NATIONAL BEEF TENDERNESS SURVEY – 2010: SHEAR-FORCE VALUES AND SENSORY-PANEL RATINGS FOR U.S. RETAIL AND FOODSERVICE BEEF

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Abstract – Retail and foodservice beef steaks from across the United States were evaluated using Warner-Bratzler shear (WBS) and consumer sensory panels. For retail, top blade had the lowest ($P < 0.05$) WBS values, whereas steaks from the round had the highest ($P < 0.05$) values. Foodservice top loin and ribeye steaks had the lowest ($P < 0.05$) WBS values compared to top sirloin steaks. Retail top blade steaks and foodservice top loin steaks received the highest ($P < 0.05$) consumer sensory panel ratings compared to the other steaks evaluated. Prime foodservice ribeye steaks were rated highest ($P < 0.05$) for overall like, like tenderness, tenderness level, like juiciness, and juiciness level, whereas ungraded ribeye steaks were rated lowest ($P < 0.05$) for like tenderness and tenderness level. The WBS values and sensory ratings were comparable to the last survey signifying that no recent changes in tenderness have occurred.

Key Words – consumer panels, market survey

I. INTRODUCTION

Throughout the years, different feeding regimens, management practices, and processing technologies have influenced the eating quality of beef steaks. Consumer attitudes are constantly changing; therefore, it is important to track trends and perspectives in order to react. The Canadian beef industry has conducted two surveys to measure retail beef satisfaction [1]. One of the purposes of the latest survey was to use the information to see how best to develop palatability enhancements for beef.

The National Beef Tenderness Survey in the United States has allowed the industry to determine which steaks are acceptable to consumers, in terms of palatability, and to determine which steaks require additional improvement. This survey, which has been conducted three other times [2-4], offers valuable data to industry personnel and consumers. The objectives of this survey were to determine the tenderness of beef steaks from US retail and foodservice establishments using Warner-Bratzler shear (WBS) and consumer sensory panels.

II. MATERIALS AND METHODS

These cities were chosen to represent a broad geographical range and to maintain some historical linkage: New York, NY; Philadelphia, PA; Los Angeles, CA; San Francisco, CA; Denver, CO; Las Vegas, NV; Tampa, FL;

Atlanta, GA; Kansas City, MO; Houston, TX; Chicago, IL; and Seattle, WA. Each city was sampled once between March 2010 and February 2011.

Two to three retail chains, representing at least one-third of the total area market share, were sampled for product in four stores per chain per city. Retail steaks were shipped overnight to Texas A&M University in insulated containers with dry ice or frozen cooler packs and were processed under refrigerated conditions (2-4 °C) upon arrival. Steaks were removed from store packaging, identified individually, vacuum-packaged, and frozen at -40 °C. Steaks were assigned randomly to be used either for WBS evaluation or for consumer sensory panels. Steaks were shipped overnight in insulated containers with dry ice to the designated university.

Collaborators also sampled one foodservice establishment in five cities, Houston, TX; Tampa, FL; Denver, CO; Las Vegas, NV; Philadelphia, PA, evaluating each USDA quality grade of subprimals that the establishment fabricated. Steaks were shipped to Texas A&M University and were processed under the same conditions as the retail steaks. Steaks were vacuum packaged, frozen, and shipped to the University of Missouri in the same manner as retail steaks. Steaks were assigned randomly to be used either for WBS evaluation or for consumer sensory panels.

Steaks were thawed in a 4 °C cooler for 48 hours before cooking. Retail steaks were cooked on grated, non-stick electric grills. The grills were pre-heated for 15 min to an approximate temperature of 177 °C. Foodservice steaks were cooked on a Garland™ gas grill pre-heated before cooking to a surface temperature of approximately 232 °C. Retail steaks were flipped upon reaching an internal temperature of 35 °C, and were removed from the cooking surface upon reaching an internal temperature of 70 °C. Cooked steaks assigned to WBS force were covered with plastic wrap before being placed in a cooler for approximately 12 h at 2-4 °C. Foodservice steaks assigned to consumer panels were kept warm by placing them in an Alto Shaam 100-TH oven and using a temperature probe inserted into one of the steaks to maintain an internal temperature of 70 °C before the panel. Internal temperature was monitored with a thermocouple using a 0.02 cm diameter, iron-constantan Type-T thermocouple wire.

Steaks for WBS were cooked in the same manner as consumer sensory panel steaks. Steaks were trimmed of visible connective tissue to expose muscle fiber orientation. At least six 1.3 cm cores were removed from each muscle. Six cores from the *M. longissimus lumborum* and four cores from the *M. psoas major* were used to uniformly sample T-bone and Porterhouse steaks. 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 200 mm/min using an 11.3 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.

Panelists were recruited from surrounding communities. Panelists were given unsalted crackers and distilled water between samples, received two 1.27 cm cubes of each steak, and evaluated eight random samples during the session. Samples were characterized using 10-point scales (see tables for scales).

Data were analyzed using PROC means, and mean separation was conducted for significance between treatments, when appropriate, using PROC GLM with Pdiff option with an alpha-level ($P < 0.05$) (SAS Institute, Inc., Cary, North Carolina).

III. RESULTS AND DISCUSSION

WBS values for retail steaks are reported in Table 1. Bottom round and top round steaks had the highest ($P < 0.05$) WBS values compared to all other steaks. Top blade had the lowest WBS values compared to all other steaks. These data

are similar to those reported by Voges *et al.* [4], which stated the shoulder clod, eye of round, top round, and bottom round had the highest WBS at 27.8, 33.2, 29.6, and 36.0 N, respectively. Additionally, Voges *et al.* [4] reported top loin, bone-in top loin, bone-in ribeye, T-bone, and porterhouse steaks to have the lowest WBS values.

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

Steak	*n*[a]	Mean, N	SE
Top blade	52	21.5b	1.0
Ribeye, lip-on, bnls	84	24.2b	0.7
Ribeye, lip-on, bone-in	31	23.9b	1.2
Top loin	79	23.3b	0.8
Top loin, bone-in	29	24.6b	1.2
T-bone	48	23.1b	1.0
Porterhouse	20	23.6b	1.5
Top sirloin, bnls, cap off	103	24.1b	0.7
Top round	44	29.8a	1.0
Bottom round	45	31.2a	1.0
P > F		<0.0001	

Within a column, means lacking a common letter (a and b) differ ($P < 0.05$).
[a] *n* = number of steaks

Least squares means for WBS values of foodservice steaks are presented in Table 2. Top loin and ribeye steaks had lower ($P < 0.05$) WBS values compared to top sirloin steaks. All steaks had low WBS values, which agrees with Voges *et al.* [4].

Table 2 Least squares means and standard errors (SE) for Warner-Bratzler shear values (N) of foodservice steaks

Steak	*n*[a]	Mean, N	SE
Ribeye	77	27.3b	0.7
Top loin	84	25.8b	0.7
Top sirloin	72	30.2a	0.7
P > F		<0.0001	

Within a column, means lacking a common letter (a and b) differ ($P < 0.05$).
[a] *n* = number of steaks

Least squares means for sensory panel ratings of retail steaks is presented in Table 3. Top blade steak received the highest ($P < 0.05$) ratings by consumers for overall like, like tenderness, tenderness level, like juiciness, and juiciness level. The top blade and boneless ribeye received the highest ($P < 0.05$) ratings for like flavor. Top round and bottom round received the lowest ($P < 0.05$) ratings by consumers for overall like, like tenderness, tenderness level, like flavor, flavor level, and like juiciness. This concurs with data reported by Voges *et al.* [4]. Steaks from the rib, loin, and chuck were consistently rated highest ($P < 0.05$) for like flavor, flavor level, like juiciness, and juiciness level, whereas steaks from the sirloin and round were rated the lowest ($P < 0.05$) for the same attributes. This agrees with Voges *et al.* [4], which exhibited the same trend.

Least squares means for sensory panel ratings of foodservice steaks are reported in Table 4. Top loin steaks received the highest ($P < 0.05$) rating for most attributes, including like tenderness, tenderness level, flavor level, like juiciness, and juiciness level. Voges *et al.* [4] found that top loin steaks, in addition to ribeye steaks, were rated the highest. In data not reported in tabular form, USDA Choice and ungraded ribeye steaks received the lowest ($P < 0.05$) ratings for overall like than did all other grades. USDA Prime ribeye steaks received the highest ($P < 0.05$) ratings for overall like, like tenderness, tenderness level, like juiciness, and juiciness level. This differs from Voges *et al.* [4] and Brooks *et al.* [2], which did not find any differences for ribeye steaks across quality grade groups, other than like flavor. No differences were found among grade groups for top loin steaks, which agrees with Voges *et al.* [4] and Brooks *et al.* [2], which did not find any differences across grades for sensory panel ratings. Ungraded top sirloin steaks received the highest ($P < 0.05$) ratings for overall like, like flavor, and like juiciness than other grades, which may be attributed to tenderization and enhancement practices. This differs from Voges *et al.* [4], which found that Prime top sirloin steaks received the highest ratings for like tenderness and juiciness level.

IV. CONCLUSION

Most steaks evaluated in this study were considered tender. When compared to previous surveys, not all WBS values decreased, however, all of the WBS values were similar to those in the 2006 survey. This may be due to increased attention given to steaks from the round since the last survey, and a possible plateau of beef

tenderness. Numerous programs focusing on beef tenderness are evident and will continue to play a role in maximizing beef tenderness and consumer satisfaction.

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REFERENCES

1. Canadian Cattlemen's Association and Beef Information Centre (2010) National Beef Quality Audit: 2009 Retail Beef Satisfaction Benchmark at http://www.cattle.ca/media/file/original/882_T3166_Retail_Benchmark_09_9.pdf
2. Brooks, J.C., Belew, J.B., Griffin, D.B., Gwartney, B.L., Hale, D.S., Henning, W.R., Johnson, D.D., Morgan, J.B., Parrish, F.C., Jr., Reagan, J.O., & Savell, J.W. (2000). National Beef Tenderness Survey-1998. Journal of Animal Science 78:1852-1860.
3. Morgan, J.B., Savell, J.W., Hale, D.S., Miller, R.K., Griffin, D.B., Cross, H.R., & Shackelford, S.D. (1991). National Beef Tenderness Survey. Journal of Animal Science 69:3274-83.
4. Voges, K.L., Mason, C.L., Brooks, J.C., Delmore, R.J., Griffin, D.B., Hale, D.S., Henning, W.R., Johnson, D.D., Lorenzen, C.L., Maddock, R.J., Miller, R.K., Morgan, J.B., Baird, B.E., Gwartney, B.L., & Savell, J.W. (2007). National beef tenderness survey - 2006: Assessment of Warner-Bratzler shear and sensory panel ratings for beef from US retail and foodservice establishments. Meat Science 77:357-364.

Table 3 Least squares means ± standard errors for sensory panel ratings (like/dislike: 10 = like extremely, 1 = dislike extremely; tenderness: 10 = very tender, 1 = not at all tender; juiciness: 10 = very juicy, 1 = not at all juicy; flavor: 10 = extreme amount, 1 = none at all) for retail steaks

Steak	*n*[a]	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Flavor level	Juiciness like/dislike	Juiciness level
Top blade	267	6.4±0.1a	6.8±0.1a	6.8±0.1a	6.3±0.1a	6.1±0.1ab	6.5±0.1a	6.5±0.1a
Ribeye, lip-on, bnls	439	6.3±0.1ab	6.3±0.1b	6.2±0.1b	6.3±0.1a	6.2±0.1a	6.0±0.1b	5.8±0.1b
Ribeye, lip-on, bn-in	182	5.9±0.1cd	6.1±0.1bc	6.1±0.1bc	5.7±0.1c	5.6±0.1cd	5.7±0.1bc	5.7±0.1bc
Top loin, bnls	421	6.1±0.1abc	6.2±0.1bc	6.2±0.1b	6.1±0.1ab	6.1±0.1ab	5.9±0.1b	5.8±0.1b
Top loin, bone-in	149	6.1±0.1abc	6.2±0.2bc	6.2±0.2bc	5.9±0.1bc	5.9±0.1abc	5.9±0.1b	5.7±0.1bcd
T-bone	346	5.9±0.1cd	5.9±0.1cd	5.8±0.1cd	5.9±0.1bc	5.9±0.1bc	5.7±0.1bc	5.7±0.1bc
Porterhouse	148	5.9±0.2bcd	6.0±0.2bcd	5.9±0.2bcd	6.1±0.2ab	6.2±0.2ab	5.6±0.2bcd	5.6±0.2bcd
Top sirloin, bnls	706	5.7±0.1d	5.6±0.1d	5.6±0.1d	5.7±0.1c	5.7±0.1c	5.5±0.1cd	5.5±0.1cde
Top round	278	5.1±0.1e	5.0±0.1e	5.0±0.1e	5.2±0.1d	5.3±0.1d	5.3±0.1d	5.3±0.1de
Bottom round	251	5.1±0.1e	5.0±0.1e	5.0±0.1e	5.2±0.1d	5.3±0.1d	5.3±0.1d	5.2±0.1e
P > F		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Within a column, means lacking a common letter (a-e) differ ($P < 0.05$).
[a] *n* = number of steaks

Table 4 Least squares means ± standard errors for sensory panel ratings (like/dislike: 10 = like extremely, 1 = dislike extremely; tenderness: 10 = very tender, 1 = not at all tender; juiciness: 10 = very juicy, 1 = not at all juicy; flavor: 10 = extreme amount, 1 = none at all) for foodservice steaks

Steak	*n*[a]	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Flavor level	Juiciness like/dislike	Juiciness level
Ribeye	152	6.8±0.1	6.8±0.1b	6.8±0.1b	6.8±0.1	6.7±0.1b	6.6±0.1b	6.6±0.1b
Top loin	144	7.3±0.1	7.5±0.1a	7.4±0.1a	7.2±0.1	7.2±0.1a	7.2±0.1a	7.1±0.1a
Top sirloin	168	7.0±0.1	6.9±0.1b	6.8±0.1b	7.0±0.1	6.9±0.1b	6.9±0.1ab	6.8±0.1ab
P > F		0.0591	<0.0001	0.0004	0.1544	0.0238	0.0037	0.0029

Within a column, means lacking a common letter (a and b) differ ($P < 0.05$).
[a] *n* = number of steaks