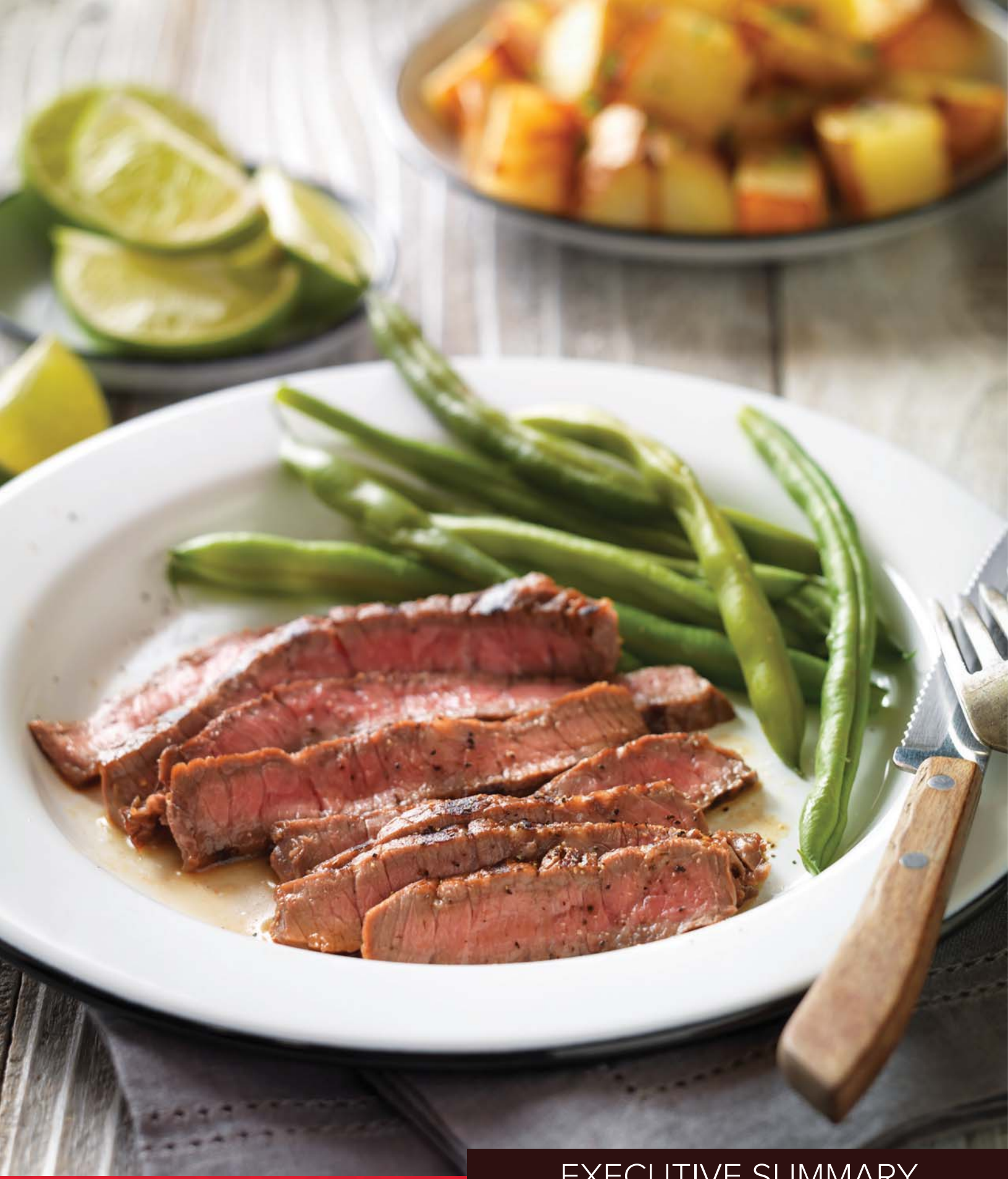

EXECUTIVE SUMMARY

2015/2016 National Beef Tenderness Survey

Funded by the Beef Checkoff.

Executive Summary

2015/2016 National Beef Tenderness Survey

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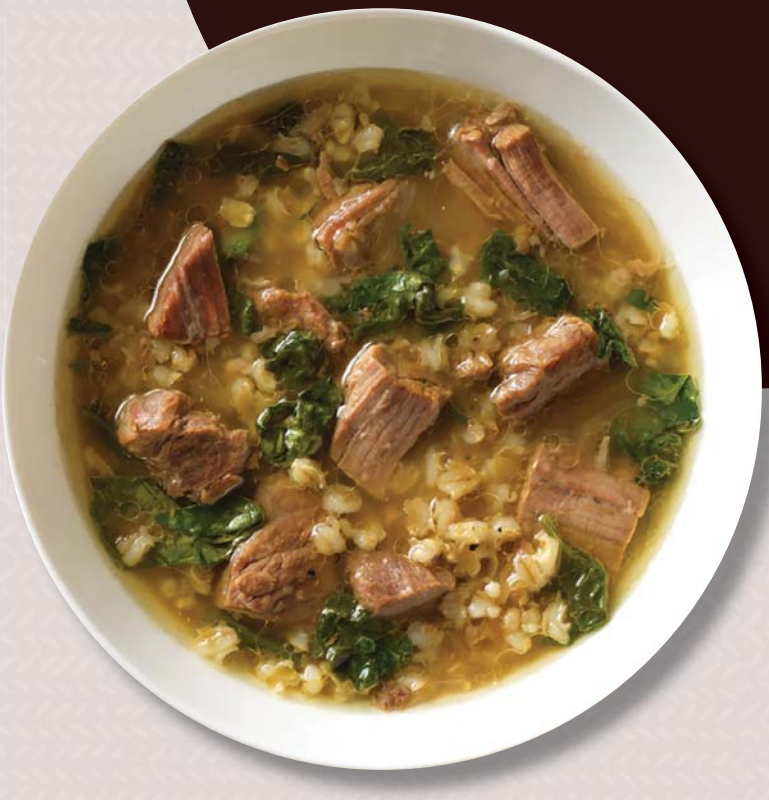
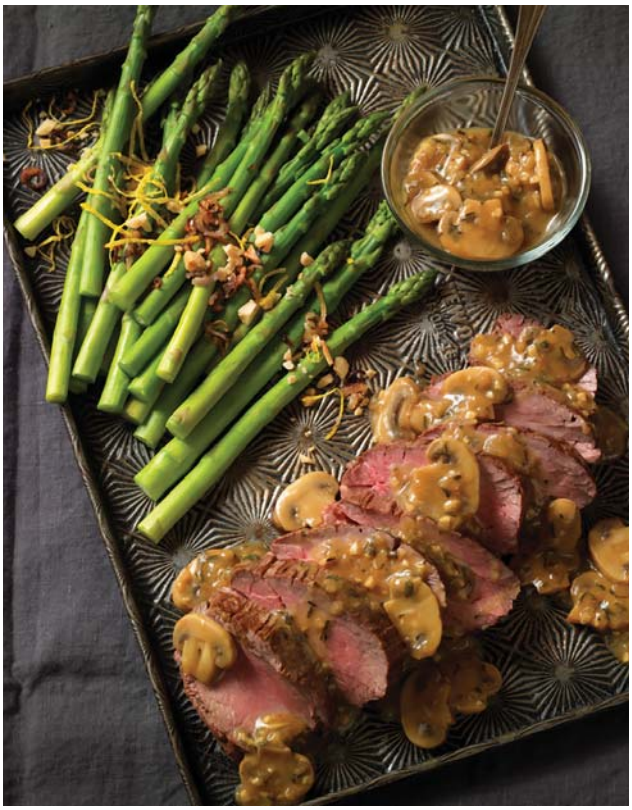


BEEF TENDERNESS: A 25-Year Journey

In the early 1990s, the beef industry responded to nearly two decades of shrinking demand for its product with a collaborative commitment to address beef's perceived quality issues. Beef was considered too fat, too inconsistent, and too tough to remain competitive in the meat case. The industry as a whole embraced a simultaneous and systematic approach to beef's various challenges, which has led to steady progress in efforts to enhance consumer satisfaction. Since consumers have determined that guaranteed-tender meat products are worth a premium, tenderness is one of the most important economic and quality factors to consider in beef production.

The National Beef Tenderness Survey (NBTS, or Survey), funded by the Beef Checkoff, has been conducted five times over the last 25 years to verify improvements in beef tenderness and direct ongoing tenderness research. The first benchmarking Survey, conducted by Texas A&M University in 1990, utilized Warner-Bratzler shear force (WBSF) tests and trained sensory panels to assess the tenderness of retail beef. The results confirmed that significant tenderness issues existed with cuts from the chuck, round, and sirloin.

Recommendations following this Survey led to substantial tenderness improvements documented in the 1999 National Beef Tenderness Survey, which evaluated both retail and foodservice cuts. Tenderness levels were again determined by WBSF tests. And, to more accurately assess consumer satisfaction, consumer evaluation panels replaced the trained sensory panels utilized in the 1990 Survey. Results showed a 20% increase in tenderness compared to 1990 findings, partially attributed to fewer "no-roll" steaks and more steaks grading high Choice or Prime than in the 1990 study. The longer, more gradual chilling procedures being practiced in 1999 reduced toughness problems associated with cold shortening/cold toughening. In addition, increased aging times at retail and a greater emphasis on producer education, which was responsible for fewer injection-site blemishes with associated toughness in the Top Sirloin, likely impacted the increased tenderness of the end product. Despite the progress noted in the 1999 Survey, a number of cuts from the round remained at the tough end of the tenderness scale, clearly indicating where future efforts needed to focus.



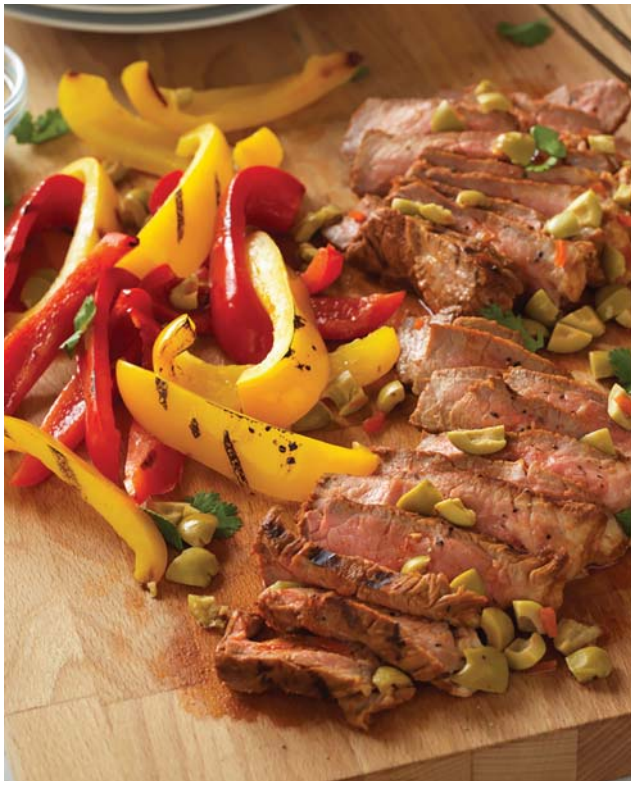
Meaningful improvements in retail and foodservice beef tenderness were again substantiated by the 2005/2006 NBTS. Results showed an approximate 18% improvement over 1999 tenderness levels (34% improvement when compared to the 1990 results) with most steaks evaluated as tender. Reasons for the improvement included increased aging times, longer and slower chill rates, processors paying more attention to tenderness parameters, and more branded programs at retail focused on tenderness. In 2005/2006, approximately 47% of retail cuts were marketed through packer or branded programs designed to guarantee certain quality traits such as phenotype, genetic makeup, aging times, and electrical stimulation. However, as in 1999, the data revealed that round cuts needed increased attention to achieve optimal tenderness. Nevertheless, the Survey results from 1990 to 2005/2006 proved that the combined efforts of all segments of the beef industry were positively impacting the quality and consumer acceptance of beef products.

The Beef Checkoff commissioned the fourth in the NBTS series in 2010/2011 with WBSF results showing tenderness values consistent with those seen in the 2005/2006 Survey. A variety of factors associated with aging were seen to influence this outcome. Compared to the 2005/2006 results, average aging times were down and the aging-day range was wider in 2010/2011. In addition, an increased percentage of some retail steaks were aged less than the industry-recommended 14-day minimum. Conversely, and likely attributable to decreased disposable income for families

during this time, the bone-in ribeye and boneless strip loin subprimals, due to their relatively higher cost, may have been frozen and held for later processing resulting in aging times significantly longer than what would normally be considered an extreme time period. Given these fluctuating aging practices, tenderness values consistent with the levels found in the 2005/2006 Survey can be seen as relatively positive. As in previous Surveys, the least tender cuts were from the round indicating the need for improved aging and consumer education focused on preparation methods tailored for round cuts.

2015/2016 Survey

The fifth NBTS was commissioned in 2015, 25 years after the original Survey. On behalf of the Beef Checkoff, Texas A&M University led a collaborative effort with North Dakota State University, Oklahoma State University, Texas Tech University, the University of Florida, and the University of Missouri to determine the tenderness status of U.S. retail and foodservice steaks. To be consistent with previous Surveys, researchers again utilized WBSF testing and consumer sensory panels. Additionally, through store visits and product packaging, researchers collected data on aging, branding, grade, tenderization, and enhancement, with all information compiled in a final report from Texas A&M University.



Retail cities were chosen to represent a broad geographical range and to maintain some historical linkage with cities that had been used in previous surveys. Cities included New York, N.Y.; Philadelphia, Pa.; Los Angeles, Calif.; Denver, Colo.; Las Vegas, Nev.; Tampa, Fla.; Atlanta, Ga.; Kansas City, Mo.; Houston, Texas; Chicago, Ill.; and Seattle, Wash. Each city was sampled over a 12-month time period. In each city, two to three retail chains, representing at least one-third of the total area market share, were selected, with four stores per chain being sampled. In an effort to accurately represent consumer demographics in a given region, corporate retail contacts were asked to identify differing retail stores in their respective chain. Thus, product was obtained from a total of eight to 12 supermarket stores per metropolitan area. In addition, if a membership club retail chain existed in a city and was not included in the one-third market share, one store of each club chain present was sampled.

The following retail cuts were sampled: Top Blade Steak; Ribeye Steak, lip on, boneless; Ribeye Steak, lip on, bone-in; Top Loin Steak, boneless; Top Loin Steak, bone-in; T-Bone Steak; Porterhouse Steak; Top Sirloin Steak, boneless, cap off; Top Round Steak; and Bottom Round Steak. Retail steaks were assigned randomly for either WBSF evaluation or consumer sensory panels and equally distributed across universities.

Collaborators also sampled one foodservice distribution establishment in six cities: Houston, Texas; Dallas, Texas; Tampa, Fla.; Denver, Colo.; Las Vegas, Nev.; and Philadelphia, Pa. Prime, high Choice, Choice, and Select USDA quality-graded steaks were collected for each of three cuts: Ribeye Roll Steak, boneless; Top Loin Steak, boneless; and Top Sirloin Butt Steak, center cut, boneless. After recording postfabrication aging times, brand designation, marketing claims, enhancement with percentage pumped, and any other noteworthy features, steaks were shipped to Texas A&M University and randomly assigned for either WBSF evaluation or consumer sensory panels. All foodservice steaks were then shipped to the University of Missouri where both WBSF tests and consumer sensory evaluations were conducted.

Cooking methods and endpoint temperatures were constant across all samples to ensure accurate detection of tenderness differences. All retail steaks were cooked on a grated, open-hearth, non-stick electric grill. Foodservice steaks were cooked on a pre-heated gas grill. ■

2015/2016 NBTS: Significant Findings

Postfabrication Aging Times

- The average postfabrication aging time at retail was 25.9 days with a range of 6 to 102 days. The 2015/2016 Survey showed the highest average compared to the three previous Surveys in which aging time was evaluated. Bottom Rounds were the retail cut with the highest frequency of product (40.7% of cases) aged less than 14 days. The mean percentage of subprimal cases aged less than 14 days was 11.9, the lowest average percentage compared to previous surveys (Tables 1 & 2).

- The average postfabrication aging time for foodservice cuts was 31.5 days with a range of 3 to 91 days. No cases of Top Loin Steaks were aged less than 14 days. As with retail cuts, the 2015/2016 Survey shows the lowest overall percentage of cases aged less than 14 days (9.1) compared to previous Surveys (Tables 1 & 2).

Table 1. NBTS 2015/2016 postfabrication storage or aging times for subprimals audited in the cold storage facilities of retail stores and foodservice distribution operations

Subprimal	Number of Cases	Days			Age < 14d, %
		Mean	Minimum	Maximum	
Retail					
Shoulder Clod	57	19.6	6	50	24.6
Top Blade	9	26.4	13	34	11.1
Ribeye, boneless	225	29.2	6	101	8.4
Ribeye, bone-in	171	28.1	16	91	0
Strip Loin	296	27.2	6	101	11.8
Strip Loin, bone-in	83	26	11	102	2.4
Short Loin	92	24	7	55	19.6
Top Sirloin	265	26.6	6	75	9.1
Top Round	186	23.2	8	100	5.9
Bottom Round	140	21.5	8	74	40.7
Overall	**1524**	**25.9**	**6**	**102**	**11.9**
Foodservice					
Ribeye	21	32.2	3	84	14.3
Top Loin	17	34.6	16	91	0
Top Sirloin	17	27.6	4	46	11.8
Overall	**55**	**31.5**	**3**	**91**	**9.1**

“The tenderness of cuts from the round remain an industry challenge. Future focus needs to include a collective effort to utilize optimal aging practices as well as more extensive consumer cooking education.”

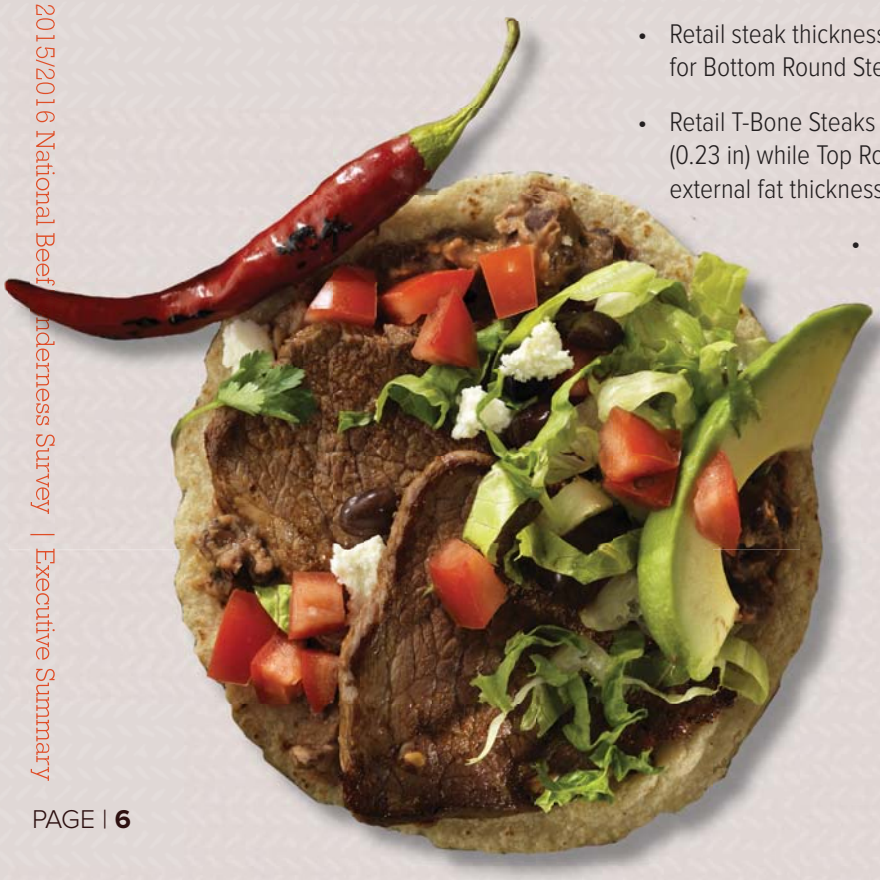
— Jeffrey W. Savell, PhD
Lead Principal Investigator

Table 2. Postfabrication storage or aging times for subprimals audited in the cold storage facilities of retail stores and foodservice operations across NBTS 1999, 2005/2006, 2010/2011, and 2015/2016 (where data available)

	NBTS 2015/2016		NBTS 2010/2011		NBTS 2005/2006		NBTS 1999	
Subprimal	**Mean Number of Days**	**Age < 14d, %**	**Mean Number of Days**	**Age < 14d, %**	**Mean Number of Days**	**Age < 14d, %**	**Mean Number of Days**	**Age < 14d, %**
Retail								
Shoulder Clod	19.6	24.6	20.3	27.2	17.3	38.9		
Top Blade	9	11.9						
Ribeye Roll			19.6	34.8	26.9	11.3		
Ribeye, boneless	29.2	8.4					21	41.9
Ribeye, bone-in	28.1	0	31.5	11.1	27.7	3	22	31.1
Strip Loin	27.2	11.8	21.6	36.2	26.2	10	20	28.6
Strip Loin, bone-in	26	2.4	29.5	20	26.2	5	14	45.5
Short Loin	24	19.6	19.1	44.2	23.1	16	18	30.2
Top Sirloin	26.6	9.1	20.3	32.4	24.4	14.8	19	31
Top Round	23.2	5.9	16.4	46.6	17.6	46.4		
Bottom Round	21.5	40.7	17.2	41.5	17.5	28.1		
All Round Subprimals							18	39
Overall	**25.9**	**11.9**	**20.5**	**35.7**	**22.6**	**19.6**	**19**	**34.1**
Foodservice								
Ribeye	32.2	14.3	29.3	10.5	30.6	37.2		
Top Loin	34.6	0	29.8	15.8	41.7	29.6	31	26.7
Top Sirloin	27.6	11.8	24.7	6.2	33.2	20.8	32	0
Overall	**31.5**	**9.1**	**28.1**	**11.4**	**30.1**	**29.5**	**32**	**19.4**

Product Information

- Approximately 34.5% of retail steaks were labeled with packer/processor or store brands or claims, down from 43% in the 2005/2006 Survey and 64% in the 2010/2011 Survey.



- Retail steak thickness averaged 2.52 cm (0.99 in) and ranged from 1.92 cm (0.75 in) for Bottom Round Steaks to 2.97 cm (1.17 in) for Top Loin Steaks.
- Retail T-Bone Steaks had the highest average external fat thickness of 0.58 cm (0.23 in) while Top Round Steaks had the least at 0.07 cm (0.03 in). The average external fat thickness of the cuts in the study was 0.4 cm (0.16 in).
- Foodservice steak thickness averaged 2.73 cm (1.08 in) and ranged from 2.47 cm (0.97 in) for Top Sirloin Steaks to 2.91 cm (1.15 in) for Ribeye Steaks.
- At foodservice, Top Sirloin Steaks had less external fat thickness at 0.04 cm (0.02 in) compared to Ribeye Steaks at 0.47 cm (0.19 in) and Top Loin Steaks at 0.50 cm (0.20 in). The average external fat thickness of the cuts in the study was 0.34 cm (0.13 in).

Tenderness

- At retail, the Top Round Steak had the highest average WBSF values of all retail cuts while the Top Loin Steak (followed closely by the Ribeye and Top Blade Steaks) had the lowest. In 2010/2011, the Bottom Round Steak had the highest average WBSF while the Top Blade Steak had the lowest. Both the Top Round Steak and the Bottom Round Steak had higher average WBSF levels than found in the 2010/2011 Survey (Tables 3 & 4).
- As in the 2010/2011 Survey, Top Loin Steaks had the lowest average WBSF values in foodservice compared to Ribeye and Top Sirloin Steaks (Tables 3 & 4).

Table 3. NBTS 2015/2016 least squares means and standard error (SE) for Warner–Bratzler shear force values (lbs) of retail and foodservice steaks

Source/Steak	Number of Steaks	Mean	SE
Retail			
Top Blade	32	4.7^{cd}	4.5
Ribeye, boneless	122	4.6^{d}	2.3
Ribeye, bone-in	42	5.2^{cd}	3.9
Top Loin	123	4.5^{d}	2.3
Top Loin, bone-in	26	5.2^{cd}	4.9
T-Bone	49	6.5^{bc}	3.6
Porterhouse	32	5.2^{cd}	4.5
Top Sirloin, boneless, cap off	129	5.1^{cd}	2.2
Top Round	51	9.0^{a}	3.5
Bottom Round	35	8.2^{ab}	4.3
P-value		<0.0001	
Foodservice			
Ribeye	80	6.7^{a}	0.7
Top Loin	68	5.5^{b}	0.8
Top Sirloin	68	6.6^{a}	0.8
P-value		<0.0001	

$^{a-d}$ Least squares means in the same column and within the same steak source without common superscript letters differ ($P < 0.05$).

Table 4. Least squares means for Warner–Bratzler shear force values (lbs) of retail and foodservice steaks, NBTS 2015/2016, 2010/2011, 2005/2006, 1999, 1990

Source/Steak	2015/2016 Mean	2010/2011 Mean	2005/2006 Mean	1999 Mean	1990 Mean
Retail					
Top Blade	4.7^{cd}	4.8^{b}			
Ribeye, boneless	4.6^{d}	5.4^{b}	5.2^{bc}	6.2	7.5
Ribeye, bone-in	5.2^{cd}	5.4^{b}	4.8^{ab}		
Top Loin	4.5^{d}	5.2^{b}	4.7^{a}	5.9	7.3
Top Loin, bone-in	5.2^{cd}	5.5^{b}	4.7^{ab}		
T-Bone	6.5^{bc}	5.2^{b}	5.0^{ab}	5.9	
Porterhouse	5.2^{cd}	5.3^{b}	5.1^{ab}	5.7	
Top Sirloin, boneless, cap off	5.1^{cd}	5.4^{b}	5.5^{c}	6.4	7.9
Top Round	9.0^{a}	6.7a	6.7^{d}	7.9	11.4
Bottom Round	8.2^{ab}	7.0^{a}	8.1^{f}	11.0	9.7
P-value	<0.0001	<0.0001			
Foodservice					
Ribeye	6.7^{a}	6.1^{b}			
Top Loin	5.5^{b}	5.8^{b}			
Top Sirloin	6.6^{a}	6.8^{a}			
P-value	<0.0001	<0.0001			

$^{a-d}$ Least squares means in the same column and within the same steak source without common superscript letters differ ($P < 0.05$).

- Tenderness categories were used to display threshold differences between both retail and foodservice cuts in the 2005/2006 Survey, the 2010/2011 Survey, and the 2015/2016 Survey. In general, all three Surveys have comparable results, though percentages in each of the four categories (Very Tender, Tender, Intermediate, Tough) fluctuate by cut from Survey to Survey (Table 5).

Table 5. Percentage distribution of retail and foodservice steaks stratified into tenderness categories for NBTS 2015/2016, 2010/2011, 2005/2006

Source/Steak	Very Tender			Tender			Intermediate			Tough		
	2015/2016	2010/2011	2005/2006	2015/2016	2010/2011	2005/2006	2015/2016	2010/2011	2005/2006	2015/2016	2010/2011	2005/2006
Retail												
Top Blade	96.9	91.9		3.1	5.4			2.7				
Ribeye, lip on, Boneless	91.8	95.5	95.1	5.7	4.6	4.9	1.6			0.8		
Ribeye, lip on, bone in	85.7	95.7	100.0	9.5	4.4		4.8					
Top Loin	95.9	84.8	98.7	3.3	10.9	1.3		2.2		0.8	2.2	
Top Loin, bone in	88.5	71.7	100.0	11.5	15.2			8.7			4.4	
T-Bone	95.9	95.6	97.0	2.0	4.4				2.1	2.0		
Porterhouse	96.9	91.1	93.8	3.1	8.9	6.3						
Top Sirloin, boneless	86.1	91.1	87.1	10.9	6.7	12.9	3.1	2.2				
Top Round	64.7	76.1	61.5	17.7	13.0	25.6	7.8	6.5	10.3	9.8	4.4	2.6
Bottom Round	37.1	47.4	22.2	31.4	23.7	48.2	17.1	23.7	18.5	14.3	5.3	11.1
Foodservice												
Ribeye	68.8	81.1	81.4	22.5	14.9	12.7	5.0	4.1	5.1	3.8		0.9
Top Loin	89.7	83.8	96.6	8.8	13.5	3.4	1.5				2.7	
Top Sirloin	69.1	58.1	73.7	23.5	32.4	22.2	5.9	5.4	2.0	1.5	4.1	2.0

Very Tender = WBSF < 7.05 lbs (3.2 kg); Tender = WBSF > 7.05 lbs (3.2 kg) < 8.6 lbs (3.9 kg); Intermediate = WBSF > 8.6 lbs (3.9 kg) < 10.1 lbs (4.6 kg); Tough = WBSF > 10.1 lbs (4.6 kg).

- As in the 2010/2011 Survey for foodservice cuts, USDA Prime steaks had the lowest average WBSF value (5.5 lb) compared to high Choice, low Choice, and Select. Low Choice and Select had the same value at 6.8 lb (Table 6).

Table 6. NBTS 2015/2016 least squares means and standard error (SE) for Warner–Bratzler shear force values (lb) for foodservice steaks stratified by USDA quality grade group

USDA Grade Group	Number of Steaks	Mean, lb	SE
Prime	56	5.5[b]	0.8
High Choice	64	6.4[a]	0.7
Low Choice	48	6.8[a]	0.8
Select	48	6.8[a]	0.9
P-value		<0.0001	

[a-b] Least squares means without common superscript letters differ ($P < 0.05$).

Sensory

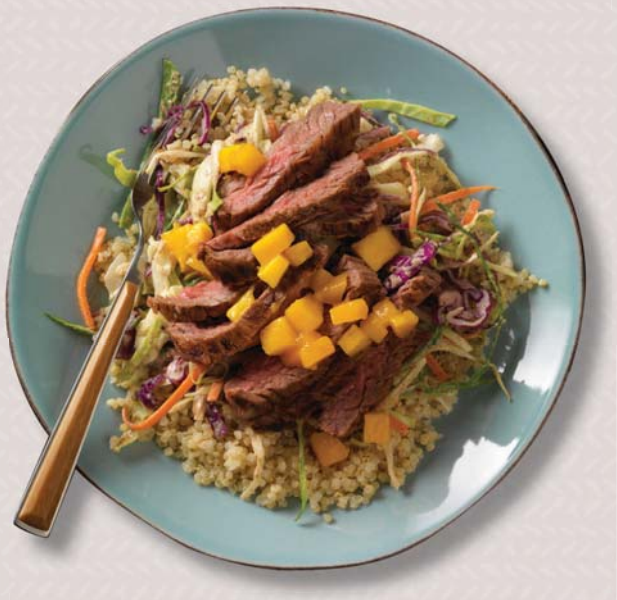
- Sensory panel ratings of retail and foodservice steaks are displayed in Table 7. In retail, the Top Blade Steak was given among the highest consumer ratings while Top Round and Bottom Round Steaks received among the lowest. For the overall like/dislike attribute, all retail cuts rated higher in 2015/2016 than in 2010/2011.

- In foodservice, the consumer sensory panel rated Top Loin and Ribeye Steaks higher than Top Sirloin Steaks in all sensory rating categories (Table 7). This differs from the 2010/2011 Survey where no statistical difference was reported between the cuts for overall liking and flavor liking attributes. ■

Table 7. NBTS 2015/2016 least squares means ± standard error (SE) for sensory panel ratings[1] for retail and foodservice steaks

Source/Steak	Overall Like/ Dislike	Tenderness Like/ Dislike	Tenderness Level	Flavor Like/ Dislike	Juiciness Like/ Dislike
Retail					
Top Blade	6.9^{a} (±0.2)	7.5^{a} (±0.2)	7.7^{a} (±0.2)	6.5^{ab} (±0.2)	7.1^{a} (±0.2)
Ribeye, lip on, boneless	6.8^{a} (±0.1)	7.0^{b} (±0.1)	6.9^{bc} (±0.1)	6.5^{ab} (±0.1)	6.4^{b} (±0.2)
Ribeye, lip on, bone-in	6.6^{ab} (±0.2)	6.6^{cd} (±0.2)	6.6^{cd} (±0.2)	6.6^{ab} (±0.2)	6.1^{bc} (±0.2)
Top Loin, boneless	6.9^{a} (±0.1)	7.0^{bc} (±0.1)	7.0^{bc} (±0.1)	6.7^{a} (±0.1)	6.5^{b} (±0.1)
Top Loin, bone-in	6.8^{a} (±0.2)	6.8^{bcd} (±0.2)	6.8^{bcd} (±0.2)	6.8^{a} (±0.2)	6.4^{bc} (±0.3)
T-Bone	6.6^{ab} (±0.2)	6.8^{bcd} (±0.2)	6.7^{cd} (±0.2)	6.5^{ab} (±0.2)	6.2^{bc} (±0.2)
Porterhouse	6.9^{a} (±0.2)	7.3^{ab} (±0.2)	7.3^{ab} (±0.2)	6.6^{ab} (±0.2)	6.5^{ab} (±0.2)
Top Sirloin, boneless	6.4^{b} (±0.1)	6.6^{d} (±0.1)w	6.5^{d} (±0.1)	6.2^{b} (±0.1)	6.0^{bc} (±0.1)
Top Round	5.5^{c} (±0.2)	5.1^{e} (±0.2)	4.9^{e} (±0.2)	5.8^{c} (±0.2)	5.2^{d} (±0.2)
Bottom Round	5.4^{c} (±0.2)	5.1^{e} (±0.2)	4.9^{e} (±0.2)	5.6^{c} (±0.2)	5.8^{cd} (±0.2)
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Foodservice					
Ribeye	7.0^{a} (±0.1)	6.9^{a} (±0.1)	6.8^{a} (±0.2)	7.0^{a} (±0.1)	6.4^{a} (±0.2)
Top Loin	7.1^{a} (±0.2)	7.1^{a} (±0.2)	7.0^{a} (±0.2)	7.0^{a} (±0.1)	6.5^{a} (±0.2)
Top Sirloin	6.5^{b} (±0.2)	6.3^{b} (±0.2)	6.2^{b} (±0.2)	6.5^{b} (±0.1)	5.5^{b} (±0.2)
P-value	0.01	0.004	0.0063	0.0107	<0.0001

$^{a-e}$ Least squares means in the same column without common superscript letters differ ($P < 0.05$).
[1] Sensory panel ratings for like/dislike: 10 = like extremely, 1 = dislike extremely; tenderness: 10 = very tender, 1 = not at all tender; juiciness: 10 = very juicy; flavor: 10 = extreme amount, 1 = none at all.



"As in previous surveys, the results from this study again demonstrate how checkoff research and beef supply chain improvements continue to enhance the consumer's eating experience."

— Jeffrey W. Savell, PhD
Lead Principal Investigator

Conclusions

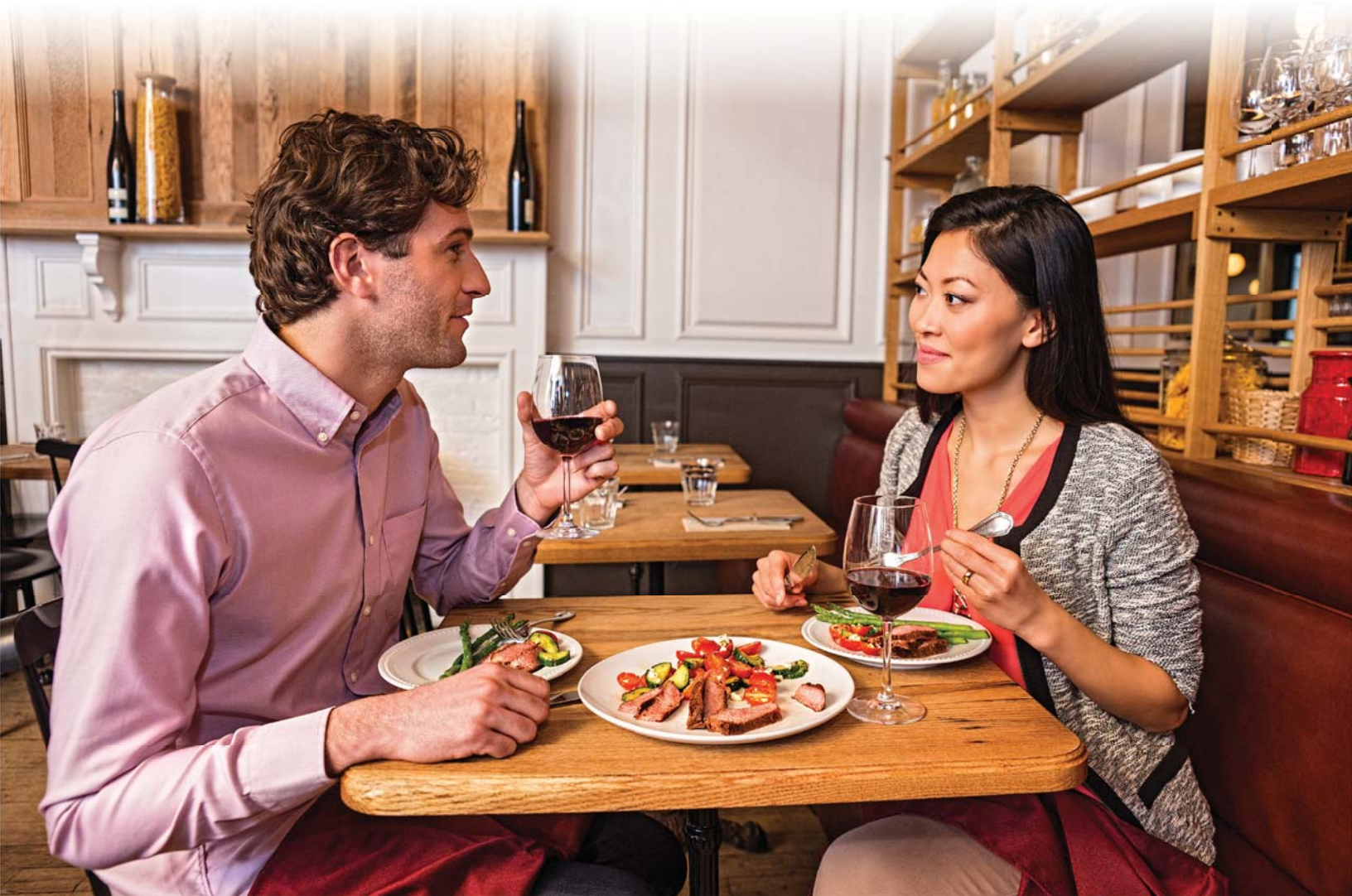
As in the 2010/2011 Survey, most steaks in the 2015/2016 Survey were considered tender. With the exceptions of T-Bone, Top Round and Bottom Round Steaks, WBSF values for retail cuts decreased from previous Survey findings. However, the percentage of foodservice cuts designated "very tender" has declined since the 2005/2006 Survey. Also similar to previous Surveys, the 2015/2016 results indicate the need for more industry focus on decreasing average WBSF values and increasing overall liking for cuts from the round. As 40% of Bottom Rounds are aged less than 14 days, increased attention to optimal aging practices could prove beneficial. An expansion of consumer education efforts on the different cooking methods for cuts from different primals could result in more consumers enjoying a satisfying beef-eating experience more often, particularly in the case of cuts from the round.

Compared to all of the Surveys since 1999, postfabrication aging times increased for most steak types. This may be due in part to requirements of different branding programs or a change in managerial practices at the retail and processor levels. And, as a consequence of the current trend to produce larger beef animals yielding larger carcasses, chilling times have naturally lengthened, thereby creating longer aging times. Increasing aging beyond the optimal time for the cut does not further improve quality, while shorter aging times less than 14 days may be responsible for the tenderness variability seen with some cuts.

A significant shift from previous Survey results was the decrease in the percentage of retail steaks labeled with packer/processor or store brands or claims. Also, unlike previous Survey findings, higher USDA quality grades for foodservice steaks did not necessarily predict tenderness improvements, particularly as seen in the WBSF values of Select and Choice cuts.

In general, tenderness levels for both retail and foodservice cuts have held steady since the 2005/2006 Survey. The results of that Survey confirmed the industry's notable progress since the early 1990s in efforts to respond to consumer demands for consistently tender, leaner, and more flavorful beef.

Despite the challenges of the last ten years, including drought, fluctuating supply, input costs, and the Great Recession, the quality of the beef being produced in the United States has remained steady and often improved. With tenderness goals being achieved, the industry is dedicating more focus to other factors impacting beef quality, such as flavor development. ■



Executive Summary

2015/2016 National Beef Tenderness Survey

Despite the challenges of the last ten years, including drought, fluctuating supply, input costs, and the Great Recession, the quality of the beef being produced in the United States has remained steady and often improved.

Funded by the Beef Checkoff.

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