NATIONAL BEEF TENDERNESS SURVEY – 2021: ASSESSMENT OF WARNER-BRATZLER SHEAR FORCE AND CONSUMER PANEL EVALUATION OF BEEF STEAKS FROM U.S. RETAIL AND FOODSERVICE ESTABLISHMENTS

A Thesis

by

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ABSTRACT

Beef retail steaks were sampled at stores across eleven U.S. cities, and beef foodservice steaks were purchased from six U.S. cities. Cities were chosen to represent a broad geographical range and upholding their historical association with cities from former surveys. Approximately 66.4% retail packages included a form of branding on the label. Cooked steaks were evaluated using Warner-Bratzler shear (WBS) force and consumer sensory panels. Approximately 66.4% of retail packages possessed a form of branding on the label. The retail tenderloin had the lowest ($P < 0.05$) WBS force value compared to other cuts. The retail steak with the greatest WBS force value was the top sirloin. Foodservice ribeye and top loin steaks had higher ($P < 0.05$) WBS force values compared to the tenderloin. Retail top blade, bone-in ribeye, Porterhouse, and tenderloin steaks all had 100% in the "very tender" category (<31.4 N). There were no ($P > 0.05$) differences in USDA quality grade groups for foodservice steaks using WBS force. Retail tenderloin received the highest ($P < 0.05$) consumer rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like. There was no ($P > 0.05$) difference between the four foodservice cuts on consumer sensory rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like. USDA quality grade for foodservice steak showed no ($P > 0.05$) difference for overall like, tenderness like, tenderness level, flavor like, and juiciness like. Ribeye, top loin, top sirloin, and tenderloin foodservice cuts reported no ($P > 0.05$) difference that USDA quality grade had on consumer rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like. All WBS force values for retail steaks have decreased compared to past surveys. However, sensory ratings for both retail and foodservice were comparable to previous surveys.

Dedication

I dedicate this work to my amazing family, friends, grad group, mentors, and student workers, who helped me get through these past two and half years.

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INTRODUCTION

Tenderness is one of the leading factors influencing consumer satisfaction, as reported in the Beef Customer Satisfaction studies (Lorenzen et al., 1999; Neely et al., 1998, 1999; Savell et al., 1999). Tenderness is often credited as the most important factor affecting the overall steak acceptability (Dikeman, 1987). The National Beef Tenderness Survey (NBTS) is a recurring study that benchmarks the tenderness of U.S. retail and foodservice beef steaks approximately every five years. On behalf of the National Cattlemen's Beef Association, Texas A&M University led in a collaborative effort with Oklahoma State University, University of Florida, University of Missouri, Texas Tech University, and North Dakota State University to conduct this survey.

In previous surveys (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007), steaks from the round primal were a part of the selected steak samples. It was concluded that round steaks needed additional assistance in reducing WBS force values and increasing consumer acceptance (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). Even with utilizing different cooking methods (e.g., moist heat) to aid in reducing WBS force values, steaks from the round primal continuously possessed lower consumer acceptance. Therefore, round steaks were omitted for this survey, and steak selection was mainly from the rib and loin primals. After the second NBTS survey, tenderloin steaks were removed from the selection list, but tenderloins were reintroduced back into this study for both retail and foodservice collections. In past surveys, data on post-mortem aging was collected from retail stores' backrooms and coolers (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). However, this NBTS did not collect post-mortem aging information.

The primary objectives of this study were: (1) to establish a new benchmark of tenderness and other sensory attributes of retail and foodservice steaks using WBS force and consumer sensory panel and (2) supplementary information from packaging about branding, claims, quality grade, and other marketing strategies of steaks sold in the U.S. was collected.

LITERATURE REVIEW

The NBTS has been conducted on five previous occasions in the U.S. (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Morgan et al., 1991; Voges et al., 2007). NBTS was first conducted in 1990 by Morgan et al. (1991), with products collected in 14 cities across the U.S. Data were used to establish a baseline of tenderness and other sensory attributes (e.g., flavor, juiciness, and amount of connective tissue) of retail steaks and roasts. Morgan et al. (1991) applied multiple cooking methods (e.g., braising, broiling, roasting) to these cuts and evaluated tenderness by both trained panelists and WBS force analyses. The second NBTS by Brooks et al. (2000) was conducted similarly to Morgan et al. (1991) but with some modifications. Instead of utilizing trained sensory panelists to evaluate the tenderness of each cut, consumer sensory panels were used to assess the consumers' ability to rate sensory attributes. In addition, foodservice steaks were included for both consumer sensory panel and WBS force evaluations (Brooks et al., 2000). When the survey was conducted again in 2006 by Voges et al. (2007), it was designed similar to the previous survey by Brooks et al. (2000). The 2010 NBTS performed by Guelker et al. (2013) introduced a moist-heat cooking method for retail top and bottom round. In 2015, the fifth NBTS (Martinez et al., 2017), possessed a singular cooking method and final internal temperature for all steaks, which was similarly structured to the 1998 NBTS (Brooks et al., 2000).

As depicted by the name, the NBTS have focused on accessing changes in beef tenderness. Postmortem aging is one factor that can impact tenderness. Postmortem aging indicting storing in a cooler. Postmortem aging is practiced around the world, due to its positive influence on beef palatability through the action of proteolytic systems within meat (Kim et al., 2018). Carcasses, primals, and/or subprimals are stored under refrigeration for days or weeks to

improve palatability. The average postfabrication aging times for retail steaks has fluctuated through the years from 25.9, 20.5, 22.6, and 19.0 days as reported by Martinez et al. (2017), Guelker et al. (2013), Voges et al. (2007), and Brooks et al. (2000), respectively. The average postfabrication aging times for foodservice steaks reported by Martinez et al. (2017), Guelker et al. (2013), and Voges et al. (2007), were 31.5, 28.1, and 30.1 days, respectively. Martinez et al. (2017) concluded an increased percentage of foodservice steaks aged for a minimum of 14 days, compared to previous surveys (Brooks et al., 2000; Guelker et al., 2013; Voges et al., 2007).

NBTS 2006 by Voges et al. (2007) collected supplementary information from the retail package about branded programs and other marketing claims. Approximately half of the retail packages contained a packer brand program, and over 40% possessed branding from the retail store. Guelker et al. (2013), found a noticeable increase to 64% of retail steaks contained a packer or store brand program on the labels or the steak packages. However, a drastic decrease was found in the 2015 NBTS conducted by Martinez et al. (2017) with only 34.5% of packages possessing store branding or any other marketing claim.

United States beef quality grades were established in 1927 as a voluntary system based on two main factors: degree of intramuscular fat (marbling) and the maturity of the animal at the point of slaughter. In 2017, 35 beef facilities nationwide implemented the USDA quality grade system, with some facilities processing 5,800 head of cattle per day, making a collective annual total of roughly 26 million fed steers and heifers (Morris, 2017). The different tiers (USDA Prime, Choice, Select, Standard, Commercial, Utility, Cutter, and Canner) of quality grades allow for smoother business transactions and consumers insight to make improved purchasing decisions through the transition of information by the marketing chain (Lusk, Fox, Schroeder,

Mintert, & Koohmaraie, 1999). However, the first three quality grades (USDA Prime, Choice, and Select) are more recognizable by consumers (USDA, 2019).

Martinez et al. (2017) observed that top blade steaks (2.30 cm), Porterhouse (2.43 cm), and top round steaks (2.28 cm), which represent cuts from the chuck, loin, and round, respectively, possessed similar thickness ($P > 0.05$). Brooks et al. (2000), Voges et al. (2007), Guelker et al. (2013) reported the retail cuts from the chuck and round were the thinnest, whereas retail cuts derived from the rib and loin were observed to be the thickest. However, it was continuously noted that the bottom round steak was the thinnest retail cut (Brooks et al., 2000; Guelker et al., 2013; Martinez et al., 2017; Voges et al., 2007). Voges et al. (2007) and Martinez et al. (2017) observed that top loin steak was the thickest retail cut at 2.60 cm and 2.97 cm, respectively. In contrast, Guelker et al. (2013) found the top sirloin steak was the thickest in its survey. Both Guelker et al. (2013) and Martinez et al. (2017) reported that the top blade was the lightest ($P < 0.05$) weighting retail steak. However, Guelker et al. (2013) reported that the top blade steak (1.75 cm) possessed similar ($P > 0.05$) thickness to the bottom round (1.59 cm) steaks. In addition, Martinez et al. (2017) reported that the top blade (2.30 cm) had similar ($P > 0.05$) thickness to the Porterhouse (2.43 cm) and the top round steaks (2.28 cm).

Brooks et al. (2000), Voges et al. (2007), Guelker et al. (2013), and (Martinez et al., 2017) reported that Ribeye and top loin foodservice steaks have greater amount of external fat thickness ($P < 0.05$) when compared to top sirloin steaks. Of the three foodservice steak cuts sampled, Brooks et al. (2000), Voges et al. (2007), and Martinez et al. (2017) all observed differences in thickness amongst them. However, Guelker et al. (2013) reported that all foodservice cuts sampled possessed similar ($P > 0.05$) thickness across the board. Voges et al. (2007) and Martinez et al. (2017) both reported that ribeye steaks weighed the most ($P < 0.05$).

In 2010, Guelker et al. (2013) observed that top sirloin steaks were the heaviest ($P < 0.05$) and top loin steaks were the lightest ($P < 0.05$).

Consumers are even willing to pay a premium to ensure a more tender cut of meat (Boleman et al., 1997). Traditionally, cuts from the chuck and round primals are less marketable than middle meats because of perceived tenderness issues. Instead of being fabricated into retail steaks, some chuck and round pieces are ground to increase marketability. However, one of the most tender cuts of beef is *M. infraspinatus*, commonly known as either Top Blade or Flat Iron, derived from the chuck (Belew et al., 2003; Sullivan & Calkins, 2011)

A study by Lusk et al. (1999) concluded in a blind taste test that 72% of consumers preferred a tender steak (measured by WBS force evaluation), and that 36% of consumers were willing to pay an average premium of $2.71/kg. for the more tender steak. Once information about level of tenderness was released to the panelists with a taste sample, 90% said they preferred the more tender steak and 51% were willing to pay average premium of $4.06/kg. for the more tender option. Overall, all panelists were 18% more likely to prefer the tender steak once product's tenderness information was disclosed. Those more willing to pay a premium for a guaranteed tender steak were individuals who were highly educated, younger females, and with higher household income levels (Lusk et al., 1999).

Marbling's impact on meat tenderness has been divided into four theories: bite, strain, lubrication, and insurance (Smith & Carpenter, 1974). The bite theory suggests that marbling dilutes the protein and decreases the mass per unit volume within a given cooked bite-size portion of meat. The bulk density of the meat decreases due to fat being less resistant to shear force; thus, making it more tender. The strain theory proposes that marbling in the perivascular cells inside the walls of the perimysium or endomysium or within the connective tissue can

weaken the connective tissue walls. A reduction in connective tissue wall integrity causes a decrease in the width, thickness, and strength of the wall, lowering the required shear force amount to cut the meat. The lubrication theory suggests that marbling surrounding the muscle fibers lubricate to the fibers and fibrils, increasing the tenderness sensation because tenderness and juiciness are closely associated with one another. Lastly, the insurance theory proposes that a high degree of marbling protects palatability against cooking using high temperature, dry-heat, and greater doneness. Marbling provides insurance to the palatability of the cooked meat, because fat conducts heat slower than lean tissue (Smith & Carpenter, 1974).

In the 1920s, WBS (Warner, 1929) was developed, and it is still a standard objective measurement of tenderness used today. WBS force threshold tenderness categories utilized in past National Beef Tenderness Surveys were established by Shackelford et al. (1991) and then expanded on by Belew et al. (2003). Tenderness categories were developed to classify WBS force values into correlated consumer acceptance groups objectively. Using 50% and 68% confidence intervals, Shackelford et al. (1991) established the threshold of tough and tender muscles with the values of ≥45.1N and ≤38.3N. Belew et al. (2003) developed a new category, "very tender" (<31.4N) when conducting a study evaluating tenderness using WBS force on 40 bovine muscles.

In the previous surveys, Martinez et al. (2017) reported the lowest numerical WBS force value for retail cuts was the boneless top loin cut at 19.9 N, which differ from the finding of Guelker et al. (2013) that the lowest force required to shear was the top blade at 21.5 N. Nevertheless, both Guelker et al. (2013) and Martinez et al. (2017) found that round steaks had the highest numerical WBS force value. In regards for foodservice, Voges et al. (2007) and Martinez et al. (2017) both reported top loin steak had the lowest ($P < 0.05$) WBS force value, at

21.9 N and 24.6, respectively. Voges et al. (2007), Guelker et al. (2013), and Martinez et al. (2017) stated a difference ($P < 0.05$) between WBS force values for top loin and top sirloin.

Consumer sensory panels provide information about the consumer's preference and acceptance of the evaluated product(s). Sensory evaluation can be completed in either in-home or central location test settings. The artificial environment within a central location test may cause consumers to be uncomfortable and cause skewed sensory verdicts (Miller, 1998). However, sample preparation and presentation are controlled in central location testing. Consumer sensory panel ballots can be designed to collect two different data types: preference and acceptance (Miller, 1998). For preference panels, consumers are asked to choose one product over another or identify the product they prefer the most. Hedonic scales for acceptance panels are used to measure the degree of liking, followed by question(s) on what is liked or disliked.

Voges et al. (2007), Guelker et al. (2013), and Martinez et al. (2017) all reported that top round and bottom round steak received the lowest across all sensory attributes compared to other retail cuts. Martinez et al. (2017) stated top blade steak received the highest consumer rating across all categories, whereas Guelker et al. (2013) found top blade received ($P < 0.05$) higher consumer rating for tenderness like, tenderness level, juiciness like, and juiciness level compared to other retail cuts. Voges et al. (2007) reported retail cuts with the highest rating for overall like by consumers were bone-in top loin and T-bone at 6.9 and 6.6, respectively.

Voges et al. (2007) and Martinez et al. (2017) reported higher ($P < 0.05$) consumer rating for ribeye and top loin in overall like, tenderness like, tenderness level, and juiciness like compared to top sirloin. Whereas, Guelker et al. (2013) reported the highest ($P < 0.05$) rating for only the top loin cut in tenderness like, tenderness level, and flavor level categories. In addition, Guelker et al. (2013) did not report any differences for foodservice steaks for overall like and

flavor like. Martinez et al. (2017) compared foodservice steaks stratified by USDA quality grade groups and only reported differences ($P < 0.05$) for tenderness level and tenderness. Thus, indicating consumers not differentiate on overall like, flavor, as well as juiciness like sensory attributes between the four USDA quality grades (Prime, Top Choice, Low Choice, and Select) of three different cuts (ribeye, top loin, top sirloin). When foodservice ribeye steaks were stratified by USDA quality grade groups for sensory panel rating, Martinez et al. (2017) only reported a difference ($P < 0.05$) in tenderness level for the Prime grade compared to the other USDA grades. Brooks et al. (2000) and Voges et al. (2007) only reported a difference ($P < 0.05$) for flavor like rating for foodservice ribeye steaks across different grade groups. For top loin steaks, Brooks et al. (2000), Voges et al. (2007), and Guelker et al. (2013) found no difference ($P > 0.05$) in all sensory rating categories among USDA quality grades. However, Martinez et al. (2017) reported only a difference ($P < 0.05$) in tenderness for top loin steaks. Martinez et al. (2017) found there were no ($P > 0.05$) differences for top sirloin steaks in all sensory rating between USDA quality grades, which differs from the Guelker et al. (2013) findings that ungraded top sirloin received the highest ($P < 0.05$) consumer rating for overall like, flavor like, and juiciness like compared to other grades. This might be due to lower quality cuts being enhanced or tenderized to improve sensory attributes.

Mechanical tenderization is a practice that aims to make cuts more tender by a machine puncturing meat with small, sharp needles or blades in order to disrupt the muscle fibers and connective tissue. However, the negative aspect of blade tenderization is that these needles or blades can transfer pathogens on the exterior surface of the product into the interior where it was once considered sterile. USDA (2017) accounted for 6.2 billion serving of beef steaks and roasts

each year to have undergo mechanical tenderization. Savell, Smith, and Carpenter (1977) reported that three out of four muscles experienced a decrease ($P < 0.05$) in WBS force value. Two of the three muscles reported further decrease ($P < 0.05$) after being blade tenderized two times. George-Evins, Unruh, Waylan, and Marsden (2004) also reported when top sirloin steaks were blade tenderized two times, then had lower ($P < 0.05$) WBS force values compared to control and steak that were blade tenderized once. Consumers did not differentiate ($P > 0.05$) in any sensory attributes for steak that were either blade tenderized once or twice. However, George-Evins et al. (2004) reported blade tenderized steaks received higher ($P < 0.05$) consumer rating for overall tenderness and myofibrillar tenderness compared to control top sirloin steaks.

Meat enhancement is a practice that injects meat with a solution of water and other ingredients (e.g. salt, phosphates, antioxidants, etc.) through multiple needles. Since a solution is getting added into the meat product, manufactures will see an increase in product yield. Enhanced meat products increase salt concentrations usually increase water holding capacity, cook yields and consumer acceptance, but product color tends to diminish more rapidly than fresh meat products. Baublits, Pohlman, Jr., Yancey, and Johnson (2006) showcased four different treatments of sodium triphosphate and sodium chloride compared to unenhanced steaks of three different cuts. Untreated steaks had lower ($P < 0.05$) consumer rating for myofibrillar tenderness rating. Cuts pumped with sodium triphosphate and 1.5% sodium chloride had the lowest ($P < 0.05$) shear force compared to untreated muscle (Baublits et al., 2006).

Morgan et al. (1991) reported that round steaks were approximately 12% tougher than the next toughest primal and possessed a shear force mean of 4.31 kg (45.11 N). Both Brooks et al. (2000) and Voges et al. (2007) reported that the bottom round steak possessed the highest ($P < 0.05$) WBS force mean of 5.09 kg (49.92 N) and 36.0 N, respectively. To aid in lowering shear

values and higher consumer acceptance, Guelker et al. (2013) utilized moist-heat cookery for round retail steaks. However, top and bottom round retail cuts still possessed the highest ($P < 0.05$) shear values of 29.8 N and 31.2 N, respectively. Martinez et al. (2017) also stated that the top round received the highest ($P < 0.05$) shear force mean of 40.2 N. Both Guelker et al. (2013) and Martinez et al. (2017) reported the top and bottom round steaks received the lowest ($P < 0.05$) sensory rating for overall like, like of tenderness, tenderness level, like of flavor, and like of juiciness categories. In conclusion, Brooks et al. (2000), Guelker et al. (2013), Martinez et al. (2017), Morgan et al. (1991), and Voges et al. (2007) all identified that steaks from the round primal need additional assistance in order to aid in raising the consumer acceptance and lowering the shear force value.

The beef tenderloin is consistently one of the, highest priced subprimals from a beef carcass. In a study conducted by O'Quinn, Brooks, and Miller (2015) reported tenderloin steaks received really high palatability scores. This might be due to the high rating of tenderness influencing the other sensory attributes of juiciness and flavor. However, 2.4% of samples received unacceptable tenderness rating and 0.21% one of those reasons were for it being “too tender.” Tenderness categories classified by Belew et al. (2003) stated that in order for a steak to be classified as “very tender,” the WBS force value has to be under 3.2 kg (31.38 N). The last time the tenderloin was included in the product selection of the NBTS was in the 1990 surveys (Morgan et al., 1991) with a shear force value mean of 2.61 kg (25.6 N).

MATERIALS AND METHODS

Retail Product Selection

From October 2021 through February 2022, eleven cities were sampled by Texas A&M University, Oklahoma State University, University of Florida, Oregon State University, Texas Tech University, and North Dakota State University. Cities were chosen to represent a broad geographical range, while also upholding historical association with cities that have been used in former surveys for retail steak selection. The selected cities for the NBTS 2021 were Atlanta, GA; Chicago, IL; Denver, CO; Houston, TX; Kansas City, MO; Las Vegas, NV; Los Angeles, CA; New York, NY; Philadelphia, PA; Seattle, WA; and Tampa, FL. Representatives from the retail marketing team from the National Cattlemen's Beef Association assisted in compiling the retail chains and wholesale clubs that were surveyed. The selected retail chains within each city were chosen to represent at least one-third of each cities' total area market shares. Two or three retail chains were selected, with four stores per chain being sampled, resulting in 8 to 12 supermarket stores per metropolitan area. To best accurately represent the consumer demographics within a given region, retail stores sampled were equally separated to represent high, medium, and low economic groups. Furthermore, if there was a retail membership club chain present in the city, it was sampled, even if it was not included in one-third of the total area market shares.

The following cuts were sampled from the retail case and corresponding Universal Product Codes (UPC) (Industry-Wide Cooperative Meat Identification Standards Committee, 2003): Top Blade Steak (UPC 1144); Ribeye steak, lip on, boneless (UPC 1203); Ribeye steak, lip on, bone-in (UPC 1197); Top loin steak, boneless (UPC 1404); Top loin steak, bone-in (UPC

1398); T-bone steak (UPC 1369); Porterhouse steak (UPC 1330); Top sirloin steak, boneless, cap off (UPC 1426); Tenderloin steak, side muscle off, defatted (UPC 1190).

After university finished collecting steaks samples in each city, steaks were shipped in insulated containers following a standardized shipping protocol (Figure 1) Texas A&M University. Once insulated containers arrived, steaks were removed then stored (2 to 4 °C). Within two days of arrival, all packaging information, including branding, quality grade, tenderization, enhancement, and other marketing claims about the steaks was recorded. Steaks were removed from store packaging, if steaks were greater than or equaled to two inches in height, they were portioned into two equal pieces. External fat and steak thickness were measured by calculating the average of three different locations to represent the entire steak. All steaks were individually identified, vacuum packaged, and stored in a -40 °C freezer.

Steaks cuts were grouped and then randomly assigned to WBS force evaluation or consumer sensory panel, splitting roughly 60% of the total retail steaks for consumer panel evaluation. Each individual retail consumer panel steak then was randomly assigned a three-digit number using Microsoft Excel number generator. Consumer panel steaks then were divided amongst Texas A&M University, Oklahoma State University, Texas Tech University, University of Florida, and North Dakota State University. Retail consumer panel steaks were the shipped to designated university in insulated containers with refrigerant material.

Foodservice Product Selection

Steaks were shipped directly to Texas A&M University from six foodservice establishments: Atlanta, GA; Auburndale, FL; Denver, CO; Edison, NJ; Houston, TX; and Las Vegas, NV. Four different steak were sampled corresponding to the Institutional Meat Purchase Specifications (IMPS) (USDA, 2014) descriptions: Ribeye steak, lip-on, boneless (IMPS

1112A); Strip loin steak, boneless (IMPS 1180); Top sirloin butt steaks, boneless (IMPS 1184); and Tenderloin steak, side muscle off, defatted (IMPS 1190). If available, eight steaks within each four USDA quality grades (Prime, Top Choice, Choice, and Select) were purchased. Foodservice steaks followed the same protocol as retail steaks, where post-fabrication time, branding, quality grade, tenderization, enhancement, and other marketing claims if provided were recorded. Steaks then were measured, vacuum packaged, stored frozen, and randomly assigned for WBS force evaluation or consumer sensory panel as stated above before being shipped to the University of Missouri for evaluation.

Cookery Method

All collaborating universities followed the same cooking protocol. Frozen steaks were placed in a cooler at 4 °C for 48 hours to thaw before cooking. Grated, non-stick electric grills were used to cook all retail steaks. Grills were pre-heated for 15 minutes to reach an approximate surface temperature of 177 °C. Garland™ gas grills (garland Commercial Ranges Ltd, Mississauga, Ontario, Canada) were used to cook all the foodservice steaks, and grills were pre-heated until the surface temperature reached approximately 232 °C. To monitor the internal temperature of steaks, a thermocouple reader (Omega™ HH506A, Stamford, CT) with a 0.02-cm diameter copper-constantan Type-T thermocouple wire was inserted into the geographic center of the steak. All the steaks were flipped at 35 °C internal temperature and removed from the grill once the internal temperature reached 70 °C. Before and after cooking, all steaks were weighed to record raw and cooked weights in order to calculate cook yields. In addition, cook times were determine by recording the time the time each steak was placed on and removed from grills. Steaks selected for consumer sensory panels were placed, when necessary, in an Alto-Shaam warmer set at 60 °C for no longer than 20 minutes before serving to panelists. Steaks for WBS

force evaluation were placed on trays to avoid overlapping, wrapped with clear plastic wrap, and stored in a cooler (2 to 4 °C) for 12 to 18 hours.

WBS Force Evaluation

Within a 12 to 18-hour window, steaks were pulled from the cooler (2 to 4 °C), allowed to equilibrate to room temperature, and trimmed of visible connective tissue to expose the muscle fibers' orientation. At least six cores that were 1.3 cm and parallel to the muscle fibers were removed from the primary muscle of each steak. However, for T-bone and Porterhouse steaks, six cores where removed from the *M. longissimus lumborum* and four cores from the *M. psoas major* to depict the samples' tenderness. Cores were seared using the TMS-Pro Food Texture Analyzer (Food Technology Corporation) with the WBS force attachment, with the muscle fibers running perpendicular to the machine attachment. The peak force attachment sheared each core, and the value was recorded, in kg and converted to N. Statistical analysis was used to obtain the average shear value of each steak sample. The equation used to convert WBS force values from kg to N was:

$$WBSF\ (N) = WBSF\ (kg) \times 9.80665002864$$

Consumer Panel

The six collaborating universities recruited panelists from their surrounding communities. All panelists completed a demographic questionnaire. Cooked steaks were cubed into 1.27 cm x 1.27 cm x thickness portions, and each panelist received two pieces of each steak as well as unsalted saltine crackers and double distilled deionized water. Panelists were served up to eight random steak samples. Steaks were characterized for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), juiciness liking (10

= very juicy; 1 = not at all juicy), tenderness level (10 = very tender; 1 not at all tender), and tenderness liking (10 = like extremely; 1 = dislike extremely).

Statistical Analysis

Sensory panel and WBS force data for foodservice steaks and sensory panel data for retail steaks were submitted by collaborating universities to Texas A&M University for data entry and analysis. Data were analyzed using JMP software and Microsoft Excel. Frequency distribution was used to analyze percentages of steaks stratified into previously defined tenderness classes (Belew et al., 2003; Shackelford et al., 1991).

For the remaining data, least squares means were calculated. Specifically, steak type was utilized as a main effect for steak measurements (steak thickness, steak weight, external fat thickness) and retail WBS force analyses. For retail consumer sensory panel data, collaborating university location and steak type were included in the model, and steak type effects were reported. Steak type, quality grade, and steak type by quality grade interaction were included in the model for foodservice WBS force and consumer panel data.

RESULTS AND DISSCUSSION

Product branding

Thirty different stores chains were sampled. Approximately 66.4% of retail packages contained a form of branding, and 55.9% possessed a marketing claim. This is an increase from the survey by Martinez et al. (2017) where only 34.5% of retail packages included any form of a company branding or marketing claim. This survey also reported the greatest amount of retail packages with store branding depicted compared to past NBTS with the previous highest amount reported by Guelker et al. (2013) of 64%. Additionally, 40.7% of foodservice steak packaging included a brand logo, with 77.1% of that being Certified Angus Beef branding, and approximately 27.9% of foodservice steaks were tenderized.

Product characteristic

Steak thickness, external fat thickness, and steak weights for retail and foodservice steaks are reported in Table 1. Historically, the thickest retail steak cuts came from the rib or loin primal. This remains true for this current survey, as the thickest retail cut was the tenderloin from the loin primal, at 3.31 cm, whereas the thinnest cut ($P < 0.05$) represented from the chuck primal being the top blade, at 1.85 cm. Retail bone-in top loin steak had more ($P < 0.05$) external fat compared to the tenderloin at 0.47 cm and 0.12 cm, respectively. In addition, the Porterhouse had heaviest ($P < 0.05$) weight of 0.59 kg for retail cuts, whereas the lightest ($P < 0.05$) retail steak was the top blade at 0.14 kg.

For foodservice steaks, the tenderloin was the thickest ($P < 0.05$) steak, at 4.85 cm. In the most recent survey, (Martinez et al., 2017), the thickest ($P < 0.05$) foodservice steak was the ribeye at 2.91 cm, however, in this survey, the ribeye steak was the thinnest ($P < 0.05$) at 2.55 cm, which differs from Guelker et al. (2013) where there were no ($P > 0.05$) differences, in steak

thickness for ribeye, top loin, and top sirloin cuts. Foodservice tenderloin and top sirloin had the least ($P < 0.05$) amount of external fat at 0.00 cm and 0.02 cm, respectively. The top loin had the most ($P < 0.05$) external fat (0.44 cm). The ribeye steak was the heaviest ($P < 0.05$) average weight at 0.35kg, which is similar to Martinez et al. (2017) findings, whereas the lightest ($P < 0.05$) foodservice steaks were the top sirloin and tenderloin at 0.23 kg

Warner - Bratzler shear force

Least squares means for WBS force values of retail steaks are reported in Table 2. Tenderloin steaks had the lowest ($P < 0.05$) WBS value at 13.31 N from all other cuts. These data differ from Voges et al. (2007), Guelker et al. (2013), Martinez et al. (2017) findings due to the reintroduction of the tenderloin to the product selection and the removal of round steaks. Morgan et al. (1991) reported similar findings of the tenderloin having the lowest ($P < 0.05$) shear force compared to other retail rib and loin cuts, at 2.61 kg (25.60 N).

Foodservice steak WBS force values are reported in Table 3. Once again, the tenderloin had the lowest WBS force value at 25.42 N and top loin had the highest at WBS force value at 38.02 N. WBS force values of ribeye (36.74 N) and top loin (38.02 N) cuts were numerically higher than those in Martinez et al. (2017) findings of 29.6 N and 24.6 N, respectively.

Shackelford et al. (1991) and Belew et al. (2003) developed tenderness categories based on WBS force values for retail and foodservice tenderness grouping in Table 4. All of the top blade, bone-in ribeye, Porterhouse, and tenderloin retail cuts had shear force values, in the very tender (< 31.4 N) category. Voges et al. (2007) had similar findings for the retail bone-in ribeye steaks. When comparing to Voges et al. (2007), Guelker et al. (2013), and Martinez et al. (2017) this survey had the highest percentage of each individual cut being in the very tender category. The retail top sirloin was the only cut with steaks that fell into the tough (> 45.1 N) category and had the highest percentage in the intermediate (38.3 N < WBS < 45.1 N) grouping.

For foodservice cuts, tenderloin had the highest percent in the very tender (< 31.4 N) category, but also had a higher percentage in the intermediate category compared, than the to top sirloin. Results show a decrease in the percent of foodservice ribeye in the very tender (< 31.4 N) categories compared to those reported by Voges et al. (2007), Guelker et al. (2013), and Martinez et al. (2017)**,** at 81.4, 81.08, 68.75%, respectively.

However, there was a major decrease to 13.10% of ribeye with a shear value under 31.4 N. This might be attributed to thinner ribeye foodservice steak, causing a faster cook time, thus resulting in creating a tougher product. Foodservice ribeye steaks depicted a 12.4% (0.36 cm) steak thickness decrease and a 37.8% faster cook time, compared to the most recent survey (Martinez et al., 2017). In order for foodservice ribeye steaks to meet weight requirements with ribeyes getting larger, foodservice establishments are forced to cut steaks thinner. In addition, the grill temperature are hotter compared to retail steak cooking protocol. Foodservice ribeyes had the highest prevalence in tender (51.19%), intermediate (27.38%), and tough (8.33%) tenderness categories. There were more steaks in the tough (> 45.1 N), category, compared NBTS results Voges et al. (2007), Guelker et al. (2013), and Martinez et al. (2017).

Least squares means for foodservice steak stratified by USDA quality grades using WBS force are depicted in Table 5. There was no ($P > 0.05$) difference between the different USDA quality grades in WBS force values. These data differ from those reported by Guelker et al. (2013) and Martinez et al. (2017), which indicated that cuts from Prime quality grades had lower ($P < 0.05$) WBS force values. However, Voges et al. (2007) also reported no significant difference for WBS force values across USDA quality grades.

Retail Consumer Sensory Evaluation

Consumer demographic characteristics of panelists that participated in retail and foodservice panels reported in Table 6. Data obtained from all collaborating universities conducting consumer sensory panel were combined. The least square means for sensory panel rating for retail steaks are presented in Table 7. Tenderloin steaks received the highest ($P < 0.05$) rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like. If the tenderloin had not been included in the survey, the top blade would have received among the highest panelist rating, similar to data reported by Martinez et al. (2017)**.** Top sirloin steak received among the lowest sensory rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like.

Foodservice consumer sensory evaluation

Least squares means for sensory panel ratings for foodservice steaks are displayed in Table 8. There was no ($P > 0.05$) difference between the cuts for all five sensory attributes. Voges et al. (2007) and Guelker et al. (2013) reported that no ($P > 0.05$) differences were observed between ribeye, top loin, and top sirloin cuts for flavor like. Table 9 provides the least squares means for sensory panel rating foodservice steaks stratified by USDA quality grade. There is no was ($P > 0.05$) difference between the USDA quality grades for overall like, tenderness like, tenderness level, flavor like, and juiciness like, which is similar to Martinez et al. (2017) who reported no significant ($P > 0.05$) difference for overall like, flavor like, and juiciness like between the USDA quality grade for foodservice ribeye, top loin, top sirloin cuts.

Least squares means for sensory panel rating for ribeye, top loin, top sirloin, and tenderloin foodservice steak stratified by USDA quality grade are displayed in Tables 10, 11, 12, and 13, respectively. For ribeye, top loin, top sirloin, and tenderloin cuts there were no ($P > 0.05$) USDA quality grade effect on consumer ratings for overall like, tenderness like, tenderness

level, flavor like, and juiciness like. Voges et al. (2007) and Guelker et al. (2013) both reported no ($P > 0.05$) differences in USDA quality grade for top loin across all sensory ratings. Martinez et al. (2017) reported similar data for top sirloin.

Cooked yield and times

Least squares means for retail and foodservice steaks of cook yield and times are reported in Table 14. Retail T-bone had a higher ($P < 0.05$) cook yield compared to top sirloin, similar to findings reported by Guelker et al. (2013) on retail steak cook yield. Tenderloin steaks had highest ($P < 0.05$) average thickness in inconjunct with the longest cook time, whereas the top blade lowest ($P < 0.05$) average thickness combined with the fastest ($P < 0.05$) cook time. Foodservice ribeye steaks had the highest ($P < 0.05$) cook yield and shortest cook time, and the foodservice tenderloin had the lowest ($P < 0.05$) cook yield and longest ($P < 0.05$) cook time. Compared to the most recent survey, all foodservice steaks decreased in cook time (Martinez et al., 2017).

CONCLUSIONS

There was increase in the number of packages with brands or claims on the retail steak labels from the past three surveys. This may be due to the retail customer being more interested in where their food comes from, which may influence their purchasing decisions. Additionally, this increase may relate to the fact that there are more banded/certification programs available than there were five years ago.

In general, most retail steaks evaluated in this study were considered very tender, and all retail cuts decreased in WBS force value when to the 2015 and 2010 surveys. Although the ribeye and top loin foodservice steaks showed an increase in WBS force values when compared to 2015 survey, this increase did not impact consumer rating of the product. A decrease in WBS was noted for the foodservice top sirloin steaks.

Since the last time being surveyed in 1990, the retail tenderloin steaks decreased in over 10 N of WBS shear force. In both retail and foodservice sections, the tenderloin had the lowest WBS force values. Retail tenderloin received the highest consumer rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like.

USDA quality grades showed no significant differences for foodservice steak using WBS force as well as consumer rating for overall like, tenderness like, tenderness level, flavor like, and juiciness like. The WBS values for retail steaks showed a decrease and foodservice steaks indicated an increase compared to the last survey, representing change for both sectors in tenderness. The U.S. beef industry may continue to use NBTS data as benchmark for tenderness of steaks from retail and foodservice establishments.

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APPENDIX A

Table 1. Least squares means ± SE from retail and foodservice establishments for steak thickness, external fat thickness, and steak weights

Source/steak	*n*	Steak thickness, cm	External fat thickness, cm	Steak weight, kg
Retail				
Top blade	74	1.85^{g} ±0.11	0.14^{d} ±0.04	0.14^{g} ±0.02
Ribeye, lip on, boneless	278	2.85^{c} ±0.04	0.36^{b} ±0.01	0.41^{c} ±0.01
Ribeye, lip on, bone-in	98	2.63^{d} ±0.06	0.37^{b} ±0.02	0.50^{b} ±0.01
Top loin, boneless	338	2.96^{b} ±0.03	0.44^{a} ±0.01	0.36^{d} ±0.01
Top loin, bone-in	54	2.40^{ef} ±0.08	0.47^{a} ±0.03	0.37^{d} ±0.01
T-bone	35	2.52^{de} ±0.10	0.41^{ab} ±0.03	0.49^{b} ±0.02
Porterhouse	82	2.58^{de} ±0.07	0.46^{a} ±0.02	0.59^{a} ±0.01
Top sirloin, boneless, cap off	471	2.27^{f} ±0.05	0.27^{c} ±0.02	0.28^{e} ±0.01
Tenderloin	232	3.31^{a} ±0.08	0.12^{d} ±0.03	0.23^{f} ±0.01
P-value		<0.0001	<0.0001	<0.0001
Foodservice				
Ribeye	174	2.55^{c} ±0.04	0.34^{b} ±0.01	0.35^{a} ±0.00
Top loin	156	2.98^{b} ±0.04	0.44^{a} ±0.01	0.34^{b} ±0.00
Top sirloin	82	2.66^{c} ±0.06	0.02^{c} ±0.02	0.23^{c} ±0.00
Tenderloin	188	4.85^{a} ±0.04	0.00^{c} ±0.01	0.23^{c} ±0.00
P-value		<0.0001	<0.0001	<0.0001

$^{a-g}$ Within a column, within a source, Least squares means with different superscript letters differ ($P < 0.05$).

Table 2. Least squares means and SE for Warner-Bratzler shear force values (N) of steaks from retail establishments

Steak	*n*	Shear force mean, N[1]	SE
Top blade	30	16.73[d]	0.99
Ribeye, lip on, boneless	108	19.70[c]	0.52
Ribeye, lip on, bone-in	36	19.88[bc]	0.90
Top loin, boneless	132	18.62[cd]	0.47
Top loin, bone-in	21	20.56[abc]	1.18
T-bone	15	23.12[ab]	1.40
Porterhouse	29	20.65[abc]	1.01
Top sirloin, boneless, cap off	179	22.01[a]	0.41
Tenderloin	86	13.31[e]	0.58
P-value		<0.0001	

[1]Warner-Bratzler shear force was determine using 1.27 cm diameter cores.
[a-e] Least squares means with different superscript letters differ ($P < 0.05$).

Table 3. Least squares means and SE for Warner-Bratzler shear force values (N) of steaks from foodservice establishments

Steak	*n*	Shear force mean, N[1]	SE
Ribeye	84	36.74[a]	3.81
Top loin	76	38.02[a]	4.01
Top sirloin	40	26.66[ab]	5.52
Tenderloin	92	25.42[b]	3.64
P-value		0.0481	

[1]Warner-Bratzler shear force was determine using 1.27 cm diameter cores.

[a-b] Least squares means with different superscript letters differ ($P < 0.05$).

Table 4. Percentage distribution of retail and foodservice steak stratified into tenderness categories based on Shackelford et al. (1991) and Belew et al. (2003) groupings

Source/steak	Very Tender, WBS force[1] < 31.4 N	Tender, 31.4 N < WBS force < 38.3 N	Intermediate, 38.3 N < WBS force < 45.1 N	Tough, WBS force > 45.1 N
Retail				
Top blade	100.0			
Ribeye, lip on, boneless	95.4	4.6		
Ribeye, lip on, bone-in	100.0			
Top loin	98.5	0.8	0.8	
Top loin, bone-in	95.2	4.8		
T-bone	93.3	6.7		
Porterhouse	100.0			
Top sirloin, boneless, cap off	93.9	3.9	1.1	1.1
Tenderloin	100.0			
Foodservice				
Ribeye	13.1	51.2	27.4	8.3
Top loin	60.5	31.6	6.6	1.3
Top sirloin	80.0	20.0		
Tenderloin	87.0	9.8	3.3	

[1]WBS force = Warner-Bratzler shear force values.

Table 5. Least squares means and SE for foodservice steaks stratified by USDA quality grade groups using Warner–Bratzler shear force values (N)

USDA grade group	*n*	Mean, N	SE
Prime	80	29.40	3.94
Top Choice	92	30.72	3.68
Low Choice	75	37.53	4.07
Select	45	30.85	5.26
P-value		0.4871	

Table 6. Sensory panel demographic characteristics of panelists that participated in the retail (combined universities) and foodservice panels

	Retail		Foodservice	
Item	*n*	%	*n*	%
Gender				
Male	253	46.6	64	61.6
Female	288	53.0	40	38.5
Age, yr.				
< 20	47	8.7	22	21.2
21 to 25	112	20.6	26	25.0
26 to 35	134	24.7	21	20.2
36 to 45	91	16.8	14	13.5
46 to 55	72	13.3	12	11.5
56 to 65	70	12.9	3	2.9
≥ 66	15	2.8	6	5.8
Working status				
Not employed	22	3.8	9	8.7
Full-time	306	53.3	41	39.4
Part-time	56	9.8	14	13.5
Student	190	33.1	40	38.5
Income, US$				
< 25,000	125	23.0	27	26.0
25,000 to 49,999	108	19.9	25	24.0
50,000 to 74,999	99	18.2	11	10.6
75,000 to 99,000	69	12.7	18	17.3
≥ 100,000	136	25.1	22	21.2
Food allergy				
No	508	93.6	99	95.2
Yes	34	6.3	4	3.9
Food manufacturer				
No	519	95.6	99	95.2
Yes	20	3.7	5	4.8
Ethnicity				
Caucasian	355	64.3	86	82.7
Hispanic	111	20.1	6	5.8
Asian or Pacific	49	8.9	6	5.8
Black	20	3.6	3	2.9
American Indian	10	1.8		
Other	7	1.3		
Consume meat				
No	1	0.2		
Yes	539	99.3	104	1.0

Table 6. Continued

Item	Retail		Foodservice	
	n	%	*n*	%
Meat types consumed				
Chicken	525	97.0	103	99.0
Pork	497	91.9	103	99.0
Beef	536	99.1	103	99.0
Fish	479	88.5	97	93.3
Overall beef consumption				
Daily	47	8.6	7	6.7
5 or more times per wk.	80	14.7	12	11.5
3 or more times per wk.	232	42.7	56	53.9
1 time per wk.	141	25.9	21	20.2
1 time every 2wks	29	5.3	5	4.8
Less than once every 2 wks.	15	2.8	2	1.9
At home beef consumption				
0 times per wk.	24	4.5	2	1.9
1 time per wk.	139	25.9	16	15.4
2 times per wk.	138	25.7	33	31.7
3 times per wk.	132	24.6	37	35.6
4 times per wk.	52	9.7	9	8.7
5 or more times per wk.	52	9.7	7	6.7
In restaurant beef consumption				
0 times per wk.	48	9.0	10	9.6
1 time per wk.	218	40.9	47	45.2
2 times per wk.	140	26.3	22	21.6
3 times per wk.	80	15.0	12	11.5
4 times per wk.	25	4.7	5	4.8
5 or more times per wk.	22	4.1	6	5.8
Degree of doneness				
Rare	38	6.8	3	2.9
Medium rare	165	29.7	22	21.2
Medium	43	7.7	2	1.9
Medium well	212	38.1	61	58.7
Well done	98	17.6	15	14.4
Purchase tendencies				
Grass-fed	111	17.7	10	9.6
Traditional	443	70.4	78	75.0
Aged	35	5.6	3	2.9
Organic	40	6.4		

Table 7. Least squares means ± SE for sensory panel rating for retail steaks[1]

Steak	*n*	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Top blade	44	6.8^{b} ±0.2	7.3^{b} ±0.2	7.3^{b} ±0.2	6.4^{bc} ±0.2	7.0^{b} ±0.2
Ribeye, lip on, boneless	170	6.8^{b} ±0.1	6.9^{c} ±0.1	6.8^{c} ±0.1	6.7^{b} ±0.1	6.4^{c} ±0.1
Ribeye, lip on, bone-in	62	6.4^{cd} ±0.1	6.4^{de} ±0.1	6.3^{de} ±0.1	6.4^{bc} ±0.1	6.0^{de} ±0.2
Top loin, boneless	206	6.7^{bc} ±0.1	6.7^{cd} ±0.1	6.6^{cd} ±0.1	6.6^{b} ±0.1	6.3^{cd} ±0.1
Top loin, bone-in	33	6.5^{bcd} ±0.2	6.6^{cde} ±0.2	6.4^{de} ±0.2	6.6^{bc} ±0.2	6.2^{cde} ±0.2
T-bone	20	6.6^{bcd} ±0.2	6.7^{bcde} ±0.2	6.7^{cde} ±0.2	6.5^{bc} ±0.2	6.5^{bcde} ±0.3
Porterhouse	53	6.4^{cd} ±0.1	6.4^{de} ±0.1	6.3^{e} ±0.1	6.5^{bc} ±0.1	5.9^{e} ±0.2
Top sirloin, boneless	292	6.4^{d} ±0.1	6.3^{e} ±0.1	6.3^{e} ±0.1	6.3^{c} ±0.1	6.0^{e} ±0.1
Tenderloin	146	7.8^{a} ±0.1	8.3^{a} ±0.1	8.3^{a} ±0.1	7.3^{a} ±0.1	7.4^{a} ±0.1
P-value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[a-e] Least squares means within a column with different superscript letters differ ($P < 0.05$).

[1] Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely), tenderness level (10 = very tender; 1 not at all tender), flavor liking (10 = like extremely; 1 = dislike extremely), and juiciness liking (10 = very juicy; 1 = not at all juicy).

Table 8. Least squares means ± SE for sensory panel ratings for foodservice steaks[1]

Steak	n^2	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Ribeye	90	7.3 ±0.2	7.5 ±0.2	7.4 ±0.2	7.2 ±0.2	6.8 ±0.2
Top loin	80	6.8 ±0.2	7.1 ±0.2	6.9 ±0.2	6.8 ±0.2	6.1 ±0.2
Top sirloin	42	7.1 ±0.2	7.5 ±0.2	7.3 ±0.2	7.2 ±0.2	6.4 ±0.3
Tenderloin	96	7.3 ±0.1	7.3 ±0.2	7.1 ±0.2	7.2 ±0.1	6.8 ±0.2
P-value		0.0634	0.3495	0.1343	0.2945	0.0678

[1]Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely**),** tenderness level (10 = very tender; 1 not at all tender), and flavor liking (10 = like extremely; 1 = dislike extremely).

Table 9. Least squares means ± SE for sensory panel ratings for foodservice steaks stratified by USDA quality grade[1]

	n	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Prime	144	7.3 ±0.2	7.4 ±0.2	7.3 ±0.2	7.2 ±0.2	6.5 ±0.2
Top Choice	174	7.1 ±0.1	7.2 ±0.2	7.0 ±0.2	7.1 ±0.1	6.6 ±0.2
Low Choice	138	7.0 ±0.2	7.3 ±0.2	7.3 ±0.2	6.8 ±0.2	6.3 ±0.2
Select	86	7.3 ±0.2	7.4 ±0.2	7.1 ±0.2	7.4 ±0.2	6.9 ±0.3
P-value		0.5636	0.7947	0.4198	0.1498	0.3948

[1]Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely**),** tenderness level (10 = very tender; 1 not at all tender), and flavor liking (10 = like extremely; 1 = dislike extremely).

Table 10. Least squares means ± SE for sensory panel ratings for ribeye foodservice steaks stratified by USDA quality grade[1]

Steak	n^2	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Prime	37	7.1 ±0.3	7.1 ±0.4	7.3 ±0.4	7.0 ±0.3	6.4 ±0.4
Top Choice	46	7.4 ±0.3	7.5 ±0.3	7.2 ±0.3	7.4 ±0.3	7.0 ±0.3
Low Choice	47	7.2 ±0.3	7.3 ±0.3	7.5 ±0.3	6.9 ±0.3	6.7 ±0.3
Select	29	7.9 ±0.4	8.0 ±0.4	7.8 ±0.4	7.6 ±0.4	7.1 ±0.4
P-value		0.3326	0.3132	0.7277	0.3876	0.4799

[1]Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely**),** tenderness level (10 = very tender; 1 not at all tender), and flavor liking (10 = like extremely; 1 = dislike extremely).

Table 11. Least squares means ± SE for sensory panel ratings for top loin foodservice steaks stratified by USDA quality grade[1]

Steak	n^2	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Prime	39	7.0 ±0.3	7.3 ±0.3	7.0 ±0.3	6.8 ±0.3	6.3 ±0.4
Top Choice	36	6.5 ±0.3	6.7 ±0.4	6.4 ±0.4	6.6 ±0.4	5.8 ±0.4
Low Choice	46	6.8 ±0.3	7.2 ±0.3	7.2 ±0.3	6.9 ±0.3	6.2 ±0.4
Select	14	6.9 ±0.5	7.1 ±0.6	6.9 ±0.6	7.1 ±0.6	6.5 ±0.7
P-value		0.7542	0.6915	0.4608	0.8089	0.7171

[1]Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely**),** tenderness level (10 = very tender; 1 not at all tender), and flavor liking (10 = like extremely; 1 = dislike extremely).

Table 12. Least squares means ± SE for sensory panel ratings for top sirloin foodservice steaks stratified by USDA quality grade[1]

Steak	n^2	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Prime	29	7.1 ±0.3	7.6 ±0.4	7.3 ±0.4	7.4 ±0.4	6.1 ±0.4
Top Choice	43	7.2 ±0.3	7.3 ±0.3	7.3 ±0.3	7.1 ±0.3	6.7 ±0.4
P-value		0.8808	0.5534	0.8500	0.5728	0.2720

[a] Least squares means that contain different superscripts letters indicates differ ($P < 0.05$).
[1]Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely**),** tenderness level (10 = very tender; 1 not at all tender), and flavor liking (10 = like extremely; 1 = dislike extremely).

Table 13. Least squares means ± SE for sensory panel ratings for tenderloin foodservice steaks stratified by USDA quality grade[1]

Steak	n^2	Overall like/dislike	Tenderness like/dislike	Tenderness level	Flavor like/dislike	Juiciness like/dislike
Prime	39	7.9 ±0.3	7.6 ±0.3	7.5 ±0.3	7.6 ±0.3	7.2 ±0.4
Top Choice	49	7.4 ±0.3	7.1 ±0.3	6.8 ±0.3	7.3 ±0.3	6.9 ±0.3
Low Choice	45	7.0 ±0.3	7.4 ±0.3	7.2 ±0.3	6.6 ±0.3	6.2 ±0.3
Select	43	7.1 ±0.3	7.1 ±0.3	6.8 ±0.3	7.3 ±0.3	6.8 ±0.3
P-value		0.1354	0.5170	0.2567	0.0902	0.1823

[a-b] Least squares means that contain different superscripts letters indicates differ ($P < 0.05$).
[1]Rating for sensory panel for overall liking (10 = like extremely; 1= dislike extremely), flavor liking (10 = like extremely; 1 = dislike extremely), tenderness liking (10 = like extremely; 1 = dislike extremely**),** tenderness level (10 = very tender; 1 not at all tender), and flavor liking (10 = like extremely; 1 = dislike extremely).

Table 14. Least squares means and SE for retail and foodservice steaks of cook yields and times

Source/steak	Cook yield (%)		Cook times (s)	
Retail				
Top blade	82.5^{ab}	±1.3	662.5^{d}	±84.7
Ribeye, lip on, boneless	81.7^{ab}	±0.7	1294.0^{bc}	±43.4
Ribeye, lip on, bone-in	82.7^{ab}	±1.1	1372.7^{abc}	±72.7
Top loin, boneless	80.6^{b}	±0.6	1334.5^{b}	±39.2
Top loin, bone-in	84.4^{a}	±1.5	1160.0^{bc}	±97.8
T-bone	84.7^{a}	±2.0	1171.9^{bc}	±127.1
Porterhouse	81.8^{ab}	±1.2	1304.6^{abc}	±79.4
Top sirloin, boneless	78.8^{c}	±0.5	1217.5^{c}	±33.1
Tenderloin	80.3^{bc}	±0.7	1465.7^{a}	±48.0
P-value	<0.0001		<0.0001	
Foodservice				
Ribeye	71.0^{a}	±0.5	785.8^{c}	±28.3
Top loin	67.8^{b}	±0.5	980.5^{b}	±27.6
Top sirloin	67.0^{b}	±0.6	1056.0^{b}	±38.0
Tenderloin	65.2^{c}	±0.4	1352.6^{a}	±25.0
P-value	<0.0001		<0.0001	

$^{a-c}$ Least squares means within a column that contain different superscripts letters indicates differ ($P < 0.05$).

APPENDIX B

Figure 1. Product Collection and Shipping Protocol

TEXAS A&M AGRILIFE

Product Collection Protocol

I. Collection Trip Scheduling
   a. Schools should notify Ayleen Gonzalez (TAMU lead graduate student for steaks on NBTS) of planned travel dates 2-3 weeks prior to the expected trip.
      i. Steaks: Ayleen Gonzalez (281-736-9001) ayleengonz@tamu.edu
      ii. Ground beef questions: Paige Williams (512-761-0604) paige.williams@tamu.edu
   b. The **tentative** collection plan is:

Time Frame	City	University	Foodservice*
August 2021	Houston	Texas A&M University	Yes
September/October	Los Angeles	Texas A&M University	No
September/October	Kansas City	Oklahoma State Univ.	No
October	Tampa	University of Florida	Yes
November/December	New York/Philadelphia	Texas A&M University	Yes
November	Seattle	University of Missouri	No
November/December	Denver	Texas Tech University	Yes
November/December	Las Vegas	Texas A&M University	Yes
November/December	Chicago	North Dakota State	No
November/December	Atlanta	University of Florida	Yes
***Foodservice product and associated costs will be directly shipped and billed to TAMU**			

   c. Unlike previous surveys, no corporate retail office contact will be made, we are entering each store as a normal shopper.
   d. Ayleen will provide each school with their respective list of store numbers to be sampled in each city at least one week prior to the scheduled trip dates.
   e. Once a trip has been scheduled, if travel dates change for any reason, please let Ayleen know as soon as possible so arrangements to receive steaks can be made.

II. Product Collection Preparation:
   a. **Because we are not obtaining corporate permissions, selected stores will be for product purchasing ONLY (no data collection allowed in retail area or backroom).**
   b. If your city includes an assignment to a Sam's and/or Costco:
      i. Membership….
      ii. Costco only accepts: most debit cards, Visa, Apple/Google/Samsung Pay, or cash
      iii. Sam's Club accepts: debit, Visa, AMEX, Mastercard, Discover, or cash

   c. **We recommend the following product collection supplies**:
      i. Large SUV (suburban or similar)
      ii. University purchasing card, if available
      iii. Wholesale club membership cards, if available
      iv. Six or more coolers – this varies by number of retail stores/day and refrigerant used
         1. We recommend a 48-quart Igloo Island Breeze or similar (Figure 1).

Figure 1

v. Refrigerant material (steaks must be kept fresh, unfrozen)
    1. Please see the shipping protocol below for validated product packing procedures.
vi. Bubble wrap (20 sq. ft. per cooler; to separate refrigerant materials from steaks)
vii. Ziploc 2 to 2.51gallon plastic bags to contain regular ice (8 bags per cooler)
viii. Ziploc 1-gallon bags to bag meat products prior to shipping (9 bags per cooler)
ix. Duct tape or Scotch Heavy Duty Shipping Tape
x. Sharpie (to mark store numbers on product labels when not present)
xi. Blue pens
xii. Clipboards
xiii. Datasheets (provided at the end of this packet):
    1. City Cover Sheet (Form A)
    2. Retail Package List (Form B)
    3. Retail – Case Survey Sheet (Form C)

III. Datasheets:

a. ***NOTE: Please scan or photocopy all datasheets before mailing originals to TAMU.***
b. Pre-filled example datasheets are included at the back of this packet (**Attachment 1**).
c. Blank datasheets are located at the back of this packet (**Attachment 2**).
d. **City Cover Page (Form A)** Form is *1 page in length, use one form per city*
    i. This form indicates the goal quantity to be purchased for each cut in each city (in terms of **number of packages** collected, not number of steaks).
    ii. This form tracks the product type, grade, and claim distribution as your collection days wears on. You will notice this form is designed to keep track of overall product totals for the city (not on a per chain basis like Form B).
    iii. As you are filling out the Retail Package List (Form B) at each store, also record the packages purchased on the City Cover Sheet (Form A).
    iv. This form also includes space for major claim types: natural (Nat), organic (Org), and conventional (Conv).

1. Often other specialty claims/programs are associated with one of these, so for simplicity, only these three were listed.
2. This is to help ensure that you can collect a representative sample in each of these markets.
3. For example, if during your store visits organic seems to be offered in approximately 20% of all top sirloins observed, then by keeping tallies in this section, you can ensure you have approximately 2-3 packages of organic top sirloins (total goal per city is 14 packages of top sirloins) by the end of your city's collection.

v. In addition, we ask that you are mindful of the order of your store visits. If the first three stores represent one chain, do not over purchase product from this retailer. We want to collect as close to an equal distribution across retail chains as possible. We realize that as you near the end of your store visit list, less product is usually needed per store to meet product targets.

e. **Retail Package List (Form A)** *Form is 5 pages in length, use one form per city*
   i. This form serves as a simple shopping list to track products/grades collected across chains and prevent the oversampling of products for a given retail chain.
   ii. The sheet is divided into self-service and full-service sections. List the grocery chain and store number at the top of each column.
   iii. We hope this form helps you keep track of what products/grades you collect across chains. The goal here is to prevent the oversampling of a given retail chain.
   iv. The sheet is divided into self-service and full-service sections. List the grocery chain and store number at the top of each column.
   v. You may tally or write the **number of packages** that are collected at each store. Counts are based not on the number of steaks, but the number of packages.
   vi. This datasheet is used in conjunction with the City Cover Sheet (B).

f. **Retail Store Survey (Form C)** Form is *3 pages in length, use one form per store*
   i. Corporate offices were not contacted for this survey. Respectfully capture as much of these data as possible without being disruptive to other shoppers.
   ii. See **Attachment 3** at the back of this packet for label category examples.
   iii. Label Categories:
      1. Retail label only: a generic label containing cut name, price, and weight, no branding of any kind is present.
      2. Store "own" brand: may be a retail label component (i.e. Kirkland's Signature at Costco stores) or a separate label (i.e. Private Selection at Kroger banner stores). The brand name/logo represent a retail banner's "house" or "own" brand that only stores under that banner would carry.
      3. National/regional/other brand: includes brands not "owned" by a specific retail chain/banner (i.e. Nolan Ryan Beef in Kroger stores across Texas and Louisiana).
      4. Note: stores may have multiple variations of each of these categories.
   iv. Featured beef sales include running ads or offers on cuts selected for use in this study. These data may include listings in the weekly ad flyer and/or what is featured in the meat department. Example feature shown in **Attachment 4**.

IV. Product Collection:

a. Upon entering each store that permits data collection:
   i. There is no need to notify store management, as we are planning to shop as a normal consumer.
   ii. Collect data of the **Retail Store Survey (Form C)** without disrupting other shoppers.
b. Retail cut photos (**see Attachment 5**) have been included for ease of identification.
c. All steaks need to be 1" thick to ensure adequate cores for shear force testing. Thin cuts are not acceptable.
d. Please note that a small selection of ground beef is also to be collected this survey.
   i. Quantities can be found on Form A. Please contact Paige with any questions.
e. Write store numbers on product packages in Sharpie:
   i. Not all stores include the store number on the packaging
   ii. Full service is wrapped and often the label does not reflect store number, grade, special programs/claims, etc. Please record these items on the outer product wrapping.
   iii. Ground beef chubs will likely not bear store numbers either. If necessary, place in a Ziploc bag and mark the bag with the store number.
f. Substitutions
   i. T-bone/porterhouse
      1. To qualify as a T-bone, the *Psoas major* muscle width must be greater than 0.5 inches and less than 1.25 inches
      2. To qualify as a Porterhouse steak, the width of the *Psoas major* muscle must be greater than 1.25 inches
      3. Stores rarely label the steaks based on these measurements. Please sample the case based on the width of the *Psoas major* and not what the store labels the product.
      4. If you choose a T-bone package that actually contains a porterhouse (or vice versa), please mark the package to reflect that so we are clear on how you intended the steak to be used for the study.

V. Shipping:

a. Meat is shipped to:

ATTN: Ayleen Gonzalez
2471 TAMU, 120 Rosenthal Center
Texas A&M University
College Station, TX 77843-2471

b. **Please use FedEx Priority Overnight to ensure next-day morning delivery.**
c. **Please do not ship datasheets inside of a cooler.**
d. We recommend for collections to take place in the beginning of the week to ensure no shipments over the weekend. Deliveries must be received by Friday. Although it is not recommended, if product is expected to arrive over the weekend, hold shipping the product until the following Monday.
e. **Product MUST be received fresh (below 40°F) and not frozen (above 28°F).**
f. **Please only use the recommended coolers or similar. Use of insulated cardboard containers is not allowed due to a history of receiving broken containers and unusable products.**

g. We have validated the following shipping methods:

i. **Dry Ice (preferred):**

1. In each cooler, start with a 2-inch base layer of bagged regular ice (doubled 2 to 2.5-gallon Ziplocs with approximately 5 pounds of ice per bag).
2. To properly separate product from refrigerant materials, we recommend bubble wrap that may be purchased in most retail grocery locations. Use two to three layers of bubble wrap between the bagged ice and product. (Thin bubble wrap is acceptable, ex. Scotch Cushion Wrap, Standard Bubble). Approximately 10 sq. ft. of wrap is needed per cooler.
3. Lay bagged (Ziplocs) meat packages on top of the bubble wrap. In our shipping test we placed approximately 28 pounds of product in a 48-quart cooler. Be sure to leave enough space for the dry ice.
4. The top layer of meat must be turned over (foam tray up).
5. Place three more layers of bubble wrap on top of the turned product.
6. Place five pounds of dry ice on top of the bubble wrap. For best results, break the dry ice block into several chunks.
7. If there is space remaining between the dry ice and cooler lid, layer additional bubble wrap to occupy the headspace.
8. Duct tape the cooler shut for shipping.

ii. **Regular Ice:**

1. In each cooler, start with a 2-inch base layer of bagged regular ice (doubled 2 to 2.5-gallon Ziplocs with approximately 5 pounds of ice per bag)
2. Place two to three layers of bubble wrap between the bagged ice and product. (Thin bubble wrap is acceptable, ex. Scotch Cushion Wrap, Standard Bubble). Approximately 10 sq. ft. of wrap is needed per cooler.
3. **Place bottom layer of bagged meat packages on top of the bubble wrap.**
   - In our shipping test, a layer of meat consisted of:

i. Three 1-gallon Ziplocs of 4 steaks each -OR-
ii. Three 1-gallon Ziplocs of of 4 ground beef chubs each -OR-
iii. Three 1-gallon Ziplocs of 2 case ready ground beef each

4. Two layers bubble wrap
5. **Place middle layer of bagged meat packages on top of the bubble wrap.**
6. Two layers bubble wrap
7. **Place top layer of bagged meat packages on top of the bubble wrap.**
8. Two layers bubble wrap
9. End with a minimum of a 2-inch base layer of bagged regular ice (doubled 2 to 2.5-gallon Ziplocs with approximately 5 pounds of ice per bag).
10. If there is space remaining between the dry ice and cooler lid, layer additional bubble wrap to occupy the headspace.
11. Duct tape the cooler shut for shipping.
12. **See Figure 2**

Figure 2. Diagram for layering a cooler with regular ice

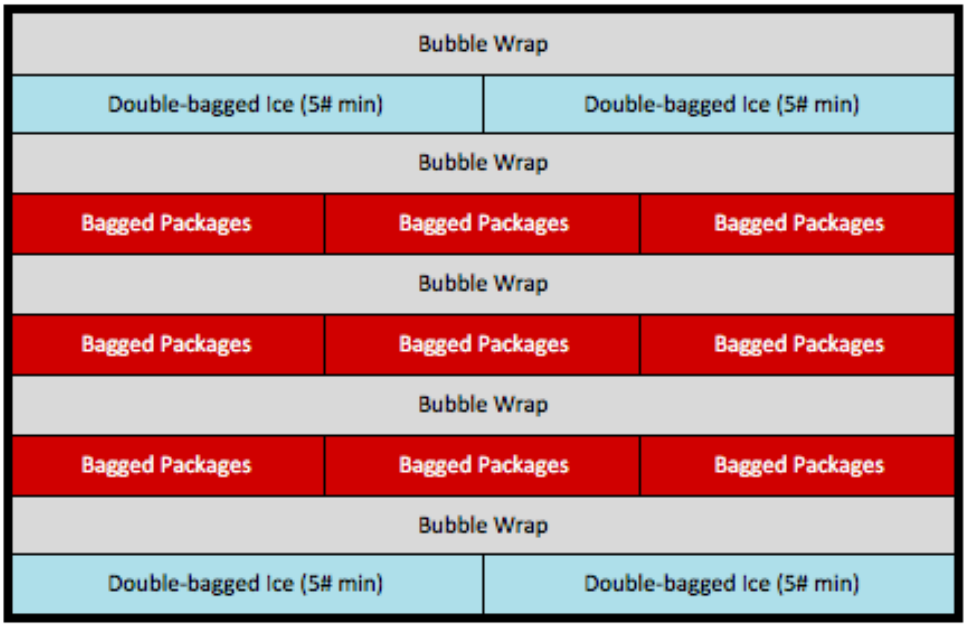

Figure 3. Bottom layer of ice

Figure 4. Bottom layer of meat

Figure 5. Middle layer of bubble wrap and meat

Figure 2. City Cover Page (Form A)

FORM A **City Cover Page** *Goal numbers refer to the number of packages, not individual steaks.

Self Service							
	TOTAL GOAL*						
Top Blade	5	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Boneless Ribeye	14	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Bone-in Ribeye	9	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Boneless Top Loin	14	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Bone-in Top Loin	9	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
T-Bone/Porterhouse	9	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Top Sirloin	14	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Tenderloin	9	1Pr 1Ch 1Se 1NG	2Pr 2Ch 2Se 2NG	3Pr 3Ch 3Se 3NG	4Pr 4Ch 4Se 4NG	5Pr 5Ch 5Se 5NG	Nat:_____ Org:_____ Conv:_____
Full Service							
Boneless Ribeye	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
Bone-in Ribeye	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
Boneless Top Loin	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
Bone-in Top Loin	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
T-Bone/Porterhouse	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
Top Sirloin	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
Tenderloin	5	1Pr 1Ch	2Pr 2Ch	3Pr 3Ch	4Pr 4Ch	5Pr 5Ch	Nat:_____ Org:_____ Conv:_____
Self-service Overwrapped Ground Beef (approximately 1 lb. per standard retail package and 2+ lbs. per club package)							
80/20 (standard retail)	6	1	2	3	4	5 6	Nat:_____ Org:_____ Conv:_____
90/10 (standard retail)	6	1	2	3	4	5 6	Nat:_____ Org:_____ Conv:_____
80/20 (club)	1	1					Nat:_____ Org:_____ Conv:_____
90/10 (club)	1	1					Nat:_____ Org:_____ Conv:_____

Date:_____ 1 City:_____

Figure 3. Retail Package List (Form B)

FORM B **Retail Package List**

	Chain:	Chain:	Chain:
Cut	**Store No.:**	**Store No.:**	**Store No.:**
Self Service			
Top Blade	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Boneless Ribeye	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Bone-in Ribeye	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Boneless Top Loin	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Bone-in Top Loin	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
T-Bone/Porter	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Top Sirloin	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Tenderloin	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG	____Pr ____Ch ____Se ____NG
Full Service Case			
Boneless Ribeye	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
Bone-in Ribeye	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
Boneless Top Loin	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
Bone-in Top Loin	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
T-Bone/Porter	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
Top Sirloin	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
Tenderloin	____Pr ____Ch	____Pr ____Ch	____Pr ____Ch
Ground Beef			
80/20 (std retail)	____	____	____
90/10 (std retail)	____	____	____
80/20 (club)	____	____	____
90/10 (club)	____	____	____

Date:_____ Page ___ of ___ City:_____

Figure 4. Retail Case Survey – Steaks (Form C)

FORM C

National Beef Tenderness Survey-2020
RETAIL CASE Survey — STEAKS

Store #_____Chain_____ City_____ Date_____ University_____ Recorded by: _____

STEAK COLLECTION
QUICK TIPS

Product collection

- Refer to the protocol and FORMS A and B for detailed instructions and shopping lists.
- Do not purchase or obtain data from seasoned or frozen products.
- Check the entire fresh meat department of each store as products are often found in multiple locations within the department.

Data collection

- **Do not collect data from seasoned, frozen, prepared meal or roast products.**
- Data should be collected from all other (PVC overwrap, MAP, etc.) fresh beef steak options offered at each store. Self and full service.
- Check the front and back of each package, as many claims appear on the secondary label panel.
- Some programs have known quality grades or claims that may be on store signage but not on the product package, please capture all available information.
- The "Natural" claim includes: "minimally processed" and "no artificial ingredients or added colors" statements, do not record separately.
- Wagyu is a breed claim, many packages do not bear a quality grade. Only circle a quality grade if listed on package or in store.
- Please see full protocol with example photos for additional information.
- **IN THE NOTES SECTION BELOW:** record total estimated case space in **inches** [L x W x D] allocated to fresh and frozen plant-based protein alternative products in each store.

Claim Key		
Nat = Natural	VF = Vegetarian Fed	DA = Dry Aged
Org = Organic	GE = No Genetically Engineered Ingredients	CT = Certified Tender
HF = Hormone Free	NP = No Preservatives	ANG = Angus
AF = Antibiotic Free	GF = Grass Fed	WAG = Wagyu

NOTES

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Entered by_____ Date_____ Checked by_____ Date_____

National Beef Tenderness Survey-2020
RETAIL CASE Survey — STEAKS

Store #_____Chain_____ City_____ Date_____ University_____ Recorded by: _____

SELF SERVICE CASE - STEAKS				
Brands Available	***Claims**** *(circle all that apply)*	***Enhanced Product*** *(circle one)*	***Tenderized*** *(circle one)*	***Quality Grades per Brand*** *(circle all that apply)*
Retail Label Only:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
Store "Own" Brand 1:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
Store "Own" Brand 2:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
Store "Own" Brand 3:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 1:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 2:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 3:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 4:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 5:	Nat Org HF AF VF GE NP GF DA CT ANG WAG Other:_____	No Yes: _____% pump	No Yes	Prime Top Choice Choice Select No Grade Listed

Entered by_____ Date_____ Checked by_____ Date_____

National Beef Tenderness Survey-2020
RETAIL CASE Survey — STEAKS

Store #_____Chain_____ City_____ Date_____ University_____ Recorded by: _____

FULL-SERVICE CASE - Steaks		
Brands Available	***Claims****	***Quality Grades per brand** (circle all that apply)*
Retail Label:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed
Store "Own" Brand 1:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed
Store "Own" Brand 2:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed
Store "Own" Brand 3:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 1:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 2:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed
National/Other Brand 3:	Nat Org HF AF VF GF DA CT ANG WAG Other:_____	Prime Top Choice Choice Select No Grade Listed

Entered by_____ Date_____ Checked by_____ Date_____

Figure 5. Retail TAMU cut information

National Beef Tenderness Survey-2020
RETAIL-TAMU Cut Information

Date_____ Evaluation Team_____ Recorded by _____

City:	Store Chain:			Store Number:
RETAIL CUT:	Top Blade Steak Top Sirloin Steak Tenderloin Steak Ribeye BI Ribeye BNLS Top Loin Steak BI Top Loin Steak BNLS T-Bone Porterhouse			
SERVICE TYPE:	Full-Service Self Service			
GRADE:	Prime Top Choice Choice Select No Grade Listed			
BRAND/CLAIM:				
Pkg Wgt (lb):	Price/lb:	# Stks/Pkg:	Pkg Date:	Sell by Date:
Measurement	*TAMU ID #*	*TAMU ID #*	*TAMU ID #*	*TAMU ID #*
Steak Thickness (in) 1				
Steak Thickness (in) 2				
Steak Thickness (in) 3				
Fat Thickness (in) 1				
Fat Thickness (in) 2				
Fat Thickness. (in) 3				
Steak Weight (g)				
Miscellaneous				

City:	Store Chain:			Store Number:
RETAIL CUT:	Top Blade Steak Top Sirloin Steak Tenderloin Steak Ribeye BI Ribeye BNLS Top Loin Steak BI Top Loin Steak BNLS T-Bone Porterhouse			
SERVICE TYPE:	Full-Service Self Service			
GRADE:	Prime Top Choice Choice Select No Grade Listed			
BRAND/CLAIM:				
Pkg Wgt (lb):	Price/lb:	# Stks/Pkg:	Pkg Date:	Sell by Date:
Measurement	*TAMU ID #*	*TAMU ID #*	*TAMU ID #*	*TAMU ID #*
Steak Thickness (in) 1				
Steak Thickness (in) 2				
Steak Thickness (in) 3				
Fat Thickness (in) 1				
Fat Thickness (in) 2				
Fat Thickness. (in) 3				
Steak Weight (g)				
Miscellaneous				

Revised 08.23.2021 ANA

Page ____ of ____

Entered by_____ Date_____ Checked by_____ Date_____

Figure 6. Foodservice-TAMU cut information

National Beef Tenderness Survey-2015
FOODSERVICE-TAMU Cut Information

Establishment_____Chain_____City_____Date_____Evaluation Team_____

TAMU ID No.	Foodservice Steak ID No.	Cut/Grade	Steak Weight (g)	Steak Thickness (in.)			Fat Thickness (in.)		

Revised 08/28/2015

Page ____ of ____

Entered by_____ Date_____ Checked by_____ Date_____

Figure 7. Foodservice-Information Form

National Beef Tenderness Survey-2015
FOODSERVICE-Information Form

Establishment_____ Chain_____ City_____ Date_____ Evaluation Team_____

Grade/Cut	Brand Designation	Claim	Pumped		Tenderization	
			Percentage Pumped	Sodium Content	Method	% Tenderized
Prime, Ribeye IMPS #1112A						
Top Choice, Ribeye IMPS #1112A						
Choice, Ribeye IMPS #1112A						
Select, Ribeye IMPS #1112A						
Prime, Top Loin Steak IMPS #1180						
Top Choice, Top Loin Steak IMPS #1180						
Choice, Top Loin Steak IMPS #1180						
Select, Top Loin Steak IMPS #1180						
Prime, Top Sirloin Butt IMPS #1184B						
Top Choice, Top Sirloin Butt IMPS #1184B						
Choice, Top Sirloin Butt IMPS #1184B						
Select, Top Sirloin Butt IMPS #1184B						

Revised 08/13/2015

Entered by_____ Date_____ Checked by_____ Date_____

Figure 8. Consumer Panel Information Sheet

TEXAS A&M UNIVERSITY HUMAN SUBJECTS PROTECTION PROGRAM

INFORMATION SHEET

Project Title: National Beef Tenderness Survey — 2020

You are invited to take part in a research study being conducted by Dr. Jeff Savell, a researcher from Texas A&M University and funded by the National Cattlemen's Beef Association. The information in this form is provided to help you decide whether or not to take part. If you decide you do not want to participate, there will be no penalty to you, and you will not lose any benefits you normally would have.

Why Is This Study Being Done?
To determine differences in consumer acceptance of differing beef steaks and patties.

Why Am I Being Asked To Be In This Study?
You are being asked to be in this study because you have enrolled yourself, agreed to participate in a consumer panel, and because you eat beef.

How Many People Will Be Asked To Be In This Study?
Approximately 200 people (participants) will be invited to participate in this study.

What Are the Alternatives to being in this study?
The alternative to being in the study is not to participate.

What Will I Be Asked To Do In This Study?
You will be asked to sample a variety of beef steak samples and complete a questionnaire related to each sample. Your participation in this study will last approximately 60 minutes.

Are There Any Risks To Me?
The only risks or discomforts would be from tasting various samples of beef. All samples will be fully cooked using University food handling and distribution policies; therefore, there should be no food safety risks associated with the products.

Will There Be Any Costs To Me?
Aside from your time, there are no costs for taking part in the study.

Will I Be Paid To Be In This Study?
Upon completion of your participation in this study, a $25.00 gift card will be given to you as compensation for your time. If you leave the study early, you may not receive compensation for your time.

What Are The Benefits Of This Research To Society?
Data will be used to inform the beef industry on potential ways to improve beef quality.

Will Information From This Study Be Kept Private?
The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the researchers conducting this study will have access to the records.

IRB NUMBER: IRB2020-1233M
IRB APPROVAL DATE: 10/27/2020

Information about you will be stored in a limited access, coded entry lab on a computer's password protected hard drive. This consent form will be filed securely in an official area.

People who have access to your information include the Principal Investigator and research study personnel. Representatives of the Texas A&M University Human Subjects Protection Program may access your records to make sure the study is being run correctly and that information is collected properly.

Information about you and related to this study will be kept confidential to the extent permitted or required by law.

Who may I Contact for More Information?
You may contact the Principal Investigator, Dr. Jeffrey W. Savell, to tell him about a concern or complaint about this research at 979-845-3992 or j-savell@tamu.edu.

For questions about your rights as a research participant, to provide input regarding research, or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office by phone at 1-979-458-4067, toll free at 1-855-795-8636, or by email at irb@tamu.edu.

What if I Change My Mind About Participating?
This research is voluntary, and you have the choice whether or not to be in this research study. You may decide to not begin or to stop participating at any time. If you choose not to be in this study or stop being in the study, you may not receive compensation for your time.

By completing this research activity, you are giving permission for the investigator to use your information for research purposes.

Thank you,

Dr. Jeffrey W. Savell

IRB NUMBER: IRB2020-1233M
IRB APPROVAL DATE: 10/27/2020

Figure 9. COVID-19 participant agreement for consumer sensory panel research

Department of Animal Science
COVID-19 Participant Agreement for
Consumer Sensory Panel Research

For the safety of all parties involved in the Department of Animal Science's research activities involving Consumer Sensory Panels, it is required that all consumers, students, staff, and faculty participating in the consumer sensory panel research will adhere to the following safety guidelines/requirements:

1. Consumers, students, staff, and faculty will self-monitor and submit body temperatures daily for 7 days before the scheduled panel date using the following link:

   https://tamuag.az1.qualtrics.com/jfe/form/SV_3kINg2FNjkgccGV

2. Consumers will wear a face-mask at all times, except when sitting in the individual panel booth for sample tasting and analysis.

3. Students, staff, and faculty will wear a face-mask at all times and will wash hands and apply hand-sanitizer before handling samples.

4. Consumer panelist will sanitize hands after being seated in the panel booth before tasting and analyzing samples.

5. If within 7 days of participating in the Consumer Sensory Panel, you experience symptoms and test positive for COVID-19, then you will report the positive test result via the following link.

   https://tamuag.az1.qualtrics.com/jfe/form/SV_1SS5YNM8bC5tL7v

As a participant in the Department of Animal Science's research activities involving Consumer Sensory Panels, I have read and agree to abide by all of the requirements listed above:

Name (Print)_____

Signature _____Date _____

Updated: October 29, 2020

Figure 10. Consumer panel demographics ballot

Date:
Session Time:

INSTRUCTIONS

Thank you for your participation in this study. Your assistance is very much appreciated. The objective of this study is to carefully evaluate beef samples. Please take your time and evaluate the samples served to you carefully.

This sampling will take about an hour. Please answer the following questions as completely as possible. If you have any questions, please ask the monitor for assistance.

Begin by filling out the basic demographic questions on the first page. This information is confidential and will not be used in publication, or have your name associated with it in any way.

After completing the demographic information, you are ready to begin the sample evaluation. Instructions at the top of each questionnaire will provide guidance on how to complete the evaluation.

Thank you very much for your help with this study.

DEMOGRAPHICS BALLOT

Please circle each appropriate response:

1. Please indicate your gender:

   Male Female

2. Which of the following best describes your age?

   20 years or younger
   21-25 years
   26-35 years
   36-45 years
   46-55 years
   56-65 years
   66 years and older

3. Please indicate your current working status:

   Not employed
   Full-time
   Part-time
   Student

4. Which of the following best describes your household income?

   Below $25,000
   $25,001 - 49,999
   $50,000 - 74,999
   $75,000 – 99,999
   $100,000 or more

5. Do you have any known food allergies or dietary restrictions?

   No Yes

IRB NUMBER: IRB2020-1233M
IRB APPROVAL DATE: 10/27/2020

Revision Date: March 31, 2016 1 of 2

Date:
Session Time:

6. Do you or any of your immediate family work for a market research firm, advertising firm, or food manufacturing company?

No	Yes

7. Please indicate your ethnic background:

White	Black
Hispanic	American Indian
Asian or Pacific Islander	Other

8. Do you eat meat?

No	Yes

9. Which of the following meats do you eat?

Chicken	Beef
Pork	Fish

10. You said that you eat beef. Approximately how often do you eat beef?

Daily	Once per week/weekly
5 or more times per week	Once every 2 weeks
3 or more times per week	Less than once every 2 weeks

11. Please mark the number of times a week you consume beef (including ground beef):

At Home:	0	1	2	3	4	5 or more
Restaurant or Fast-food Establishment:	0	1	2	3	4	5 or more

12. Please indicate your preferred degree of doneness for beef:

Rare (cool red center)	Medium Rare (warm red center)
Medium (hot pink center)	Medium Well (slightly pink center)
Well Done (no pink)	

13. When purchasing beef, what do you typically buy?

Grass-fed	Aged
Traditional	Organic

Figure 11. Consumer sensory panel ballot

Date _____ **Participant No.**

Session Time _____ **Sample No.**

INSTRUCTIONS

Prior to tasting each sample, please take a bite of a cracker followed by a sip of water. After tasting each sample, place a mark in the box that best represents your answer for each of the following questions.

1. Indicate by placing a mark in the box your **OVERALL LIKE/DISLIKE** of the meat sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Dislike Extremely — Like Extremely

2. Indicate by placing a mark in the box your **LIKE/DISLIKE** for the **FLAVOR** of the meat sample.

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Dislike Extremely — Like Extremely

3. Indicate by placing a mark in the box your **LIKE/DISLIKE** for the **TENDERNESS** of the meat product.

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Dislike Extremely — Like Extremely

4. Indicate by placing a mark in the box the **LEVEL** of **TENDERNESS** of the meat product.

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Dislike Extremely — Like Extremely

5. Indicate by placing a mark in the box your **LIKE/DISLIKE** for the **JUICINESS** of the meat product.

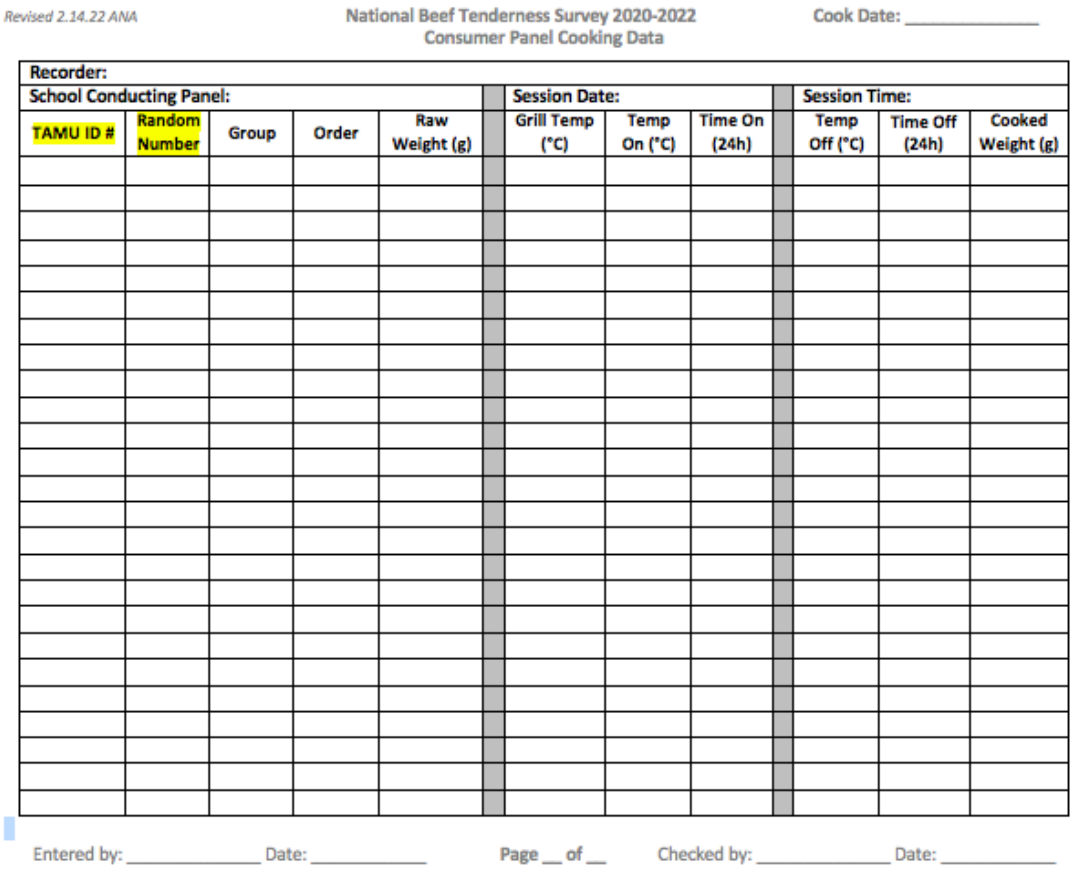
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Dislike Extremely — Like Extremely

IRB NUMBER: IRB2020-1233M
IRB APPROVAL DATE: 06/02/2021

NBTS2020

Figure 12. Consumer panel cooking data



Revised 2.14.22 ANA

National Beef Tenderness Survey 2020-2022
Consumer Panel Cooking Data

Cook Date: _____

Recorder:											
School Conducting Panel:						Session Date:				Session Time:	
TAMU ID #	Random Number	Group	Order	Raw Weight (g)		Grill Temp (°C)	Temp On (°C)	Time On (24h)	Temp Off (°C)	Time Off (24h)	Cooked Weight (g)

Entered by: _____ Date: _____ Page __ of __ Checked by: _____ Date: _____

Figure 13. WBSF cooking data

Revised 3.9.16 ANA

National Beef Tenderness Survey 2015-2016
WBSF Cooking Data

Cook Date: _____

Recorder:

TAMU ID #	Raw Weight (g)		Grill Temp (°C)	Temp On (°C)	Time On (24h)		Temp Off (°C)	Time Off (24h)	Cooked Weight (g)

Entered by: _____ Date: _____ **Page __ of __** Checked by: _____ Date: _____

Figure 14. Warner-Bratzler shear record

National Beef Tenderness Survey
Warner-Bratzler Shear Record

Recorded by _____ Date _____

Y-Max	Sample	TAMU ID	Shear 1	Shear 2	Shear 3	Shear 4	Shear 5	Shear 6	Shear 7	Shear 8	Shear 9	Shear 10
	1											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
	10											
	11											
	12											
	13											
	14											
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	24											
	25											
	26											
	27											
	28											
	29											
	30											

Revised 03/09/2016

Entered by _____ Date _____ **Page** ____ **of** ____ Checked by _____ Date _____