

SURVEY OF QUALITY ATTRIBUTES OF BEEF FROM FARMERS MARKET  
VENDORS IN TEXAS

A Thesis

by

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## ABSTRACT

The growing demand for “local” food creates a unique market for beef, especially small, niche producers who sell their products at Farmers Markets. Therefore, to establish a baseline for tenderness of beef sold by these vendors, beef steaks ( $n = 39$  ribeyes,  $n = 39$  top loins, and  $n = 38$  top sirloins) were procured from 25 vendors at Farmers Markets across Texas. To compare a consumer acceptability of Farmers Market beef and retail beef, steaks ( $n = 20$  ribeyes,  $n = 20$  top loins, and  $n = 20$  top sirloins) were procured from 3 major retail stores in the Bryan/College Station area. Farmers Market steaks were evaluated using Warner-Bratzler shear (WBS) force and consumer sensory panels; retail steaks were evaluated using consumer sensory panels. No significant differences were identified among cuts for mean WBS values. There were also no significant differences between cuts for sensory panel ratings for products from Farmers Markets or retail. However, when comparing consumer sensory panel ratings within source, retail steaks received higher ratings ( $P < 0.05$ ) than Farmers Market steaks for overall liking and tenderness liking. Farmers Market ribeye and top loin steaks were thicker ( $P < 0.05$ ) than top sirloins. However, top sirloins were heavier ( $P < 0.05$ ) than top loins and ribeyes. When possible, information was collected at the Farmers Markets on breed, feeding regimen, and other production practices as well as a variety of marketing claims. This study created a benchmark for beef sold at Texas Farmers Markets and will help these producers better understand how their products compare to retail beef from traditional supermarkets.

## **DEDICATION**

This work is dedicated to my family and friends. I would not be where I am today without their love and support.

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## I. INTRODUCTION

Consumer preferences have evolved, and demands for source and production information of their food has increased. In recent years, buying “local” and gaining a better understanding of where food comes from have become more important to consumers when purchasing food products (Martinez et al., 2010). The Economic Research Service (ERS) states that consumers’ top reasons for purchasing locally grown foods are freshness, support for the local economy, and taste (Low et al., 2015). With the growing trend in consumer demand for “local” products and the perception of such products being fresher, the popularity of Farmers Markets also has increased. USDA’s Agricultural Marketing Service defines a Farmers Market as “two or more farm vendors selling agricultural products directly to customers at a common, recurrent physical location,” and it maintains a list of markets to assist consumers in locating locally grown products (United States Department of Agriculture, 2018). In 2012, 163,675 farms in the U.S. were marketing their products locally. Additionally, between 2002 and 2007, the number of U.S. farms with direct-to-consumer (DTC) sales increased by 17 percent, and sales of DTC products increased by 32 percent (Low et al., 2015).

While many people may associate Farmers Markets with vegetables, fruit, honey, and canned goods, beef is also commonly purchased from these venues. With respect to beef sold at Farmers Markets, little is known about the quality and consistency of these products. Nationwide studies, such as the National Beef Tenderness Surveys (NBTS) (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007), have been used by researchers and the industry to monitor



tenderness and consumer acceptability of beef. As a result of the NBTS, data on tenderness of beef across the United States for both the retail and foodservice sectors are available (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Voges et al., 2007). These surveys evaluated beef from retailers in the top one-third market share of major U.S. metropolitan areas. These surveys were not designed to evaluate quality and consumer acceptability of beef sold at smaller or niche markets, like Farmers Markets.

To gain an initial understanding of the types and quality of beef sold at Farmers Markets, a statewide study was conducted across Texas. The objectives of this study were: (1) to determine the tenderness and consumer acceptability of beef sold by vendors at Texas Farmers Markets, (2) to collect additional information about marketing claims, branding, and current regulations for beef sold at Texas Farmers Markets, and (3) to measure fat thickness and steak thickness of beef sold at Texas Farmers Markets. Creating a baseline for tenderness and having consumer sensory data for steaks sold at Farmers Markets across Texas will provide vendors with information that may enhance consumer satisfaction and help increase their sales. Furthermore, data generated from this study can be used to guide further research on consumer satisfaction and potential methods for enhancing consumer acceptance of beef sold at Farmers Markets in the coming years.

## **II. REVIEW OF LITERATURE**

Consumers expect high-quality products whether they are purchasing beef from a grocery store chain or a local Farmers Market. A variety of factors influence consumer acceptability of beef, including tenderness, juiciness, color, and flavor (Morgan et al., 1991). Furthermore, breed type, environmental characteristics, age at harvest, marbling, post-mortem treatments, and the type of cut all affect the tenderness, juiciness, and flavor of beef (Spehar, Vincek, & Zgur, 2008; Tullio, Juarez, Larsen, Basarab, & Aalhus, 2014). Of these factors, tenderness has been shown to be one of the most important when determining consumer acceptability (Boleman et al., 1997; Morgan et al., 1991). Furthermore, Spehar et al. (2008) found that consumer dissatisfaction with beef is largely caused by variations in meat tenderness.

There have been many studies over the years that determined the importance of tenderness to consumers and how to improve beef tenderness. Over the past three decades, the National Beef Tenderness Survey (NBTS) has been one of the most influential studies focusing on palatability of beef steaks sold in the United States (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). Each time the NBTS is conducted, it includes two or three retail chains that represent one-third or more of the total area market share in each city surveyed. While this survey allows sampling of cuts from a large portion of the market share in each area, niche producers, such as those that sell their beef at Farmers Markets, are not included in the survey. Surveying the palatability and tenderness of various beef cuts sold at Farmers Markets across Texas is extremely important in understanding

the quality of the products sold by local producers, especially because there is a growing demand for local products. With the heightened demand for local products, consumers also are requesting the history behind the products they are buying.

### *2.1 Evolution of beef tenderness*

The information collected and published from each NBTS provides data on which cuts need improvement and which cuts have the highest consumer acceptability, allowing producers to better meet consumer demands, which in turn should increase profitability. This economic incentive drives the beef industry to continue to improve production practices and provide high-quality beef to consumers. According to the 2015 NBTS, tenderness of most retail beef cuts in the United States improved compared to the tenderness observed in previous studies (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007).

To date, each tenderness survey used Warner-Bratzler Shear (WBS) force and consumer sensory panelists to evaluate the tenderness of beef cuts (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). Four categories of WBS force values are used when determining the tenderness of cuts, “very tender,” “tender,” “intermediate,” and “tough” (Belew, Brooks, McKenna, & Savell, 2003; Shackelford, Morgan, Cross, & Savell, 1991). When comparing the WBS force values to consumer sensory panelist ratings, Miller et al. (1995) found that consumers could detect similar tenderness levels to those found using WBS force. There also have been differences in consumer acceptability for steaks at home versus in a restaurant. Consumers eating at home expected a higher degree of tenderness than when eating in a

restaurant (Miller et al., 1995). Steaks that were rated by consumers in a restaurant had an average WBS force value of 4.0 kg, whereas steaks consumed at home had an average WBS value of 3.5 kg (Miller et al., 1995). However, when rating overall consumer acceptability, the panelists were less critical than when rating tenderness acceptability (Miller et al., 1995). This shows that while tenderness is important, it is not the only factor that consumers consider when purchasing retail beef products at home or at a restaurant.

When looking at the tenderness of specific muscles, the *M. psoas major* and the *M. infraspinatus* have been found to be the most tender (Belew et al., 2003; McKeith, DeVol, Miles, Bechtel, & Carr, 1985). Whereas, the *M. gluteus medius* of the loin and several other muscles from the round are normally found to be the least tender (Belew et al., 2003). Understanding inherent tenderness levels of individual muscles has been a determining factor in which beef cuts are used for each NBTS.

Savell et al. (1989) stated that the successful marketing of products should lead to specific demands being satisfied, but that the beef industry has not always been adequately focused on marketing and determining consumer demands. Because of these concerns, the National Consumer Retail Beef Study was conducted to provide the beef industry with information on how to better meet the demands of its consumers. Phase one of this study focused on palatability ratings and marbling levels in different regions and major cities across the United States (Savell et al., 1987). Phase two was designed to evaluate consumer acceptability of price, taste, and external fat trim of four major primal cuts of beef (Savell et al., 1989). Consumer ratings of beef are greatly influenced by

taste, price, and leanness, with taste being identified as the most important (Savell et al., 1989). Savell et al. (1989) also determined that consumers were concerned about the amount of fat on the retail cuts based on increased sales of leaner cuts and perceived health benefits reported by consumers during the study.

The first NBTS was conducted in 1990 by Morgan et al. (1991) to determine the average tenderness and sensory ratings of beef retail cuts sold across the United States. Tenderness has been shown to be the most important factor affecting taste and consumer acceptability of beef (Boleman et al., 1997; Morgan et al., 1991). WBS force values and trained sensory panelists' ratings revealed top sirloin steaks to be the least tender when compared to top loin and ribeye steaks (Morgan et al., 1991). However, there were no differences in panelists' ratings for juiciness or flavor between ribeye, top loin, and top sirloin steaks. Furthermore, retail cuts from the round were found to be the toughest cuts as compared to cuts from other primals. Retail cuts from the chuck were reported as being the second toughest primal cuts, but roughly twelve percent more tender than retail cuts from the round (Morgan et al., 1991). The beef industry increased efforts to improve the tenderness of cuts from the round and chuck based on findings by Morgan et al. (1991) that showed those to be the least tender primal cuts.

Brooks et al. (2000) expanded the NBTS to include foodservice steaks along with retail steaks from across the country. Improvements in WBS values were seen when comparing data from the 1991 NBTS to the 2000 NBTS (Brooks et al., 2000; Morgan et al., 1991). These improvements were attributed to fewer No-Roll (ungraded) steaks and an increase in higher-quality steaks compared to the previous study which used similar

product selection criteria. Another factor that may have contributed to the increase in tenderness is the transition beef packers made from a 20 to 24 h chilling time between slaughter and grading to a 36 to 48 h chilling time (Brooks et al., 2000). Rapid chilling of beef carcasses was caused issues with cold shortening, which in turn increased toughness of associated cuts (Locker, 1960). Brooks et al. (2000) stated that longer and more gradual chilling methods introduced in the 1990's may have aided in increasing the tenderness of beef. Still, Brooks et al. (2000) reported that retail cuts from the round still had the highest WBS values, and improvements in tenderness of these cuts were still needed.

Voges et al. (2007) also found that retail cuts from the round (top round, bottom round, and eye of round), had higher WBS values than all other cuts and were the only cuts to have WBS values higher than 45.1 N during the 2006 NBTS. Overall, WBS values reported in the 2006 NBTS were more favorable than previous NBTS. Voges et al. (2007) stated that longer aging times, slower chill rates, and an increase in beef tenderness programs could all have affected the increase in tenderness found across all steak types. Yet, retail cuts from the round still required improvement to reach an acceptable tenderness level as determined by both WBS values and consumer sensory panelists' ratings.

The greatest difference in the 2010 NBTS conducted by Guelker et al. (2013) when compared to the previous tenderness surveys was the use of both moist-heat cookery and dry-heat cookery for round steaks. Previously, all steaks were cooked using dry-heat, on grated, nonstick electric grills (Brooks et al., 2000; Morgan et al., 1991;

Voges et al., 2007). Whereas, in 2010, steaks that were selected for moist-heat cookery were subject to cooking in a convection oven with 250-mL of water included. There was no difference found in WBS values between the two cooking methods used for round steaks (Guelker et al., 2013). Similar to the previous NBTS findings, when compared to all other steaks, top and bottom round steaks had the highest WBS values and lowest consumer sensory panel ratings for overall like, tenderness liking, tenderness level, flavor liking, and flavor level (Brooks et al., 2000; Guelker et al., 2013; Morgan et al., 1991; Savell et al., 1989; Voges et al., 2007). Furthermore, Guelker et al. (2013) found results similar to the three previous NBTS, in that, when comparing ribeye, top loin, and top sirloin steaks, no differences were found in WBS values. Additionally, the ribeye and top sirloin cuts fell into the “tender” or “very tender” categories as previously defined by Belew et al. (2003). However, when looking at consumer panelists’ ratings, there was a significant difference in overall like/dislike for all three cuts, both on a bone-in and boneless basis (Guelker et al., 2013). Overall, tenderness values improved, with a plateau in tenderness for a few cuts, when compared to the 1991, 2000, and 2006 NTBS findings (Brooks et al., 2000; Guelker et al., 2013; Morgan et al., 1991; Voges et al., 2007).

The latest NBTS conducted by Martinez et al. (2017) was executed in a manner similar to the four previous NBTS; however, after no differences between cookery methods were found in the 2010 survey, moist-heat cookery was dropped from the study. In line with findings from the four previous NBTS, WBS values for top and bottom round steaks were the highest of all cuts evaluated (Brooks et al., 2000; Guelker et al.,

2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). Top and bottom round steaks also were found to have the lowest numerical value for consumer sensory panel ratings across all categories, which again does not differ from the surveys (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). A decrease was seen in the percentage of steaks in the “very tender” category for ribeyes, top sirloins, top rounds, and bottom rounds, with an increase in distribution across the “tender,” “intermediate,” and “tough” categories (Belew et al., 2003) in the 2015 NBTS (Martinez et al., 2017).

Marketing beef by characteristics such as aging duration, breed type, and feed regimen, allow consumers to feel empowered by their purchasing decisions to select products based on a variety of pre-harvest and post-harvest factors may impact palatability and overall eating experience. In the 2006 NBTS, roughly 47 percent of steaks surveyed were from a branded program (Voges et al., 2007). This number increased to about 64 percent in the 2010 NBTS (Guelker et al., 2013). Surprisingly, the 2015 NBTS reported that only about 34.5 percent of the product purchased had branding designations on the label (Martinez et al., 2017). Martinez et al. (2017) attributed this sharp decline in branding to increased retail store closures/mergers resulting in a retail sector consisting of only a few major companies.

## *2.2 Change in consumer demands*

The United States food system began shifting from local sources to national or global sources after World War II (Martinez et al., 2010). The number of Americans directly in contact with how their food is produced dramatically decreased to roughly 1.9



percent by the early 2000s (Dimitri, Effland, & Conklin, 2005). Consumer expectations for most of the late 20<sup>th</sup> century seemed to mostly revolve around palatability of food products, especially beef, which is still apparent today (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Savell et al., 1989; Voges et al., 2007). However, consumer expectations about their food have also evolved over the years to include more than palatability. Consumers want to know how animals are raised (i.e. grass-fed versus grain fed) and meat is produced (i.e., what slaughter techniques are used) (Johnson, Marti, & Gwin, 2012). Texas Farmers Markets are niche markets that allow consumers to talk one-on-one with producers and gain this type information. Between the 1997 and 2007 Census of Agriculture, direct-to-consumer (DTC) marketing grew by roughly 118 percent, reaching \$1.2 billion (Johnson et al., 2012). However, only about 7 percent of livestock operations in the United States participated in DTC sales in 2007, whereas 44 percent of all vegetable and melon farms participated in DTC sales during the same year. The limited number of beef vendors when compared to other commodities is mostly attributed to the limited availability of slaughter and processing facilities (Martinez et al., 2010).

Many consumers who are focused on quality, animal welfare, nutritional value, and environmental implications when purchasing food usually consider themselves “local” buyers. The problem with the term “local” is that the definition varies. It can refer to a region, specific company or marketing channel (Johnson et al., 2012). This issue caused Congress to formally define “local” as “less than 400 miles from its origin, or within the state in which it is produced” in the 2008 Food, Conservation, and Energy

Act (Johnson et al., 2012). Additionally, Iowa State University conducted a price comparison survey between foodstuffs produced and sold locally versus non-local foodstuffs sold in four major cities across the state (Pirog & McCann, 2009). Interestingly, price comparisons varied by product with local string beans, local cabbage, and local sweet onions to be priced significantly higher than their non-local counterparts. Whereas, local tomatoes, local brown eggs, and local sweet corn were priced significantly lower than their non-local counterparts (Pirog & McCann, 2009). Pirog and McCann (2009) also conducted a price comparison for local versus non-local meat products. However, because the researchers determined that product attributes must be similar for both local and non-local products (i.e., Organic, hormone-free), meat products were not purchased from local Farmers Markets, but local butcher shops instead. Locally produced 90-percent lean ground beef was found to be priced lower than non-local ground beef. In contrast, the non-locally produced pork chops were found to be priced significantly lower than the locally-sourced pork chops. Findings from this study indicate that locally produced foodstuffs can be competitively priced compared to their non-local counterparts, especially during peak seasons for certain produce (Pirog & McCann, 2009). Unfortunately, the wide range of attributes that are seen on beef packaging at Farmers Market make a price comparison to retail beef products extremely difficult.

In a study focused on increasing food prices caused by rising fuel prices, consumers were asked a variety of questions revolving around how they would change their purchasing habits if food prices spiked. When asked, “[what] actions food retailers

should take to reduce fuel usage and food prices?”, 42 percent of participants agreed and 39 percent strongly agreed that “food retailers should buy more locally grown and processed products,” (Pirog & Rasmussen, 2008). Pirog and Rasmussen (2008) also found that only about 16 percent of those surveyed were willing to grow more of their own fruits and vegetables as food costs rose. Similarly, only 17 percent stated that they were very likely to “purchase more food from a Farmers Market” if food prices continued to rise (Pirog & Rasmussen, 2008). Interestingly, the demand for locally-sourced products had already begun to increase dramatically by 2008 when this survey was conducted (Johnson et al., 2012).

### *2.3 Food safety*

The beef industry strives to produce safe, wholesome, and delicious products for consumers. Thus, the safety of Farmers Market beef is just as important as the quality. The Texas Department of Safety and Health Services (TDSHS) states that all vendors at Texas Farmers Markets wanting to sell beef products from their privately-owned herd must process their animals at a facility that maintains compliance with Texas Health and Safety Code Chapter 433 (State of Texas, 1989). All meat products that enter retail markets in the United States are required, by law, to be inspected prior to and after slaughter (Johnson et al., 2012). Meat can be inspected for retail consumption under three categories: (1) federal inspection conducted by Food Safety and Inspection Service (FSIS) employees, with resulting products permitted for sale across state lines; (2) state inspection performed by TDSHS Meat Safety Assurance personnel for product intended for intrastate commerce only; and (3) Talmadge-Aiken (TA) agreement facilities, where

inspection is conducted by state employees under an FSIS grant of inspection, allowing interstate commerce (Johnson et al., 2012). Furthermore, cattle must be processed as “for retail” and not as custom exempt (State of Texas, 1989), meaning that any beef product that will enter commerce or be sold for a monetary value must be inspected using one of the three inspection categories mentioned previously. Products must be transported and stored, prior to sale, in a way so as not to adulterate the product. This includes keeping raw beef products refrigerated or frozen at all times, having the correct label, and not cross-contaminating cooked product with raw product. Lastly, vendors also must obtain a temporary food establishment permit prior to selling their products (Texas Department of State Health Services, 2015).

Even though the beef industry and government agencies have implemented guidelines and regulations regarding the production and maintenance of a safe and wholesome food supply, consumers still do not have 100 percent confidence in the United States food supply. In a 2008 study, 755 participants were surveyed on their perceptions of the United States food supply. The majority of respondents reported that they perceived the United States food system to either be “somewhat safe” or “very safe” (Pirog & Rasmussen, 2008). Comparatively, only about 15 percent of respondents found the global food supply to be “somewhat safe” or “very safe.” Over 50 percent of consumers surveyed stated that “a food safety seal or inspection certification” was important for increasing consumer confidence in the food supply. Whereas, “whether the food item is organic” and “knowing the farmer or others who produced, harvested, and processed the food” were cited as factors important to increasing consumer confidence

for 21 and 26 percent of individuals surveyed, respectively (Pirog & Rasmussen, 2008). However, when asked about their purchasing changes due to food safety concerns in tomatoes at the time, 44 percent said they had “no change” in purchasing patterns and only 9 percent stated that they now “wash tomatoes more thoroughly” (Pirog & Rasmussen, 2008).

### III. MATERIALS AND METHODS

#### *3.1 Steak collection*

Farmers Markets ( $n = 21$ ) were chosen to represent a broad geographical range of Texas, and the study was conducted between August 2016 and April 2017. Steaks ( $n = 39$  ribeyes,  $n = 39$  top loins, and  $n = 38$  top sirloins), similar to United States Department of Agriculture (2014) Institutional Meat Purchasing Specifications (IMPS) 1112, 1180, and 1184, respectively, were purchased from 25 vendors with no more than two vendors at a single market to prevent over-sampling a geographical area. At each Farmers Market, information related to marketing and branding claims for all beef vendors were recorded, as well as any additional information about production practices or processing of the steaks.

Steaks also were purchased from three major retail chains (one store per chain) in Bryan and College Station, Texas ( $n = 20$  ribeyes,  $n = 20$  top loins, and  $n = 20$  top sirloins). Retail steaks were purchased to allow the direct comparison of Farmers Market steaks to retail steaks from supermarkets during the consumer sensory panel. Similar to Farmers Market steaks, marketing claims and processing facility were also documented for each steak.

All steaks were transported to Texas A&M University on the same day in insulated containers with refrigerant materials. Upon arrival, steaks were individually identified, vacuum-packaged, frozen and stored ( $-40\text{ }^{\circ}\text{C}$ ) until subsequent analyses.

### *3.2 Dry-heat cookery*

Steaks were thawed at approximately 4 °C for 48 h. Before cooking, external fat and steak thickness were measured at three different locations per steak. Steaks were cooked on grated, non-stick electric grills (Hamilton Beach Indoor/Outdoor Grill; Hamilton Beach, Southern Pines, NC). Grills were preheated for 15 min to approximately 177 °C. All steaks were turned upon reaching an internal temperature of 35 °C and removed when reaching an internal temperature of 70 °C. Internal temperature of each steak was monitored with a thermocouple reader (Model HH506A; Omega Engineering, Inc., Stamford, CT) using a 0.02-cm diameter, copper constantan Type-T thermocouple wire (Omega Engineering, Inc.). For each steak, pre- and post-cook weights and cook time were recorded. Cooked steaks assigned to consumer sensory panel were placed in a food warmer set at 60 °C (Alto-Shaam, Model 750-TH-II, Milwaukee, WI) for no longer than 20 min before serving to panelists. Cooked steaks destined for Warner-Bratzler shear (WBS) force determination were placed on tray in a manner to avoid any overlapping, covered with plastic wrap, and placed in refrigerated (2 to 4 °C) conditions for 12 to 18 h.

### *3.3 Warner-Bratzler shear force*

Before analyses, chilled steaks were allowed to equilibrate at room temperature before muscle fiber orientation was exposed by trimming steaks of visible connective tissue. Using a hand-held coring device, six 1.3-cm cores were removed parallel to the muscle fibers of each steak. Cores were sheared once, perpendicular to the muscle fibers, on a United Testing machine (United 5STM-500, Huntington Beach, CA) at a cross-

head speed of 200 mm/min using a 10-kg load cell, and a 1.02-cm thick V-shaped blade with a 60° angle and a half-round peak.

### *3.4 Consumer sensory panel*

Consumer panel procedures were approved by the Texas A&M Institutional Review Board for Use of Human in Research (IRB2016-0325M). Consumer panelists ( $n = 80$ ) were recruited from the Bryan/College Station area using an existing consumer database. Upon arrival at the sensory facility, an orientation was held to provide instructions for sample evaluation and ballot completion. Participants then signed a consent form and completed a questionnaire on demographics (Table 1) and consumption patterns (Table 2).



**Table 1.** Demographic attributes of consumers who participated in the sensory panels.

Item	Farmers Market	
	<i>n</i> <sup>1</sup>	%
Gender		
Male	38	48
Female	41	52
Age, yr		
< 20	10	12
21 to 25	19	24
26 to 35	20	25
36 to 45	8	10
46 to 55	8	10
56 to 65	8	10
≥ 66	7	9
Working status		
Not employed	9	10
Full-time	28	32
Part-time	11	13
Student	39	45
Income, US\$		
< 25,000	28	35
25,000 to 49,999	13	16
50,000 to 74,999	13	16
75,000 to 99,000	8	10
≥ 100,000	18	23
Food allergy		
No	77	96
Yes	3	4
Food manufacturer		
No	78	97
Yes	2	3
Ethnicity		
Caucasian	64	79
Hispanic	8	10
Asian or Pacific	2	3
Black	4	5
American Indian	2	2
Other	1	1

<sup>1</sup>Number of responses

**Table 2.** Consumer panelists' consumption patterns.

Item	Farmers Market	
	<i>n</i> <sup>1</sup>	%
Meat consumption		
Yes	80	100
Type of meat consumed		
Chicken	80	100
Pork	76	95
Beef	80	100
Fish	74	92
Overall beef consumption		
Daily	11	14
5 or more times per wk	23	29
3 or more times per wk	29	36
1 time per wk	17	21
1 time every 2wks	0	0
Less than once every 2 wks	0	0
At home beef consumption		
0 times per wk	3	4
1 time per wk	20	25
2 times per wk	21	27
3 times per wk	17	22
4 times per wk	6	8
5 or more times per wk	11	14
In restaurant beef consumption		
0 times per wk	1	2
1 time per wk	35	44
2 times per wk	18	23
3 times per wk	16	20
4 times per wk	5	7
5 or more times per wk	3	4
Degree of doneness		
Rare	1	1
Medium rare	34	41
Medium	25	31
Medium well	19	23
Well done	3	4
Purchase tendencies		
Grass-fed	10	11
Traditional	69	73
Aged	8	8
Organic	8	8

<sup>1</sup>Number of responses.

Cooked steaks were cut into cuboidal portions (1.27 cm × 1.27 cm × steak thickness), and served warm to consumer panelists in individual booths equipped with red theater gel lights. Samples were served in a random order and identified with random three-digit codes. Panelists were provided Nabisco Unsalted Tops Premium Saltine Crackers (Kraft Foods Global, Inc., East Hanover, New Jersey) and double-distilled, deionized water to use as palate cleansers between samples. Panelists characterized each sample using 9-point scales: overall liking (9 = like extremely; 1 = dislike extremely), flavor liking (9 = like extremely; 1 = dislike extremely), juiciness liking (9 = like extremely; 1 = dislike extremely), and tenderness liking (9 = like extremely; 1 = dislike extremely).

### *3.5 Statistical analysis*

Data were analyzed using JMP Software (JMP®, Version 13.1, SAS Institute Inc., Cary, NC, 1989-2007). Analysis of variance was conducted using the Fit Y by X function, and Student's t test was used to conduct least squares means comparisons. The distribution function was used to determine frequency distributions, means, standard deviations, and minimum and maximum values.

## IV. RESULTS AND DISCUSSION

### *4.1 Steak measurements*

Average steak thickness, external fat thickness, and steak weights for Farmers Market steaks are reported in Table 3. Farmers Market ribeye and top loin steaks were thicker ( $P = 0.0107$ ) than top sirloin steaks. These findings are in line with Voges et al. (2007), who also reported a greater mean steak thickness for ribeye and top loin steaks than top sirloin steaks. Data reported by Guelker et al. (2013) differ from the current study with no differences found across cuts for steak thickness. For external fat thickness, we found no differences ( $P = 0.8502$ ) across steak types. Guelker et al. (2013) reported that ribeye steaks had a greater external fat thickness when compared to top sirloin steaks. In the present study, steak weights varied across types, with top sirloin steaks weighing the most ( $P < 0.0001$ ). Guelker et al. (2013) and Voges et al. (2007) also found that top sirloin steaks weighed significantly more than ribeye and top loin steaks.

**Table 3.** Least squares means (SE) for steak thickness, external fat thickness, and steak weights for Farmers Market steaks.

	<i>n</i> <sup>1</sup>	Steak thickness, cm	External fat thickness, cm	Steak weight, g
<b><i>Farmers Market</i></b>				
Ribeye	39	2.6 <sup>a</sup> (0.11)	0.7(0.08)	333.1 <sup>b</sup> (25.63)
Top loin	39	2.6 <sup>a</sup> (0.11)	0.6(0.08)	253.1 <sup>c</sup> (25.63)
Top sirloin	38	2.1 <sup>b</sup> (0.12)	0.7(0.09)	470.1 <sup>a</sup> (25.96)
<i>P</i> -value		0.0107	0.8502	<0.0001

<sup>1</sup>Number of steaks

<sup>a-c</sup>Least squares means in the same column and within the same source without common superscript letters differ ( $P < 0.05$ ).

The North American Meat Institute (2015) developed the Meat Buyer's Guide for a variety of reasons, one being to assist retailers with cutting specifications for the fabrication of uniform cuts of meat, which helps ensure cut consistency for consumers. The Meat Buyer's Guide states that "ragged edges shall be removed" and that cutting should be done in a manner to keep straight lines and "an approximate right angle to the length of the cut" (North American Meat Institute, 2015). However, steaks found at Farmers Markets did not typically meet the descriptions outlined in the guide. Additionally, many of the available steaks were "wedge" cuts, meaning the steak gradually increased in thickness from one end to the other. In an effort to quantify this visible difference for each steak, thickness was measured in three locations and the difference between thickest and thinnest was calculated. A mean difference was then derived for each steak type. The mean difference in steak thickness were 0.7, 0.7, and 0.8 cm for Farmers Market top loin, top sirloin, and ribeye steaks, respectively (data not reported in tabular form). Comparatively, retail steaks had a mean difference in steak thickness of 0.5, 0.5, and 0.6 cm for top loin, top sirloin, and ribeye steaks, respectively (data not reported in tabular form). The larger mean differences for Farmers Market steak thicknesses support the visual assessment that variation in Farmers Market of steak thicknesses exceed those for retail steaks. This is important because if an individual steak varies in thickness (is thicker on one end than the other), the thinner portion of the steak would most likely reach a higher degree of doneness than the thicker end, potentially impacting consumer acceptance.

#### 4.2 Cook yields and times

No differences ( $P > 0.05$ ) were found across steak types for cook yields or cook times (data not reported in tabular form). Similarly, Guelker (2011) and Henderson (2016) found no differences in cook times when comparing retail ribeye, top loin, and top sirloin steaks. Henderson (2016) also reported no differences in cook yields across all retail cuts. However, Guelker (2011) found that ribeye, bone-in and top loin, boneless and bone-in, steaks had higher cook yield percentages when compared to top sirloin steaks.

#### 4.3 Warner-Bratzler shear force

WBS force values for Farmers Market steaks are reported in Table 4. WBS force values were not found to differ ( $P = 0.4939$ ) among Farmers Market ribeye, top loin, or top sirloin steaks. These results are in agreement with findings from both the 2010 and 2015 NBTS by Guelker et al. (2013) and Martinez et al. (2017), respectively, who found no significant differences in WBS force values between retail ribeye, top loin, and top sirloin steaks. Part of this similarity can be attributed to the muscles that are in each of these three steak cuts. The ribeye and the top loin steaks are primarily comprised of the *M. longissimus thoracis*, while the *M. gluteus medius* is the predominant muscle of top sirloin steaks. Both muscles are ranked in the tender category within the relative tenderness ranking (Belew et al., 2003).

**Table 4.** Least squares means and SE for Warner–Bratzler shear force values (N) for Farmers Market steaks.

Steak type	<i>n</i> <sup>1</sup>	Mean (N)	SE
Ribeye	19	22.2	2.0
Top loin	20	24.9	1.9
Top sirloin	19	25.3	1.9
<i>P</i> -value		0.4939	

<sup>1</sup>Number of steaks

Belew et al. (2003) created four tenderness categories: “very tender,” “tender,” “intermediate,” and “tough” as a way to determine expectant palatability based on WBS force measurements. As seen in Table 5, Farmers Market ribeye steaks had the highest percentage in the “very tender” category at 94.4%, compared to 85.0% and 80.0% of top loin and the top sirloin steaks, respectively. Farmers Market top loin steaks were the only cut with representation in all four categories, with 5.0% in each of the “tender,” “intermediate,” and “tough” categories. Guelker et al. (2013) found similar results with ribeye steaks having the highest percentage in the “very tender” category, as well as top loin steaks being the only cut to have representation in all four categories. However, Voges et al. (2007) and Martinez et al. (2017) reported that top loin steaks out performed ribeye and top sirloin steaks with the highest percentage in the “very tender” category at 98.7% and 95.9%, respectively. Martinez et al. (2017) also reported ribeye steaks as the only cut having representation in all four categories.



**Table 5.** Percentage distribution of Farmers Market steaks stratified into tenderness categories based on Belew et al. (2003).

Steak type	<i>n</i> <sup>1</sup>	Very Tender, WBS <sup>1</sup> < 31.4 N	Tender, 31.4 N < WBS < 38.3 N	Intermediate, 38.3 N < WBS < 45.1 N	Tough, WBS > 45.1 N
Ribeye	19	94.4		5.5	
Top loin	20	85.0	5.0	5.0	5.0
Top sirloin	19	80.0	20.0		

<sup>1</sup>WBS = Warner-Bratzler shear force values.

#### *4.4 Consumer sensory panel*

Consumer panelists evaluated both Farmers Market and retail steaks to allow for direct comparison of sensory attributes. LS means of consumer sensory ratings for steak type and source main effects are outlined in Table 6. No differences ( $P > 0.05$ ) were found across cuts or between sources for flavor liking or juiciness liking categories. Similarly, data from Voges et al. (2007), Guelker et al. (2013), and Martinez et al. (2017) showed no significant differences in any consumer ratings between ribeye steaks and top loin steaks. Martinez et al. (2017) also found no significant difference for juiciness liking when comparing ribeye, top loin, and top sirloin steaks. However, for overall liking and tenderness liking categories in the present study, retail steaks were rated higher ( $P = 0.0493$ ,  $P = 0.0058$ , respectively) by consumers than Farmers Market steaks. There were no steak type differences ( $P > 0.05$ ) for any of the consumer palatability traits evaluated, which varies from Voges et al. (2007) and Guelker et al. (2013) who reported significantly higher consumer ratings for ribeye steaks and top loin steaks than top sirloin steaks for all four categories. Furthermore, Martinez et al. (2017) reported that the boneless ribeye and top loin steaks received higher ratings for overall liking and tenderness liking when compared to boneless top sirloin steaks.

**Table 6.** Least squares means (SE) for sensory panel ratings<sup>1</sup> by source and steak type main effects

Main effects	<i>n</i> <sup>2</sup>	Overall liking	Tenderness liking	Flavor liking	Juiciness liking
<b>Source</b>					
Farmers Market	59	5.9 <sup>b</sup> (0.16)	5.8 <sup>b</sup> (0.21)	6.1(0.13)	6.1(0.16)
Retail	60	6.4 <sup>a</sup> (0.16)	6.7 <sup>a</sup> (0.21)	6.2(0.12)	6.1(0.15)
<i>P</i> -value		0.0493	0.0058	0.6430	0.7853
<b>Steak Type</b>					
Ribeye	40	5.9(0.19)	6.2(0.25)	5.9(0.15)	5.7(0.19)
Top loin	39	6.4(0.19)	6.4(0.26)	6.4(0.15)	6.3(0.19)
Top sirloin	39	6.1(0.19)	6.2(0.25)	6.2(0.15)	6.1(0.19)
<i>P</i> -value		0.1798	0.7550	0.0871	0.0680

<sup>a-b</sup>Least squares means in the same column and main effect without common superscript letters differ ( $P < 0.05$ ).

<sup>1</sup>Sensory panel ratings for like/dislike: 9 = like extremely, 1 = dislike extremely; tenderness: 9 = very tender, 1 = not at all tender; juiciness: 9 = very juicy; flavor: 9 = extreme amount, 1 = none at all.

<sup>2</sup>Number of steaks.

#### 4.5 Marketing and branding claims

A number of marketing and branding claims were observed when visiting Farmers Markets. The claims that were most widely seen or those that may impact consumer acceptance of the product are listed in Table 7.

**Table 7.** Distribution of steaks across marketing and branding claims for Farmers Market steaks.

Steak type	<i>n</i> <sup>1</sup>	Go Texan	Angus Influence	Grass-fed	All Natural	Organic
Ribeye	39	9	22	37	35	0
Top loin	39	4	24	33	32	3
Top sirloin	38	5	24	34	34	0

<sup>1</sup>Number of steaks

According to the United States Department of Agriculture (2017), organic products reached over four percent of total food sales in the United States and continues to grow each year. In this study, only three steaks purchased from Farmers Markets were labeled as “organic.” However, the “all natural” marketing claim was found on 87.1 percent of the steaks purchased. After speaking with many of the vendors, it became evident that the time and cost associated with obtaining United States Department of Agriculture (USDA) certification for organic products were the main reasons for labeling products as “all natural” instead. The USDA requires producers to meet the following basic steps to become certified organic: (1) the farm or business adopts organic practices, selects a USDA-accredited certifying agent, and submits an application, (2) the certifying agent must review the application, (3) on-site inspection by USDA inspectors must be conducted, (4) certifying agent must review the inspector’s report and determine if the applicant complies with the USDA organic regulations. Once

the applicant meets all requirements and all of the previously listed steps are completed, the organic certification is granted. The farm or business must also be reviewed and inspected annually. The expenses related to producing certified organic beef vary farm to farm and can range between hundreds to thousands of dollars. These costs are associated with changing production practices to meet standards, and any applicable certification fees (United States Department of Agriculture, n.d.). Most Farmers Markets vendors stated that they did not produce enough beef each year for the certification process to be financially feasible or worth the time required to obtain and maintain certification.

Advertising Angus influence was another commonly seen marketing claim. Over half of the steaks were marketed as having some level of Angus influence. Although not sold as a certified, branded product, such as Certified Angus Beef, vendors marketed their beef as Angus or Angus-cross, to capitalize on the perceived popularity of Angus beef and impact on consumer purchasing decisions. While not all Farmers Market vendors sold Angus-influenced beef, many still used breed type as a marketing tool. Vendors utilized cattle breeds to market both novel, such as Scottish Highland, and easily recognizable, such as Texas Longhorn. This merchandising approach piqued interest and increased discussions with consumers.

Go Texan “promotes the products, culture, and communities that call Texas home” (Texas Department of Agriculture, n.d.). By becoming a Go Texan member, producers are (1) able to use the Go Texan logo on their products, (2) listed on the Go Texan website directory and other forms of social media, (3) provided networking opportunities in the Go Texas e-newsletter and LinkedIn, and (4) offered discounted

rates for advertising and trade shows. Only four vendors purchased from during this study marketed their product as Go Texan.

However, as vendors look for ways to meet consumer demands for locally grown products, Go Texan could be useful marketing tool. Buying local has become an increasingly common purchasing trend for consumers (Low et al., 2015). In a report to congress, Low et al. (2015) stated a 180 percent growth in Farmers Markets in the United States from 2006 to 2014. Sales at Farmers Market are categorized as direct-to-consumer sales. From 2002 to 2007, farms using DTC sales increased by 17 percent, with total DTC sales increasing by 30 percent (Low et al., 2015). Farmers Markets provide both producers and consumers with a venue to market, sell, and purchase food products that would be considered by most as local.

While visiting Farmers Markets, the following information was collected: establishment number of harvest facility, associated inspection agency (state or federal), and product storage type used. Approximately two-thirds of steaks purchased at Farmers Markets were state inspected by personnel from the Texas Department of State Health Services – Meat Safety Assurance Unit (Table 8). All steaks, with the exception of four that were purchased from the same vendor, had either a USDA or Texas inspection legend on the packaging. The four steaks lacking an inspection legend were diverted to WBS force analysis to ensure that only inspected products were served to consumer panelists. Vendors used the following product storage styles: chest/upright freezers ( $n = 11$ ) and ice chest coolers ( $n = 14$ ) (data not presented in tabular form). Of the ten

vendors using chest/upright freezers, two were not using a power source; however, all purchased products were frozen at the time of sale.

**Table 8.** Inspection for Farmers Market steaks.

Steak type	<i>n</i> <sup>1</sup>	USDA Inspected	State (Texas) Inspected	No Inspection Legend
Ribeye	39	9	28	2
Top loin	39	12	26	1
Top sirloin	38	10	27	1
Total	116	31	81	4

<sup>1</sup>Number of steaks

#### 4.6 Pricing

While a price comparison was not produced for Farmers Market and retail steaks during this study, it is important to note some of the differences seen. Farmers Market vendors we purchased from sold their products either by the pound or by the package (price data not reported in tabular form). Prices on a per pound basis ranged from \$9.00/lb for a sirloin steak to \$38.50/lb for a ribeye steak. Steaks that were priced per package ranged from \$5.00/package for a sirloin steak to \$36.96/package for a sirloin steak. Future research of Farmers Market products should include data on pricing to quantify the variation of prices between cuts, as well as across the Farmers Markets. Furthermore, creating a price comparison of Farmers Market and retail beef could be beneficial to consumers. While many consumers purchase product based on quality attributes and production practices, pricing is still an important factor.

#### *4.7 Recommendations*

Farmers Markets provide an environment that allows consumers the ability to speak directly to producers about the product they are purchasing. While this direct marketing scheme allows producers provide specific production-related information that consumers are demanding, there is still the issue product inconsistency. As stated above, consumers' demands have evolved over the years to include more than just palatability traits, although consumers still want a flavorful, tender, and juicy product that has a consistent appearance at every purchase. Product and labelling inconsistencies could be a rate limiting step for many producers at Farmers Markets.

Small beef processors, which are mainly being used by Farmers Market vendors, are in need of educational workshops and materials on proper fabricating techniques to create a more consistent product that could benefit both producers and consumers. Such training and outreach materials should be based on the National Meat Buyers Guide and IMPS guidelines to create consistency both within Farmers Market steaks and between Farmers Market and retail steaks. Additionally, there were some packaging issues and incorrect labels for Farmers Market steaks. Providing producers and processors with guides on better packaging practices should help to prevent freezer burn and excess purge from occurring as often, which would also lead to a higher quality product for consumers. By providing processors with a better understanding of fabrication and packaging, consumer confusion due to product and packaging and labeling issues can be minimized.



## V. CONCLUSION

This survey was conducted to establish a baseline for the tenderness and palatability of beef sold at Texas Farmers Markets. Additionally, these data allowed for direct comparisons of consumer sensory ratings between Farmers Market and retail beef cuts.

Overall, the WBS force values of Texas Farmers Market steaks were similar to those seen for retail products on a national level when comparing values to the previous National Beef Tenderness Surveys. Similarly, consumer panelists' ratings for all three cuts from Farmers Markets were lower for overall liking and tenderness liking when compared to the retail steaks used in this study and the previous National Beef Tenderness Surveys. Although, the Farmers Market beef differed from retail for some consumer ratings, at least ninety-percent of the Farmers Market steaks were considered to be "very tender" or "tender" from a shear force perspective.

Beef consumers frequently make purchasing choices on expected palatability characteristics, and many of them are challenging the beef industry to share more information on the origin of beef products and how cattle are raised. Farmers Market vendors understand consumers' desire to know more about their food and, as a result, often provide information on their type of cattle and production practices. While there are areas for improvement in fabrication and packaging, results from this study indicate that small producers and niche vendors at Farmers Markets are producing and selling beef products in a manner that allows consumers to both connect with their food and

have an eating experience comparable to that with beef products purchased from retail chain stores.

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