabular form). According to the proposed standard for SSF specifications for tenderness marketing claims developed by the ASTM International Committee F10.60 on Livestock, Meat and Poultry Marketing Claims, approximately 85% of the steaks evaluated with the SSF objective tenderness measurement met the criteria, SSF $\leq$ 20 kg or 196.1 N, to be considered *Certified Tender* which is similar to the amount of steaks that qualified for the same program found in Emerson et al. [10].

C. Consumer sensory evaluations

The top loin received the highest ($P < 0.05$) ratings by consumers across all categories, while top loin, bone-in steaks received the lowest ($P < 0.05$) ratings by all consumers. When stratified by enhancement, enhanced/blade tenderized top loin steaks received the highest ($P < 0.05$) ratings in tenderness level and flavor like/dislike categories compared to their non-enhanced counterparts (data not shown in tabular form). The top loin was similar in consumer rankings to those documented by Voges et al. [7] while the top loin bone-in data more closely resembled the data presented by Guelker et al. [5].

IV. CONCLUSIONS

In general, WBS values for the current study appear to be similar in those found in the 2010 National

Beef Tenderness Survey [5]. When compared to other National Beef Tenderness surveys, top loin WBS values have increased from the 2006 survey, but decreased from the 1991 and 2000 surveys. Consumer panelist data for top loin steaks have remained constant. Information from our study will serve as a benchmark for retail beef tenderness and will be used to support further research to improve the tenderness of beef in the U.S. retail sector.

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