DETERMINATION OF THE EFFECT OF BRANDING ON CONSUMER PALATABILITY TRAITS OF GROUND BEEF AND BEEF STRIP LOIN STEAKS

by

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Abstract

The objectives of these studies were to determine how consumer palatability ratings of beef strip loin steaks and ground beef are affected when products are identified with a brand, USDA grade, or product type. Strip loins were selected to represent five quality levels and six ground beef treatments were chosen, representing a variety of fat levels and product types. After aging steaks for 14 d and ground beef for 8 d, 2.5 cm steaks and 151.2 g patties were formed. Consumer panelists evaluated samples for tenderness, juiciness, flavor liking, and overall liking as well as texture liking for ground beef samples. Additionally, consumers rated each palatability trait as either acceptable or unacceptable and rated the sample as either unsatisfactory, everyday quality, better than everyday quality, or premium quality. Samples were fed in two rounds – blind and informed testing. In the first round of blind testing, consumers were served one sample from each treatment with treatments not disclosed. For the second round of informed testing, USDA grade, or product information was disclosed prior to sampling. Samples evaluated by consumers were paired for blind and informed testing. During blind testing, Certified Angus Beef (CAB) steaks rated similar ($P > 0.05$) to Choice for all palatability traits; however CAB rated greater ($P < 0.05$) than Choice for all traits for informed testing. Additionally, Angus Select and Select steaks were rated similar ($P > 0.05$) when tested blind, but Angus Select was rated greater ($P < 0.05$) than Select for flavor and overall liking when treatment was informed. Prime, CAB, and Angus Select had increased ($P < 0.05$) ratings for flavor and overall liking due to brand disclosure. However, Choice and Select samples did not receive any increase ($P > 0.05$) in ratings for palatability traits when brand was informed. Multiple traits were rated greater for Prime, CAB, and Angus Select products indicating these products received a “brand lift” (change in ratings due to brand knowledge) in palatability due to brand identification. However, when

brand information was disclosed for Choice and Select steaks, consumers indicated no increase in palatability perception. Few differences were observed in blind testing for ground beef; however, during informed testing, 90/10 CAB ground sirloin rated greater ($P < 0.05$) than all other products for all palatability traits besides juiciness. Increased ($P < 0.05$) ratings were found for CAB products for multiple traits while the only non-branded product that received increased ($P < 0.05$) ratings was 90/10 ground beef during informed testing. There were few differences among ground beef products when tested blind, indicating that during blind testing, brand, fat percentage, and subprimal source have little effect on ground beef palatability. However, when product and brand were identified, multiple treatments received increased ratings for palatability traits indicating branding and product type knowledge influence the palatability of ground beef.

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Chapter 1 - Literature Review

The Effect of Marbling on Beef Palatability

The United States Department of Agriculture (USDA) created grading standards for livestock in 1916 in order to develop a uniform grade nomenclature that would be used for marketing reports (USDA, 1997). In 1924 the standards to facilitate beef grading for the U.S. were published in a USDA bulletin (USDA, 1997). After revision in 1926, the Official United States Standards for Classes and Grades of Slaughter Cattle were published in 1928 (USDA, 1997). Voluntary grading of beef carcasses began in 1927 with federal grading of agricultural products being authorized by Congress in 1946 through the Agricultural Marketing Act (USDA, 1997). Quality grading of beef carcasses allows consumers to have an idea of the expected eating experience prior to consumption. The relationship between USDA quality grade and eating experience has resulted in the development of premiums for producers who produce higher quality grading beef that would be expected to eat at a higher level.

Palatability is used to describe the eating experience of many different products. Kurtz (1959) described palatability as a complex of sensations resulting from the stimulation of odor, taste, and feel. Palatability has many different parts that all contribute to the overall eating experience. The palatability of meat generally refers to tenderness, juiciness, and flavor (Aberle et al., 2001); although many other factors can play into the palatability of a product such as aromas, cooking method, degree of doneness, and visual appearance (Cross et al., 1986). Additionally, all palatability characteristics interact during the eating experience to produce an overall eating satisfaction (Aberle et al., 2001). No single palatability trait can be considered the most important due to a high relationship between factors, with many authors reporting high

correlation coefficients among them (Jost et al., 1983; Caine et al., 2003; Killinger et al., 2004b; Thompson, 2004; Powell et al., 2011; Corbin et al., 2015; Legako et al., 2015).

Numerous studies have evaluated the effect of marbling on palatability traits. Marbling, or intramuscular fat, is a major factor when determining the quality grade of similar age beef and the predicted overall eating experience (USDA, 2014). Marbling has been studied extensively due to its large effect on beef palatability. There are multiple ways to evaluate beef palatability and include using trained or consumer panelists for blind studies as well as gathering objective data using instruments.

Trained Panel Evaluation of Beef Steaks of Varying Marbling Levels

Sensory panels consisting of trained panelists that evaluate samples have been used to identify differences among products for over 50 years. Trained sensory evaluation utilizes a set of techniques in order to accurately measure human responses to foods and minimize potential variation and biased effects (Bratcher, 2013). Panelists selected for sensory evaluation are trained to detect specific traits and their respective level on a predetermined scale. These types of sensory panels remove variability from sensory analysis because panelists, theoretically, will be ranking traits of interest identically. Thus reducing the amount of variation between each participating panelist. The need for trained panel evaluations became clear in the early 1940's when it was determined instruments were not able to measure certain sensory attributes such as flavor and texture (Gengler, 2009). Trained panelists were then developed in an effort to have more objective measurements of food due to variability in human evaluators (Gengler, 2009).

Marbling and USDA Quality Grade research by Ramsbottom and Strandine (1948) is some of the earliest documented "committee" ratings of beef steaks. In that study, 50 different beef muscles compromising 88% of the lean of three US Good carcasses were evaluated

organileptically and with shear force for tenderness. In general, the tenderness ratings were not affected by intramuscular fat content among different muscles (Ramsbottom and Strandine, 1948). The muscle with the greatest percentage of fat, 18.1% (intercostals) had a rating of "slightly tough" while other muscles such as the psoas major (PM) and minor, and the longissimus muscles, which had a lower fat percentage rated "slightly tender", "tender" or "very tender" (Ramsbottom and Strandine, 1948). With this study, it is clear to see that using only the fat percentage of muscles to predict tenderness ratings is not reliable due to other factors such as collagen, fiber type, and muscle playing a large role in the tenderness of meat from various muscles of the carcass.

Studies in the 1960's and 1970's reported varying results for the effect of marbling on beef palatability. Beef longissimus dorsi (LD) steaks of carcasses grading from Prime to Standard were collected and it was reported that steaks in the "high marbled" (average 9.4% fat) category were more tender, juicy, and flavorful than "low marbled" (average 5.8% fat) steaks when cooked to the same internal temperature (Gilpin et al., 1965). Conversely, trained panel tenderness, juiciness, and flavor ratings were not affected by marbling when comparing Select and Prime LD steaks (Tuma et al., 1962). Additionally, steaks from the longissimus thoracis (LT) were not affected by marbling for flavor, tenderness, or juiciness when quality grades of Select, Choice, and Prime were evaluated (Parrish et al., 1973).

Moving to the 1980's and 90's, more studies found similar results, indicating increased marbling level was associated with increased trained panel sensory evaluation (Tatum et al., 1980; Tatum et al., 1982; Smith et al., 1985; Savell et al., 1987; Miller et al., 1997). In 1980 a study was conducted using longissimus (LM) steaks that graded High, Average or Low Choice as well as High, Average, and Low Select that were evaluated by a trained panel (Tatum et al.,

1980). In this study, all Choice treatments were similar for tenderness, with only Low Choice rating similar to all other quality grades while High Choice and Average Choice rated greater than all other treatments for flavor desirability (Tatum et al., 1980). The percentage of samples rated very desirable (mean rating > 6.0 / 8.0) and desirable (mean rating 4.5-5.99 / 8.0) for all traits were calculated (Tatum et al., 1980). It was reported that nearly all samples (> 95%) from Select and Choice were rated desirable or very desirable for flavor with nearly 20% more of the Choice samples rating very desirable for tenderness compared to Select (Tatum et al., 1980). Tatum et al. (1982) using a similar desirability scale as Tatum et al. (1980) for desirability reported that 90% of Select or greater quality grade LM steaks were desirable (4.5 or greater mean response) for tenderness, flavor, and overall. A similar study followed by Smith et al. (1985) where longissimus lumborum (LL) steaks of marbling levels of Standard to Prime were used. Marbling of Choice and greater resulted in greater scores of tenderness, juiciness, flavor, and overall palatability for A maturity carcasses compared to lower marbling (Smith et al., 1985). Additionally, marbling accounted for 24 to 34% of variability in sensory panel ratings of tenderness, juiciness, flavor, and overall palatability for LD steaks (Smith et al., 1985). Also, it was reported that as LD steaks increased in marbling from Standard to Prime, panel ratings for juiciness, tenderness, and flavor intensity increased (Savell et al., 1987). Miller et al. (1997) also reported LL steaks from Choice carcasses were greater in initial juiciness and tenderness, sustained juiciness and tenderness, and flavor intensity compared to Select steaks.

More recently, Vote et al. (2000) and Lorenzen et al. (2003) both reported differences in tenderness and beef flavor using trained panelists with Choice steaks rating higher than Select. Additionally, Lorenzen et al. (2003) demonstrated that juiciness increases with increased marbling for LD steaks. However, Vote et al. (2000) reported no differences in juiciness between

LD steaks of Choice and Select. Woolley, (2014) demonstrated that steaks from the LL of Prime to Standard carcasses increased for tenderness, juiciness, and flavor as quality grade increased. Moreover, Emerson et al. (2013) reported marbling explained 61% of the variation for the overall sensory experience for trained panelists. The authors also reported that 98-99% of the steaks with Prime received positive ratings for overall experience while only 15% of Standard steaks received positive ratings for overall sensory experience (Emerson et al., 2013). Acheson et al. (2014) demonstrated that as marbling increased from Select to Top Choice (Modest^{00} to Moderate^{100} marbling score), tenderness ratings increased 20% and juiciness increased by 15%, with meaty/brothy, and buttery/beefy descriptors also increasing with increased marbling.

Consumer Sensory Evaluations of Beef Strip Loin Steaks of Various Quality Grades

While utilizing trained panels is important to detect product differences, it is also important to determine if these differences are detected by consumers and how they affect the overall sensory experience (AMSA, 2015). Many different consumer tests can be utilized and the best fitting test for the study objectives should be chosen (AMSA, 2015). Quantitative tests for consumers are often used in order to determine preference and liking for sensory attributes (AMSA, 2015). These panels are helpful in giving data that can be used to predict population estimates of cooked beef palatability which is why panel selection should be based on the target population (AMSA, 2015). Consumer panelists are able to use their own perceptions instead of being trained to rate products a specific way.

Consumers have been able to identify differences in beef during sensory panels and have been a useful tool for determining how consumers in a larger population will view various products. Consumer panels have been used to determine the effects of marbling on all palatability traits as well as muscles. Nelson et al. (2004) reported that marbling had highest

correlation (r = 0.30) to sensory tenderness in the middle meats, like LL steaks. Studies have also used experimental auction techniques to evaluate consumers' willingness to pay for steaks of varying marbling levels (Platter et al., 2005; Killinger et al., 2004a; Killinger et al., 2004b). Results from Platter et al. (2005) indicated that consumers were more likely to bid on steaks of higher marbling degrees as well as placed premiums on steaks of higher quality grades. Conversely, consumers in Killinger et al. (2004a) reported they were willing to pay more for high (Top Choice) marbled steaks only if they preferred to buy high marbled steaks. Consumers who preferred low (Select) marbled steaks reported no willingness to pay more for either marbling level (Killinger et al., 2004a). Additionally, Killinger et al. (2004b) reported no difference in the willingness to pay for high (Top Choice) and low marbled (Select) steaks by consumers when grouped based on sensory ratings that were greater for either high or low marbled steaks. Results from these studies indicate that consumers have differing preferences for marbling levels. Assessment of consumer ratings for differing marbling levels under controlled circumstances has been utilized to remove bias about marbling while sampling steaks.

Consumer panels have been utilized since the 60's and are still being used currently to evaluate a range of quality grades and muscles. The medial cuts, specifically the LD, LL, and LT have also been evaluated for the effect that marbling may have on palatability. Steaks from the LD were reported to increase in ratings for juiciness, flavor, and general opinion when marbling increased from Select to Prime, with no differences in tenderness reported (Breidenstein et al., 1968). Also, Choice LD steaks were more juicy, flavorful, and had a greater overall acceptability compared to Select LD steaks (Francis et al., 1977). Additionally, consumers from Killinger et al. (2004b) evaluated Top Choice and Select LD steaks and reported tenderness, flavor, and overall acceptability to be greater for Top Choice steaks. The LL has been demonstrated to have

increased ratings of tenderness, juiciness, flavor liking, and overall liking when marbling increases from Standard to Prime (O'Quinn et al., 2012). Similarly, Woolley (2014) reported an increase in ratings for the LL as quality grade increased from Standard to Prime, when steaks were cooked to three degrees of doneness. Also, Corbin et al. (2015) reported similar findings to both Woolley (2014) and O'Quinn et al. (2012) for LL steaks of quality grades from Prime to Select with increased ratings of tenderness, juiciness, flavor, and overall liking. Conversely to O'Quinn et al. (2012), High Choice was rated lower than Low Choice for tenderness and Low Choice was rated similar to Prime for flavor; however, these steaks were all selected based on a similar instrumental tenderness values (Corbin et al., (2015). In contrast, Powell et al. (2011) demonstrated no differences in tenderness liking, juiciness liking, flavor liking, or overall liking for LL steaks from Select and Choice quality grades. Laster et al. (2008) reported Select LT steaks had decreased ratings for juiciness liking, level of juiciness, flavor liking, beef flavor, and overall liking compared to Top Choice steaks. However, Kukowski et al. (2004) demonstrated no differences in LT steaks for tenderness, juiciness, flavor, or overall liking from Choice and Select carcasses.

Evaluating consumer perception of marbling has previously been studied at a central location in a laboratory setting. However, consumers do not consume meat in a laboratory when they purchase it. Therefore, other studies have evaluated the effect of marbling on consumer palatability in home and found differing results. Claborn et al. (2011) evaluated LL steaks of Top Choice, Low Choice, and Select and reported no differences in tenderness or flavor; however, Top Choice steaks were rated greater in juiciness compared to the Low Choice and Select steaks. Also, when Top Choice, Low Choice, High Select, and Low Select steaks from the LD were evaluated, Top Choice steaks from the LD were rated greater for overall liking than lower quality

graded steaks (Neely et al., 1998). Additionally, the overall desirability of LM steaks was demonstrated to increase for consumers in San Francisco, Kansas City, and Philadelphia when steaks increased in quality grade from Standard to Prime and when evaluated in-home (Savell et al., 1987). Moreover, consumer's average ratings for Prime and High Choice were greater than Average Choice, Low Choice, High Select and Standard (Branson et al., 1986). Conversely, McKenna et al. (2004) demonstrated that when consumers prepared LD steaks of Low Choice, High Select and Low Select, no differences were reported for tenderness, juiciness, flavor, or overall satisfaction between quality grades evaluated. Also, consumers in Killinger et al. (2004b) reported that when Top Choice and Select steaks were evaluated in-home by consumers, there was no differences in tenderness, juiciness, flavor, or overall acceptability for LD steaks. However, consumers reported differences for Top Choice and Select LD steaks when evaluated in a laboratory setting from the same study (Killinger et al., 2004b). These findings show that when consumers prepare beef at home as opposed to under controlled conditions, marbling may play a smaller roll in palatability perception and environment can have an effect on sensory ratings.

Muscles from the round (semimembranosus, SM) and the sirloin (gluteus medius, GM) have been evaluated by many authors at multiple quality grades. Neely et al. (1998) reported no differences in tenderness, juiciness, flavor intensity and desirability, and overall liking for the GM or SM when evaluated at quality grades of Top Choice through Low Select. When Breidenstein et al. (1968) evaluated the SM muscle from carcasses of quality grade categories of High Prime, Prime, Top Choice, and Select, no differences were observed for tenderness. However, as marbling level increased from Select to High Prime, ratings for juiciness and flavor increased for the SM (Breidenstein et al., 1968). Legako et al. (2015) also demonstrated no

tenderness differences in the SM or GM muscle when comparing quality grades ranging from Standard to Prime. Additionally, Low Choice SM and GM steaks were rated the lowest for juiciness, flavor liking, and overall liking (Legako et al., 2015). Similar to both previous studies, Hunt et al. (2014) reported no differences in tenderness for the SM and GM muscles for Select and Choice quality grades. However, Hunt et al. (2014) also demonstrated no differences in juiciness, flavor or overall liking for the SM muscle. But, steaks from Choice carcasses were reported to be higher for juiciness, flavor, and overall liking for the GM muscle (Hunt et al., 2014). Similarly, the GM of Top Choice carcasses has been reported to be more tender, juicy, flavorful, and liked overall compared to High Select steaks (Behrends et al., 2005). Conversely, Laster et al. (2008) reported that quality grades of Top Choice and Select had no effect on palatability traits of juiciness liking and level, flavor liking, beef flavor, or overall liking for the GM muscle. Also, when Choice and Select GM muscles were evaluated, no differences between quality grades were reported for tenderness, juiciness, flavor liking or overall liking (Powell et al., 2011).

When muscles of the chuck, triceps brachii (TB), serratus ventralis (SV), and infraspinatus (IF), were evaluated at quality grades of Choice and Select, authors report varied findings. Powell et al. (2011) demonstrated that there was no difference for palatability traits of tenderness, juiciness, flavor, or overall liking for either the TB or IF muscles. Conversely, Kukowski et al. (2004) reported that Choice IF were more tender and juicy than their Select counterparts while the TB only rated higher in juiciness for the Choice steaks. Additionally, the Choice SV was considered to be more tender, juicy, and liked overall compared to Select steaks; however, no differences were reported for flavor of any muscles evaluated (Kukowski et al., 2004). Also, Hunt et al. (2014) reported no differences in tenderness for Choice and Select SV

steaks, but Choice steaks were rated higher for flavor, juiciness, and overall liking compared to Select SV steaks.

These findings demonstrate that marbling effects are muscle dependent with the medial cuts having more consistent results compared to muscles from the chuck and round. Additionally, greater differences in palatability traits are reported when multiple quality grades are assessed compared to studies in which only Choice and Select are compared.

Relationship of Warner-Bratzler Shear Force to Sensory Panel Ratings and Marbling

Instrumental tenderness has been used for many years to identify tenderness of meat products without the use of human subjectivity. There are multiple different measures for instrumental tenderness including Warner-Bratzler Shear Force (WBSF) which has been utilized for many years as a mechanical measure of tenderness. Multiple research experiments were conducted to create the WBSF method, and this research was governed by the necessity for quality and palatability to be evaluated by laboratory means (Warner, 1928). The method created by Warner (1928) was described as a blade moving through a stationary guide where the force required to shear the sample was recorded, with this method by Warner (1928) reporting a high repeatability (0.79) between left and right sides of the carcass. Additionally, this method created by Warner was studied in an attempt to make improvements to the machine and develop a physical means of measuring the tenderness of meat (Bratzler, 1932). This study evaluated different blades on meat cores that were taken parallel to the muscle fiber orientation and sheared perpendicular to the muscle fibers and additionally, had samples evaluated by a sensory panel (Bratzler, 1932). The triangular blade that was evaluated showed less variation than that of a circular or square blade (Bratzler, 1932). There was also an indication of a correlation ($r = 0.79$) between the shearing values of cooked beef and the palatability ratings for tenderness (Bratzler,

1932). Through these two studies, the creation and specifications were defined for the WBSF measurement of meat.

Shackelford et al. (1991) established threshold levels for tenderness acceptability of consumers that related to WBSF values. They reported that steaks having a WBSF value of < 3.2 kg of force gave a 95% chance that consumers will rate the steak slightly tender or above. This study was the first attempt at establishing thresholds for consumer acceptance of tenderness based on WBSF values. Later, Miller et al. (2001) established consumer acceptability thresholds for WBSF values and reported that at 4.0 kg of force, 94% of consumers would consider the steak tenderness acceptable and < 3.0 kg of shear force would result in 100% of consumers rating a steak acceptable for tenderness. Additionally, consumer panel tenderness ratings have been shown to be correlated (r = -0.19 to -0.72) with WBSF (Breidenstein et al., 1968; Jost et al., 1983; Destefanis et al., 2008; Yancey et al., 2010; Powell et al., 2011; Hunt et al., 2014; Lorenzen et al., 2003). Correlations between trained sensory panel ratings of tenderness and WBSF (r = - 0.42 to - 0.90) have also been demonstrated (Ramsbottom and Strandine, 1948; Koch et al., 1979; Caine et al., 2003; Nelson et al., 2004; Howard et al., 2013). These elevated correlations for trained panels are due to panelists being trained to act as similar to each other as possible.

A range of different quality grades of the LD have been assessed by many authors for WBSF evaluation. McBee and Wiles (1967) reported a 26% decrease in WBSF for the LD as quality grade increased from Standard to Prime. Similarly, a 20.5% decrease in WBSF was demonstrated for the LL when quality grade increased from Standard to Prime (Savell et al., 1987). Emerson et al. (2013) also reported a large decrease in WBSF (31.6%) for the LM as quality grade increased from Standard to Prime. Additionally, Yancey et al. (2010) reported a

decrease of 18.4% for the LT muscle when quality grade increased from Select to Prime. Tatum et al. (1980) also evaluated the LT from quality grades of High Choice to Standard and reported a decrease of 27% for WBSF values with the increase in quality grade. When Top Choice and Select quality grades are evaluated for WBSF of the LD, decreases are reported as well. Hunt et al. (2014) demonstrated a large (23.9%) decrease in WBSF values for the LL as quality grade increased from Select to Top Choice. Acheson et al. (2014) also reported a decrease of 17.6% in WBSF values for the LM when quality grade was increased from Select to Top Choice. Similarly, when the LD was assessed for WBSF at quality grades of Select and Top Choice a decrease of 13.8% was reported (Jennings et al., 1978). Additionally, Derington et al. (2011) demonstrated a decrease of 4% for the LL when quality grade increased from Select to Top Choice. Also, Luchak et al. (1998) demonstrated a decrease of 5.3% and 11.1% for the LL and LT, respectively, as quality grade increased from Select to Choice. The LL was evaluated by Vote et al. (2000) of quality grades of Select to Choice and a decrease of 15.4% was reported as quality grade increased. Similarily, Lorenzen et al. (2003) demonstrated WBSF decreased by 5.5% for the LD as quality grade increased from Select to Choice. Conversely, Breidenstein et al. (1968) reported no differences for shear force values when evaluating the LM muscle for the quality grades of Select to Prime; however, multiple different maturities were evaluated in that study. Also, Voges et al. (2007), Parrish et al. (1973), and Dow et al. (2011) reported no differences among LT or LL steaks with quality grades ranging from Prime to Select for WBSF values. Moreover, marbling has shown to be correlated to WBSF from r = -0.10 to -0.72 (Breidenstein et al., 1968; Koch et al., 1976; Jennings et al., 1978; Jost et al., 1983; Emerson et al., 2013; Hunt et al., 2014).

Ground Beef Palatability

Ground beef is the most popular beef item for preparing meals, representing nearly 50% of beef consumed in home, and represents 64% of total pounds of beef sold in the food service industry (NCBA, 2012). Much of the published research on ground beef was conducted in the 80's and early 90's due to health concerns related to fat content. Additionally, most of this work evaluated methods that could be used to increase palatability while decreasing fat content. More recently research has focused on different lean and fat sources, premium and non-traditional grind materials, and determining how fat levels affect palatability traits. Ground beef allows the U.S. beef industry to make a significant profit from lower quality cuts and trimmings. Thus, it is important to research the effects that these variables could have on ground beef product eating quality.

Studies of ground beef involving different fat sources and trim give good insight into how these factors affect the palatability of ground products. A study by Kerth et al. (2015) formulated 20% fat ground beef patties using a single lean source and fat from either the brisket, chuck, plate, flank, or round. In that study, consumers reported no differences in palatability traits from ground beef formulated with different fat sources when all treatments were formulated to the same fat level (Kerth et al., 2015). When a trained panel evaluated ground beef from the brisket, flank, and plate that was formulated to 10%, 20%, and 30% fat, differences were reported for the brisket and flank, with these primal lean sources having higher ratings for bloody/serumy than the plate (Blackmon et al., 2015). Patties formulated to 30% fat were also considered to have greater fat-like score, while 20% and 10% fat samples were similar for fat-like flavor (Blackmon et al., 2015). In a similar study using ground knuckles and chuck from Select and Top Choice carcasses it was reported that quality grade had no effect on sensory characteristics for the

knuckle (Highfill, 2012). However, patties made from Top Choice chuck rolls were less firm and had a greater mouth coating than chuck patties from Select carcasses (Highfill, 2012). McHenry (2013) also formulated ground beef from different lean sources and reported that 20% fat burgers from the chuck were more desirable in flavor attributes compared to ground beef from the brisket and sirloin caps when evaluated by trained panelists. It was also reported that ground beef from tenderloins was the lowest for buttery/beef fat flavor and hardness as well as had the highest tenderness value by trained sensory panelists (McHenry, 2013). Additionally, when beef rounds were used for 10% or 20% fat ground beef from cow (Utility) carcasses, Top Choice carcasses, and commodity (Select) carcasses, no differences were reported for sensory scores of flavor, juiciness, off-flavor, or texture (Myers, 2012). Also in the same study, plates were used as a fat source from Top Choice and commodity carcasses and no differences were observed in sensory ratings for different fat sources (Myers, 2012). Myers (2012) indicated that no sensory benefit is reported when using higher quality graded carcasses for fat or trimmings from the round. It is unclear whether fat and lean source affect palatability characteristics of ground beef due to conflicting findings from previous research and the limited number of published studies that have evaluated the subject.

Much previous research has evaluated how fat level can alter palatability characteristics of ground beef patties. Troutt et al. (1992b) evaluated ground beef patties of 5% to 30% fat in increments of 5%. The lower fat ground beef patties (5-10%) were rated tougher by trained sensory panelists as well as for objective tenderness values compared to the higher fat (20-30%) patties. Additionally, patties formulated with 20-30% fat were rated more juicy and flavorful by panelists (Troutt et al., 1992b). Similarly, Berry (1992) utilized ground beef formulated from 0% to 20% fat with 4% increments and demonstrated an increase in juiciness, initial and final

tenderness, and flavor. Additionally, Miller et al. (1993) reported greater tenderness, juiciness, flavor, and overall palatability for 22% fat ground beef compared to 10% fat patties. Troutt et al. (1992a) reported similar findings to other studies with 5-10% fat ground beef patties rating lower for juiciness and greater for firmness compared to 20-30% fat patties. However, no differences in this study were reported for beef flavor between fat levels (Troutt et al., 1992a). Moreover, Cross et al. (1980) demonstrated an increase in juiciness scores as fat level increased from 16% to 28%, but no differences in flavor were reported for treatments. Meyers (2012) and Garzon et al. (2003) also reported 20% fat ground beef to be juicier and more tender than 10% fat ground beef with no difference in flavor. Additionally, Berry (1994) reported an increases in initial and final tenderness for patties as fat increased from 14%, to 19%, and 24%. Also, the 24% fat treatment was rated the greatest for juiciness (Berry and Leddy, 1984) Conversely, Berry (1993) reported no difference in juiciness between ground beef formulated to 6% and 20% fat while 20% was demonstrated to be greater in beef flavor intensity. Also, Desmond et al. (1998) reported no tenderness differences for ground beef of 10% and 20% fat but juiciness scores were greater for 20% fat ground beef. It is clear that decreasing fat level in ground beef has detrimental effects to sensory traits. While juiciness and tenderness results are relatively consistent among studies, results for beef flavor traits have been mixed. These differences among studies could be explained by the different lean and fat sources used for ground beef formulation. Additionally, large differences in the percentage of fat compared among studies may also be responsible for the observed differences.

Many forms of instrumental tenderness have been used to evaluate objective tenderness of ground beef. Different methods include shear force using a straight blunt blade following WBSF methods, and Allo-Kramer shear force. Highfill (2012) reported that patties from the

chuck and Top Choice carcasses were more tender instrumentally than patties from Select carcasses as well as ground beef from the knuckle. Moreover, Berry (1992) reported as fat level of ground beef increased from 0% to 20%, shear values decreased. Also, Troutt et al. (1992a) demonstrated both Instron shear force and Lee-Kramer shear force were greater for 5-10% fat patties compared to 20-30% fat patties. Desmond et al. (1998) also demonstrated Instron and Kramer shear force values to be greater for 10% fat ground beef when compared to 20% fat ground beef. Similarly, Berry (1994) reported 4% fat ground beef patties had greater Instron shear force as compared to the 20% fat patties when using an Allo-Kramer blade. Also, Cross et al. (1980) reported shear values were similar over differing fat levels (16%, 20%, 24%, and 28%); however, total work by the machine was decreased as fat level increased. Though most studies agree that increasing fat decreases shear value, Berry (1993) reported that 20% fat patties were greater in shear values compared to that of 6% fat ground beef. Additionally, when Troutt et al. (1992b) tested ground beef of fat levels from 5% to 30% in 5% increments, the only difference in shear force was reported for 5% patties, where shear force was greater than all other treatments. However, in the same study, Lee-Kramer shear force values decreased with increased fat level (Troutt et al., 1992b). Blade and testing protocol for shearing ground beef patties plays a large role in the effect of fat on ground beef patties, with less varied results from Kramer shear force testing. Overall, ground beef shear values are lower for higher fat inclusion formulations.

In a study by Lusk and Parker (2009), consumers were asked whether they preferred 10% fat or 20% fat in their ground beef, with the majority of consumers indicating they preferred the lower fat level. These consumers were also willing to pay an average of $2.00 more per pound as well as considered fat level a more important trait than that of price or package size (Lusk and Parker, 2009). These results are reflected by current prices for retail ground beef (Martinez,

2008; Speer et al., 2015). Ground beef with less fat is more expensive than that of higher fat with retail prices of lean and extra lean ground beef (90% to 95% lean) garnering a 31% premium in price compared to 75% to 80% lean ground beef (USDA, 2015b). Though consumers are willing to pay a premium for lower fat content ground beef research indicates, in blind testing, ground beef with higher fat contents is demonstrated to be more juicy and tender than lower fat content ground beef patties (Cross et al., 1980; Troutt et al., 1992a; Troutt et al., 1992b; Miller et al., 1993; Berry, 1994; Desmond et al., 1998; Garzon et al., 2003; Myers, 2012; Blackmon et al., 2015).

Branding of Products

Brands relay information, in the form of cues, to consumers which can assist in quality expectations being formed when selecting foods to buy (Steenkamp and vanTrijp, 1996). Perceived quality of products by consumers has been shown to be affected by branding strategies (Dodds et al., 1991), because consumers form quality expectations by utilizing past experiences and information presented at the time of purchase (Steenkamp, 1990). Consumers will choose products that can give them the same experience they had in previous purchases (Bredahl, 2004). A major part of a brand is its brand equity which is the set of assets, or liabilities, linked to a brand's name and symbol that can add, or subtract, to the value provided by a product (Aaker, 1991). An important feature of branding is to differentiate one firm's products from relatively homogeneous products, creating a unique identity for the product in the eyes of the consumer (Keller and Richey, 2003). When a product becomes a brand, it promises a particular level of quality and a distinctive position among other choices (Farhana, 2012). The brand identifies a known set of attributes at a known quality level to consumers (Owen et al., 2000). Many authors have stated that brands are used to help alter the perception or quality of meat and help represent

a producer's promise to deliver a consistent product (Cobbwalgren et al., 1995; Wachenheim et al., 2000; Grunert et al., 2004; Font-i-Furnols and Guerrero, 2014). Quality has been shown to be the most important branded product meaning to consumers, which means that consumers choose the brand because it is a source of information about quality (Wachenheim et al., 2000; Strizhakova et al., 2008). Not all brands demonstrate equal quality though. This can be shown with the difference in price among brands (Richardson et al., 1994). Some brands can gain a premium for their product, but some may just brand for differentiation and not garner premiums (Low and Blois, 2002).

Of particular interest in this study is the branding of beef products which have grown since previous years. From 2004 to 2010, there was a 50% increase in the amount of fresh beef products sold with a brand in the retail case (NCBA, 2010). This resulted in 63% of beef products being associated with a brand (NCBA, 2010). In 2015, the number of total fresh meat products with a brand in the retail case grew again resulting in 96% of fresh meat sold under a brand (Kelly, 2016). With nearly all fresh meat sold under a brand, it is clear that beef branding plays a large role in the purchasing decisions of consumers. The USDA monitors 107 certified beef programs (USDA, 2016a), which include store and national brands that are present in retail cases. Consumers use extrinsic cues including price, packaging and branding in addition to intrinsic cues (physical characteristics of the product that could be purchased), such as color of the lean and amount of fat in beef in order to form expectations about meat quality (Bredahl, 2004; Verbeke et al., 2005; Banović et al., 2009; Font-i-Furnols and Guerrero, 2014). In a study by Wachenheim et al. (2000) 84.5% of consumers reported having a positive image of a beef brand; however, only 34% were willing to pay a premium for a branded beef product. Numerous studies have focused on the willingness of consumers to pay for branded beef. Morales et al.

(2013) reported 55% surveyed beef consumers in Australia were willing to buy branded beef. Consumers with decreased confidence in buying and selecting beef were willing to pay more for a branded products (Morales et al., 2013). A study conducted in Canada with four hypothetical brands, where consumers were asked to bid in an auction at a meat counter, reported that consumers were willing to exchange their generic steak for that of a branded beef steak (Froehlich et al., 2009). On average, consumers bid on every hypothetical brand at a premium of at least $1.10 / 12 oz and the highest premiums were given for the brands with claims of natural, tenderness, and Angus breed (Froehlich et al., 2009).

A national study of beef products was conducted to determine the average national premium and discounts for branded beef using retail scanner data (Schulz et al., 2012). In that study, of the 62 different brands evaluated, 55 had a premium associated with them compared to unbranded products (Schulz et al., 2012). Regional brands were reported to have an average of a $0.76 / lb premium over that of national brands, while new brands (brands out for < 3 years) were sold at an average of $1.69 / lb premium compared to that of brands in the industry for > 10 years (Schulz et al., 2012). Additionally, brands that included special (labels that relate information about practices, i.e. no antibiotics), program (breed specific), and store brands, were sold at premiums of $1.31 to $2.32 / lb, with store brands having the lowest premium and special brands carrying the largest dollar benefit (Schulz et al., 2012). In another study evaluating self-reported meat purchases, only 35% of beef steaks sold were branded and the majority of brands measured for beef were Angus brands (Parcell and Schroeder, 2007). Branded beef steaks of low quality (cuck, blade, arm, shoulder, flank, London broil, and cube steak) were sold at a premium of $0.76 / lb compared to the store brands (Parcell and Schroeder, 2007). Additionally, medium quality (T-bone, sirloin, strip, top loin, top sirloin, top sirloin tip, porterhouse, and round steak)

steaks were sold at a premium of $1.26 / lb with high quality (ribeye and tenderloin) were sold at $1.22 / lb compared to the store or supermarket brand (Parcell and Schroeder, 2007). Additionally, Prime steaks were sold for premiums of $1.40 / lb and $2.46 / lb for low quality and high quality cuts respectively compared to non-graded cuts (Parcell and Schroeder, 2007). However, a different trend was demonstrated for Choice and Select steaks, where no premiums were garnered for these grades compared to non-graded and a discount of $0.04 / lb was reported for Select medium quality steaks (Parcell and Schroeder, 2007). A retail scanner data study was performed by Ward et al. (2008) where premiums garnered for branded steaks and roasts ranged from $0.00 / lb to $6.20 /lb compared to products with no brand. Prime steaks and roasts were again demonstrated to gain a premium of $1.37 / lb while Choice steaks were sold at a $0.70 / lb premium compared to non-branded products, and Select steaks did not receive any benefit or discount compared to unbranded steaks and roasts (Ward et al., 2008). Another large scale study using consumers reported data demonstrated that three of the six national brands steaks were purchased at a premium ranging from $0.36 / lb to $2.01 / lb compared to unbranded products and no national brands were discounted (Martinez, 2008). Brands that included non-breed specific claims such as no antibiotics/hormones, source verified or grass-fed received the highest premiums of $4.15 / lb with breed-specific brands garnering premiums of $0.89 / lb (Martinez, 2008). Of the private label brands that were in the study, all but one was marketed at a premium of at least $0.21 / lb; however, one private label brand product was discounted $0.44 / lb compared to non-branded steaks (Martinez, 2008). Very few brands receive no premiums when compared to unbranded products; however, specific brands can receive larger premiums compared to others.

Branding and product differentiation are only rewarded when consumers are willing to pay for information or characteristics associated with the brand (Mennecke et al., 2007). When determining consumers' willingness to pay, typically consumers are put through a test that allows them to choose to pay more for a different product than the one they have. Some studies use an auction type setting where bids are placed on products to determine how much more consumers would be willing to pay and others use a survey where consumers simply state how much more they would pay for a different product. A classic example of consumer willingness to pay for branding is with Quaker Oats brand. Quaker Oats are sold at a 3,000% increased price than the price of the basic ingredient used (Morgenson, 1991). Similar results have been demonstrated with other food products. The well-known branded version of raisins, chicken noodle soup, ketchup, and grape juice were all sold for premiums above the same product under a store brand in Philadelphia (Stanton and Herbst, 2005). Feldkamp et al. (2005) examined willingness to pay for beef steak with using a generic steak and several branding strategies that included: USDA Choice, Certified Angus Beef (CAB), Natural, and Guaranteed Tender. Consumers were allowed to exchange their given generic steak for that of a branded steak with associated claim (Feldkamp et al., 2005). When assessed, only 25% of consumers were not willing to pay a premium to exchange their steak for a CAB steak, and 29% of consumers who were willing to pay a premium were willing to pay between $1.51 and $2.00 additional per steak, with an average premium of $1.63 / steak for CAB (Feldkamp et al., 2005).

The company CAB was established nearly 40 years ago and the sales of this brand have continued to grow throughout the years. Also, CAB has seen a 129% increase in sales in the past 12 years and pounds sold has increased each year for the last consecutive 10 years (CAB, 2015). Not only does branding benefit the CAB company, but also the packers who segregate and sell

CAB qualifying carcasses. They reported a 35% increase in premiums from 2010 - 2011 (CAB, 2015). Additionally, since 1978, the time it takes to market one million pounds of CAB meat has dropped from 22 months to 22 hours (Parcell and Schroeder, 2007). Brands play a large role in differentiating products for consumers and brands can add economic value to many different products for retailers and companies.

Perceived Quality of "Angus"

In order to be certified by the USDA as Angus, there are certain specifications that must be met. Cattle may be qualified for an Angus program by meeting one of two requirements (USDA, 2016). Cattle qualifying for the program can be certified by genotype, indicating parentage by identification (brands or tattoos) as well as traceable to one registered Angus parent (USDA, 2016). Additionally, cattle can qualify for and Angus brand by phenotype, which must show 51% black hide with no non-Angus characteristics such as dairy conformation or neck humps due to Brahman influence (USDA, 2016). Guidelines for USDA certification provides assurances to consumers that "Angus" products are from animals that meet specific criteria of the brand. The first branded beef program, CAB, was created in 1978 and was developed during a period where there was a decreasing amount of "premium quality" beef (Hildebrand et al., 1994). Additionally, CAB strip loin steaks have been reported to be more tender, juicy, and flavorful than that of Select steaks from multiple muscles (TB, LM, GM, SM; Claborn, 1996).

The CAB brand is not the only brand associated with the "Angus" breed. In 2013, 53 of the brands certified by the USDA contained the word "Angus" and this number has now grown to 71 in 2016, an increase of 34% in just the past four years (USDA, 2016a). However, the percentage of brands containing "Angus" specifications has remained a constant fraction (2/3) of total brands (USDA, 2016a). It is clear that marketing the Angus breed comes with greater

perceived quality by consumers which is a large incentive for brands to include the Angus name. Before the CAB program, there was no way for differentiation of Angus breed beef products in the market (Stanton and Herbst, 2005). The Angus breed has been evaluated for economic value associated with branding, as well as the palatability associated with the breed compared to other continental and European breeds with mixed results for sensory traits being reported.

Angus beef has been compared to beef from many breeds by sensory analysis. The U.S. Meat Animal Research Center has conducted several cycles (I to VIII) of studies evaluating different breeds for many factors including trained sensory panel traits of tenderness, juiciness, and flavor. These studies were part of the Germplasm Evaluation program for determination of breed type on the carcass characteristics. The LM muscle was used for evaluation from steers of Angus and Hereford dams mated with the breeds of interest for that specific cycle.

In the first cycle of these studies, no differences were reported in tenderness, juiciness, or flavor desirability scores for Angus compared to other breeds (Koch et al., 1976). In cycle II, cattle from Angus dams were reported to be more tender than that of Hereford dams and Angus steaks were higher for tenderness than all other breeds except Hereford/Angus, and Red Polled (Koch et al., 1979). Additionally, Angus steaks were more juicy than Hereford, while flavor was not affected by breed type (Koch et al., 1979). Cycle III reported Hereford steaks were more tough than that of Angus and juiciness was lower for Angus than Hereford-Angus steaks (Koch et al., 1982). In cycle IV, flavor intensity scores showed little difference (4%) between Angus/Hereford steaks and all other breeds while juiciness and tenderness of Angus/Hereford steaks were greater than Nellore cattle (Wheeler et al., 1996). During cycle V, Angus steaks were more tender than Hereford when compared at a similar marbling level and Angus/Hereford steaks were more juicy compared to all other breeds (Wheeler et al., 2001). For cycle VI, at

constant age, Angus steaks were higher in tenderness compared to all breeds besides Wagyu; but, were less juicy than Wagyu and Swedish Red and White LM steaks (Wheeler et al., 2004). In cycle VII, no differences were reported between Angus and other breeds for tenderness or beef flavor intensity; however, Angus and Red Angus LM steaks were more juicy than from Gelbvieh and Charolais at adjusted age and carcass weight (Wheeler et al., 2005). For cycle VIII, Angus was rated more tender, juicy, and greater in beef flavor intensity than all other breeds when adjusted to constant marbling and fat trim, except Hereford (Wheeler et al., 2010).

Other studies have evaluated beef palatability from Angus and other breeds as well and reported differences between breeds. Tatum et al. (1990) demonstrated that Red Angus rated higher in tenderness and flavor intensity than Gelbvieh steaks from the LM (Tatum et al., 1990). Additionally, Red Angus were shown to have greater flavor scores than that of Simmental LM steaks (Laborde et al., 2001). When Angus, Charolais, and Holstein cattle were evaluated by a trained sensory panel, it was reported that LL steaks from the Angus breed were juicier and higher in beef flavor than steaks from the other breeds (Sinclair et al., 2001). Also, Angus LM steaks were more juicy and tender than Brahman LM steaks (Adams et al., 1982). No differences in flavor for Angus and all other breeds evaluated was reported (Adams et al., 1982). The assessment of British (Angus and Hereford) and Dairy (Holstein and Jersey) carcasses for sensory traits showed no differences for tenderness, juiciness, or flavor between Angus and Dairy breeds (Ramsey et al., 1963).

Conversely, some studies have reported no differences in palatability traits at all for many breeds of cattle. When Angus, Limousin, Charolais, and Simmental breeds were compared at the same intramuscular fat level, a trained sensory panel reported that all breeds were similar in flavor; however, Angus was the least juicy but had greater tenderness than Simmental (Chambaz

et al., 2003). Consumers also reported no differences in tenderness, juiciness, flavor, or overall satisfaction when sampling Angus LL steaks compared to breeds from English, Continental/European cross, or Brahman cross cattle (McKenna et al., 2004). Again, differences were not detected by a trained panel when assessing the flavor and tenderness of LM steaks from Angus, Brahman, or Angus-Brahman crosses (McKeith et al., 1985). Also, Angus has been reported to be more juicy than Simmental cattle (Cross et al., 1984).

Blind and Informed Testing

Branding can play a large role in the perception of eating quality of products. This has been demonstrated by multiple studies that compare results of testing products blind and then under informed conditions. Using the same products and consumers for both testing procedures allows the two to be compared against one another in order to determine how much of an effect the brand has on perceived ratings of the products. These studies have been done throughout the world with a wide variety of products. Some products have more effect of brand than others with some having no effect at all; however, this changes from product to product.

A classic study was conducted by Allison and Uhl (1964) and showed the relationship of brand identification on beer drinkers. Regular consumers of beer were asked to try 6 bottled beers with no identification on them and blindly rate them for overall liking on a hedonic scale for the first round of testing (Allison and Uhl, 1964). During this testing, no differences were reported between the 6 products tested; however, consumers were then asked to rate the same beer tested blind, with all branding information known (Allison and Uhl, 1964). The results of the informed testing had increased results for overall liking by 6% to 21% compared to the blind testing for all brands (Allison and Uhl, 1964). Results such as these from very early studies

suggest that branding is an effective way to increase the liking of products without having to make any alterations to the original product itself.

These branding effects have been observed with other products as well, including spaghetti noodles, oral nutrient supplements, yogurt, chocolate hazelnut spreads, Chinese noodle broth, and multiple fast food products (Skipper et al., 1999; Di Monaco et al., 2004; Robinson et al., 2007; Paasovaara et al., 2012; Kim et al., 2015; Spinelli et al., 2015). When consumers were asked liking of spaghetti noodles before information about packaging was given, few differences were demonstrated between products, with 3 products scoring lower than all others (Di Monaco et al., 2004). When brand was given, the most well recognized brand, Barilla, increased liking scores by 15% as well as another brand (Voiello) by 20% that had high expected liking scores given (Di Monaco et al., 2004). Branding information increased geriatric patients acceptance of nutritional supplements with changes as high as 30% compared to blind sampling (Skipper et al., 1999). Along with the elderly, children have been noted to prefer the samples with brands compared to the same unbranded sample (Robinson et al., 2007). When children aged 3 - 5 were asked what sample they preferred, they chose the sample that they knew was McDonald's over samples of the same food that was unbranded (Robinson et al., 2007). Of six hazelnut spreads tested, consumers rated two of the most well- known brands greater for liking scores by 7% when informed of brand (Spinelli et al., 2015). Also, when six noodle broths were compared blind and with packaging information, consumers liked the two of the same brands best when tested in both situations and one brand increased overall liking by 7% under informed conditions (Kim et al., 2015). Additionally, Fornerino and d'Hauteville (2010) reported that brand was more important for some orange juice brands than taste was, finding correlations as high as 0.50

between liking and brand effect. It is clear that no one age group nor product can be affected by packaging, but all types of consumers and products are influenced by brand packaging.

Branding doesn't always improve consumers' liking of products. Many studies have shown decreased liking of products when brand is known, compared to when tested blind. Mueller and Szolnoki (2010) tested the liking of wine when blind and when bottle information was presented to consumers. Consumers reported higher overall liking scores by 5% to 10% for every wine tested during blind examination compared to when they were given the bottle information while sampling (Mueller and Szolnoki, 2010). Additionally, in the spaghetti noodle study, one brand had decreased liking scores by 15% when brand name was informed (Di Monaco et al., 2004). Also, brands are not always negatively or positively affected. A study by Della Lucia et al. (2014) examined acceptance of eight different commercial brands of Pilsen beer. The results of this study showed the complex relationship of branding on consumer acceptance because negative, positive, and no influence was demonstrated for different products (Della Lucia et al., 2014). Four of the brands used had negative influences on acceptance when consumers were aware of the brand, but three of the beers had increases in acceptance when brand was given while sampling (Della Lucia et al., 2014).

Similar responses for blind and informed studies have been shown when consumers were asked to rate products. In Szőke et al. (2012) 5 different products (frozen sweet corn, fresh champignon, hazelnut chocolate bar, non-carbonated bottled water, and Sedum species) were evaluated under blind and informed testing scenarios. No differences was demonstrated among four of the five products during the testing; however, a chocolate hazelnut bar had three traits affected by informing consumers of the brand (Szőke et al., 2012). The same was demonstrated for orange juice brands, when carton was presented along with the sample, where no changes for

6 of the 7 products were reported and all products were similar for overall liking (Kim and Lee, 2015). When 10 samples of low calorie biscuits were sampled under blind conditions and then sampled with packaging information, no changes in overall acceptance were reported for any products (Carrillo et al., 2012). Additionally, when consumers from Spain sampled US beef (CAB specifications) blind, and under informed conditions (feeding, muscle fat content, and geographical locations) no change was demonstrated in the aroma, tenderness, flavor, or general acceptability (Beriain et al., 2009). Juiciness, however, did receive a small increase of 2% when sampled under informed conditions (Beriain et al., 2009)

Purchasing motivation has also been studied under blind and informed testing conditions. When purchasing intention was asked to participants during testing, consumers showed increased purchasing intent for national branded hazelnut spreads when compared to private label brands when tested in informed situation. However, blind testing revealed no difference in purchasing intent (Rossi et al., 2015). When brands were considered similar or during informed and blind testing, no difference was demonstrated in purchasing motivators (Kim et al., 2015). This increase in purchase intent was also demonstrated in beef steaks where the highest rated steak that was grass-fed and not imported had the highest future purchase intent (Banović et al., 2009). The study by Banović et al. (2009) showed that the steak with the highest experienced quality was the steak that was greatest for purchase intent indicating that future purchasing intent was highly influenced by experienced eating quality. The brand highest rated was also the most well-known brand which could have influenced the expected and experienced eating quality (Banović et al., 2009). Knowledge of branding and labeling also play a large role in the palatability perception of chicken meat (Samant and Seo, 2016). When consumers were split into two groups with half of consumers having knowledge of sustainability labels and the other half having no

knowledge of label claims, differences were seen for sensory aspects (Samant and Seo, 2016). Consumers with knowledge of the label claims found differences in overall liking and tenderness for the chicken products while consumers with no knowledge of label claims found no differences (Samant and Seo, 2016). Additionally, unique to this study, the products tested were all the same with only the label claims being different for products (Samant and Seo, 2016).

Branding can affect the palatability characteristics of food products in positive ways, negative ways, or not at all. This is due to the familiarity with the brand as well as the expected quality associated with the brand being evaluated. Consumers may like a brand more when it is well recognized and this can influence their eating experience when testing under informed settings. It is important to discover how products test under blind circumstances without the influence of packaging to understand how consumers view products and their sensory characteristics without outside information. However, research needs to identify not only what cues consumers look for in products with branding but how those cues and brands influence their perceived quality when eating food and other products. Blind and informed testing gives clear insight into how branding can influence the eating characteristics and quality of many different foods and items and shows the affect outside information has on palatability characteristics.

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Chapter 2 - Determination of the effect of branding on consumer palatability ratings of beef strip loin steaks

Abstract

The objective of this study was to determine the influence of knowing the brand or USDA grade on consumer palatability ratings of beef strip loin steaks. Strip loins were selected to represent five brands - USDA Select, Choice, Prime, Certified Angus Beef (**CAB**; upper 2/3 Choice), and Select from phenotypical Angus cattle. After 21 d of aging, 2.5 cm thick steaks were cut, pairing consecutively cut steaks for consumer evaluation. Consumer panelists (n = 112) evaluated samples for tenderness, juiciness, flavor liking, and overall liking. Additionally, consumers rated each palatability trait as either acceptable or unacceptable and rated the sample as either unsatisfactory, everyday quality, better than everyday quality, or premium quality. Samples were fed in two rounds – blind and informed testing. In the first round, blind testing, consumers were served one sample from each treatment, with no product information. In the second round, consumers were informed of the brand or USDA grade prior to sampling. During blind testing, CAB rated similar ($P > 0.05$) to Choice for all palatability traits; however CAB rated greater ($P < 0.05$) than Choice for all traits for informed testing. Additionally, Angus Select and Select were rated similar ($P > 0.05$) for all traits when tested blind, but Angus Select was rated greater ($P < 0.05$) than Select for flavor and overall liking when treatment was informed. Prime, CAB, and Angus Select had increased ($P < 0.05$) ratings for flavor and overall liking due to brand disclosure. However, Choice and Select samples did not receive any increase ($P > 0.05$) in ratings for palatability traits when brand was informed. Treatment knowledge increased ($P < 0.05$) the percentage of Prime samples rated acceptable for flavor and the percentage of Angus Select samples rated acceptable for flavor and overall liking. Conversely, there was no difference

($P > 0.05$) in the percentage of Choice and Select samples rated as acceptable for all palatability traits. Multiple traits were rated greater for Prime, CAB, and Angus Select products indicating these products received a "brand lift" in palatability due to brand identification. However, when brand information was disclosed for Choice and Select steaks, consumers indicated no increase in palatability perception.

Keywords: angus, beef, branding, consumer, marbling, palatability

Introduction

In consumers' eyes, not all beef is considered equal. In addition to USDA quality grades, 107 branded beef programs are utilized for marketing of beef (USDA, 2016). This large number of product categories allows consumers to have choices in the meat they purchase. Blind testing of beef where consumers are not provided product information prior to testing, has been used to measure palatability of meat samples for decades.

While important to evaluate palatability characteristics of beef through blind testing, consumers do not select, purchase, and consume beef without product information. Evidence suggests that branding and product labeling has an influence on consumers' decisions before having firsthand experience of the product (Levin and Gaeth, 1988).

Perceived quality of products by consumers has been shown to be affected by branding strategies (Dodds et al., 1991) because consumers form quality expectations by utilizing past experiences and information presented at the time of purchase (Steenkamp, 1990). Additionally, consumers perceive beer, hazelnut cocoa spreads, and low-calorie biscuits differently when brand information is known (Allison and Uhl, 1964; Della Lucia et al., 2014; Spinelli et al., 2015).

It has been shown that blind palatability ratings of steaks increase as marbling increases (Smith et al., 1985; O'Quinn et al., 2012; Emerson et al., 2014; Corbin et al., 2015). Additionally, numerous studies have evaluated the economic impact of branding and consumers' willingness to pay for branded beef products (Wachenheim et al., 2000; Froehlich et al., 2009; Morales et al., 2013); however, no research has focused on the effect of branding on consumer perception of beef eating quality. Therefore, our objective was to determine how consumer palatability ratings of beef strip loin steaks are affected when products are identified with a brand or USDA grade.

Materials and Methods

Steak Treatments and Preparation

Beef strip loins (IMPS #180, NAMP, 2010) were selected to equally represent (n = 40; 8 / treatment) five brands - USDA Select, Choice (lower 1/3 Choice), Prime, Certified Angus Beef (**CAB**; upper 2/3 Choice), and Select from phenotypical Angus cattle (Angus Select). The Angus Select product was selected based on the phenotypical Angus characteristics (51% black hided, no apparent dairy or *bos indicus* influence), while the Select product was selected from carcasses with no apparent dairy or *bos indicus* influence that were not identified as phenotypical Angus (51% black hided). Also, all included carcasses were selected based on ribeye area (25.4 – 40.6 cm^2), fat thickness (< 2.54 cm), and hot carcass weight (< 477 kg). Product was selected by trained Kansas State University (**KSU**) personnel from a commercial beef processor in Nebraska, USA. Upon selection, the research team recorded USDA marbling score, carcass, lean, and skeletal maturity, ribeye area, fat thickness, hot carcass weight, and the percentage of kidney, pelvic, and heart fat (Table 2.1). Strip loins were vacuum-packaged and transported, under

refrigeration (2 °C) to the KSU Meat Laboratory, in Manhattan, Kansas, where they were aged at 0 – 4 °C for 21 days prior to steak fabrication.

After 21 d of wet aging in vacuum bags, strip loins had external fat trimmed and were fabricated into 2.5 cm thick steaks. The most anterior "wedge" steak was cut and used for color and pH analysis. Wedge steaks were placed on trays with the fresh cut surface exposed, covered from light with butcher paper and allowed to bloom for 15 min. After blooming, L*, a*, and b* were measured three times on each steak using a Hunter Lab Miniscan EZ spectrophotometer (Illuminant A, 2.54-cm diameter aperture, 10° observer; Hunter Associates Laboratory, Reston, VA) and the three readings were averaged for each steak. Steak pH was measured using a pH meter (model HI 99163; Hanna Instruments, Smithfield, RI) immediately following color measurement. Following color and pH measurement, wedge steaks were frozen for proximate analysis.

After wedge steak removal, steaks were fabricated from anterior to posterior and designated to Warner-Bratzler Shear Force (steaks 1 and 8), or paired for consumer blind and informed sampling (steaks 2 and 3; steaks 9 and 10). Following fabrication, steaks were weighed, individually vacuum-packaged, and frozen (-20 °C) until subsequent analysis.

Consumer Panel Testing

Consumer testing was conducted at the KSU Animal Science building in Manhattan, Kansas. Consumer panelists (n = 112) were recruited from Manhattan, KS and the surrounding communities and were paid to participate in the study. Panelists were only allowed to participate one time. Consumer sampling was conducted in a large room, under fluorescent lighting. Five panel sessions were conducted with 21 consumers and one panel session of 7 consumers. Each panel lasted approximately 1.5 h.

Steaks were thawed at 2 – 4 °C for 24 h prior to consumer testing. Prior to cooking, thawed steaks were weighed for determination of thaw loss. Steaks were then cooked to a medium (71 °C) degree of doneness at 163 °C in a convection oven (DFG-100-3 Series, GS Blodgett Co., Inc. Burlington, VT) with cooked temperature monitored, using thermocouples attached to a Doric Mini-trend Data Logger (Model 205 B-1-c OFT, Doric Scientific, San Diego, CA), and verified by probe thermometers (Model 450-ATT, Omega Engineering, Stamford, CT). After cooking and weighing for cook loss determination, steaks were cut into 1.3 cm^2 × steak thickness cubes and two cubes were immediately served to 7 predetermined consumers.

Consumers were provided utensils, an expectorant cup, ballot, and palate cleansers to use between samples (unsalted crackers and apple juice). Prior to the start of each panel session, panelists were given verbal instructions explaining the ballot, testing procedures, and use of palate cleansers. The ballot included a brief demographic questionnaire used to characterize gender, household size, income level, education level, ethnicity, and beef consumption habits. Additionally, consumers were asked to complete a beef brand awareness questionnaire, identifying knowledge of brands and their perceived quality level associated with known brands. Also, a beef purchasing motivator questionnaire was presented prior to sample evaluation that asked consumers to rate the importance of multiple fresh beef steak purchasing motivators.

Serving of samples was conducted in two rounds. In the first round, consumers were served one sample from each treatment, in a random order, blind (ie: panelists were only informed that all samples evaluated were beef steaks). Each sample was evaluated for tenderness, juiciness, flavor, and overall liking on 100 mm line scales anchored at both ends with descriptive terms: 100 = extremely juicy, tender, and like extremely; 50 = neither tough nor tender, juicy and neither dislike or like; 0 = extremely tough, dry, and dislike extremely.

Additionally, scales were verbally-anchored midway with a neutral point. Moreover, consumers rated each palatability trait as either acceptable or unacceptable and classified the sample as unsatisfactory, everyday quality, better than everyday, or premium quality.

Following completion of the first round, all ballots were collected and consumers received a new ballot for evaluation of samples during the second round of testing. Testing procedures for round two were identical to round one; however, prior to the serving of each sample, consumers were given a description of the product to be tested. Consumers were informed of the brand of the product (Select, Choice, Prime, CAB, or Angus Select) prior to evaluation of each sample with the label of brand, including the CAB logo when tested, on the ballot sheet (Table 2.2). Additionally, the brand to be evaluated was presented to consumers in front of the room on a projection screen. Samples evaluated in round two were paired with samples from round one, allowing for a direct comparison of consumer ratings and evaluation of the effects of branding and grade identification on palatability perception.

Warner-Braztler Shear Force

Steaks for shear force testing were prepared and cooked as previously described for consumer testing. Following cooking, samples were allowed to temper (2 – 4 °C) overnight. For Warner-Braztler Shear Force (**WBSF**) testing, six 1.27-cm diameter core samples were removed from each steak parallel to the muscle fiber orientation. Each core was sheared (crosshead speed of 250 mm/min) once through the center, perpendicular to the muscle fibers, using an INSTRON Model 5569 testing machine (Instron, Canton, MA). Shear force values were recorded in kg and the shear force values of the six cores were averaged for each steak.

Proximate Analysis

Frozen steaks for proximate analysis were thawed for 24 h at 2 – 4 °C. All exterior fat was removed leaving only the longissimus muscle for analysis. Each sample was frozen in liquid nitrogen and homogenized using a commercial 4-blade blender (Model 33BL 79, Waring Products, New Hartford, CT) and then transferred to Whirl-Pac (Nasco, Ft. Atkinson, WI) bags and stored in a -20 °C freezer until subsequent analysis. Moisture content was determined by microwave radiation (**CEM**), SMART Trac™ Fat and Moisture Analyzer using the protocols described by AOAC Official Method [985.14 (A2)]. Crude protein was determined using a LECO TruMac N (St. Joseph, MI, USA) analyzer (AOAC, 2005). A modified Folch method was used for fat percentage analysis using methods described by Martin et al. (2013). Ash percentage was determined using a muffle furnace and following the methods of AOAC, 2005.

Statistical Analysis

Statistical analysis was conducted in SAS (Version 9.4; SAS Inst. Inc., Cary, NC) using PROC GLIMMIX with $\alpha = 0.05$. The model for carcass data and WBSF included the fixed effect of brand. Also, steak peak cooking temperature was included in the WBSF model as a covariate. For all consumer panel data, the model included the fixed effect of treatment and the random effect of panel session number. Additionally, all acceptability data were analyzed with a model that included a binomial error distribution. Demographic data was summarized using PROC FREQ and all Pearson correlation coefficients were calculated and tested using PROC CORR. Moreover, the Kenward-Roger approximation was used for estimating denominator degrees of freedom for all consumer panel, carcass, and proximate data analyses.

Results

Carcass Data Results

Carcasses used for this study had no differences ($P > 0.05$) in lean, skeletal, or overall maturity, with carcasses all being "A" maturity (Table 2.1). Marbling score increased ($P < 0.05$) with increasing quality grades, with both Select and Angus Select being similar ($P > 0.05$). Ribeye area of carcasses grading Angus Select were greater ($P < 0.05$) than CAB and Choice; but similar ($P > 0.05$) in size compared to Select and Prime. Few differences were found in fat thickness between treatments; however, Angus Select had less ($P < 0.05$) fat thickness compared to Prime and CAB carcasses. No differences ($P > 0.05$) were observed among quality grades for hot carcass weight or the percentage of kidney, pelvic, and heart fat. Prime and CAB carcasses had higher ($P < 0.05$) yield grades compared to Choice, Select and Angus Select carcasses.

Color, Proximate, Moisture Losses and Warner-Bratzler Shear Force Measurements

Color, pH, proximate, moisture losses, and WBSF data are shown in Table 2.3. For color readings, a* and b* values were not different ($P > 0.05$) among treatments. However, L* readings for Prime were the greatest ($P < 0.05$), indicating Prime samples were lighter in color than all other treatments. Choice, CAB, and Select samples were similar ($P > 0.05$) for L* value. No differences ($P > 0.05$) among treatments for pH were observed.

Proximate data indicated no difference ($P > 0.05$) among quality treatments for protein and ash percentages; however, differences ($P < 0.05$) were found among treatments for fat and moisture percentage. As quality grade decreased from Prime to Select, moisture percentage increased by 5.6%. Additionally, Choice, Select, and Angus Select treatments were similar ($P > 0.05$) for both moisture and fat percentage. Prime had the greatest ($P < 0.05$) amount of fat at

8.9%, followed by CAB at 5.4%. Choice samples had, on average, 0.8 - 1.0% more fat than Angus Select and Select samples, respectively; however, were found to be similar ($P > 0.05$) to these treatments for fat percentage.

Analysis of WBSF indicated Prime samples were the most tender ($P < 0.05$). Additionally, Choice, Select, and CAB treatments were similar ($P > 0.05$) for WBSF, with Angus Select samples found to be tougher ($P < 0.05$) than all treatments, other than Select.

Cooking and total loss percentages were similar ($P > 0.05$) for all treatments with the exception of Prime, which had a lower ($P < 0.05$) cooking and total loss percentage than Select, Angus Select, and Choice steaks (Table 2.3). For thawing loss, Select was greater ($P < 0.05$) than all treatments, other than Angus Select, with Prime, CAB, and Choice having a similar ($P > 0.05$) percentage of thawing loss.

Demographic, Brand Awareness, and Purchasing Motivators

The demographic profile of consumer panelists who participated in the study is presented in Table 2.4. Approximately 57.8% of consumer panelists were female and 42.2% male. Panelist's age spanned from under 20 years old to over 60 years old with a majority (60.0%) within an age of 20-49 years old. A large percentage of consumers who participated in the panels were married (67.0%) and Caucasian/White (72.5%). The majority of consumers (> 75%) had an annual household income of at least $50,000, and over half of participants (> 60%) were also at least a college graduate, with 28.6% of consumers having completed post graduate education. Nearly half (47.8%) of consumers consumed beef 1 to 3 times a week and 63.1% considered beef the meat with the most preferred flavor. Flavor was the most important palatability trait when eating steaks for 49.6% of consumers, with tenderness the most important trait for 40.5%, and juiciness most important for 9.9% of consumers.

Consumers were asked to rate the importance of 15 different fresh beef steak purchasing motivators on a scale from extremely unimportant to extremely important (Table 2.5). According to consumer panelists, the most important ($P < 0.05$) traits when purchasing beef included "price", "steak color", and "size, weight, and thickness". Additionally, "USDA grade" and "marbling" were rated more ($P < 0.05$) important than "animal welfare", "nutrient content", "local", "eating satisfaction claims", and "country of origin". But, the claims of "animal welfare", "nutrient content", "local", "eating satisfaction claims", and "country of origin" were rated more ($P < 0.05$) important than "natural and organic claims" and "brand of product".

When asked to identify and rate the perceived quality of 9 beef brands or grades, four of the brands (Select, Choice, Prime, and CAB) had close to 80% or more of consumers indicate they had knowledge of the brand, each with a higher ($P < 0.05$) percentage than all other brands included in the survey (Table 2.6). Also, less than 10% of consumers indicated knowledge of the brands Black Canyon Angus Beef, Creekstone Farms, and Angus Pride. Interestingly, 25.9% of consumers stated knowledge of the brand "Angus Select", a fictional generic brand that was created for the current study. Moreover, consumers rated this brand similar ($P > 0.05$) in quality level to that of CAB. Also, consumers rated Choice and Select among the lowest for perceived quality level. Many of the Angus brands were perceived to have a high quality associated with them, with all brands containing "Angus" rating greater than 6.9 out of 10. Additionally, mean perceived quality of brands and grades spanned from 6.4 to 8.5 out of 10, indicating consumers considered all of these brands and USDA grades to be better than average quality.

Consumer Palatability Ratings of Beef Strip Loins Steaks

Consumer palatability ratings of strip loin samples are found in Table 2.7. During blind testing, Prime rated higher ($P < 0.05$) for tenderness compared to all other treatments, except

CAB. Prime was also rated greatest ($P < 0.05$) for juiciness by consumers in blind sampling. Tenderness and juiciness of CAB, Choice, Select, and Angus Select were all rated similar ($P > 0.05$) by consumers in blind testing. For flavor liking, Prime and CAB rated similar ($P > 0.05$) and greater ($P < 0.05$) than Select. Ratings for overall liking followed a similar pattern to flavor liking, with Prime rating greater ($P < 0.05$) than other treatments and similar ($P > 0.05$) to only CAB. Consumers rated the overall liking of CAB similar ($P > 0.05$) to Choice but greater ($P < 0.05$) than the two Select treatments. Angus Select strip loin steaks were rated similar ($P > 0.05$) to Select for all palatability traits during blind testing.

When brands of the treatments were disclosed prior to consumer testing, palatability scores were affected (Table 2.7). Prime rated greatest ($P < 0.05$) for juiciness and overall liking, with only CAB rating similar ($P > 0.05$) to Prime for tenderness and flavor liking. Also, CAB rated greater ($P < 0.05$) than all other treatments, other than Prime, for tenderness, flavor liking, and overall liking. Additionally, CAB samples were rated higher ($P < 0.05$) than both Choice and Select samples for all palatability traits. Angus Select samples rated similar ($P > 0.05$) to CAB for juiciness and greater ($P < 0.05$) than both Choice and Select for flavor liking. During informed testing, Angus Select was rated higher ($P < 0.05$) than Select samples for both flavor liking and overall liking, both of which were similar ($P > 0.05$) for the two treatments during blind evaluation.

Table 2.8 shows the percentage change in consumer ratings of palatability traits as a result of brand disclosure prior to testing. Angus Select samples had an increase ($P < 0.05$) of 16.5% for flavor liking scores, while CAB and Prime also had increased ($P < 0.05$) flavor liking ratings of 14.6% and 14.7%, respectively. Moreover, juiciness scores increased ($P < 0.05$) for CAB (13.6%) and Angus Select (15.2%) steaks due to brand disclosure. Overall liking increased

($P < 0.05$) for CAB, Prime, and Angus Select samples by 9.8%, 12.4%, and 12.9%, respectively. Although Prime, CAB, and Angus Select steaks received increases when brand was informed, Choice and Select samples did not follow the same trend. The observed changes in palatability scores for both Choice and Select steaks were not significantly different ($P > 0.05$) from 0 for all palatability traits. Although change in tenderness for treatments were not different ($P > 0.05$) from 0, Prime and CAB had greater ($P < 0.05$) increases compared to Select and Choice with Angus Select rating similar ($P > 0.05$) to all treatments. Additionally, the observed change for overall liking was lower ($P < 0.05$) for Choice than all other treatments other than Select.

Consumer Acceptance of Sensory Traits

The percentage of samples rated acceptable for each palatability trait for blind testing is presented in Table 2.9. The percentage of samples rated acceptable for tenderness was lower ($P < 0.05$) for Angus Select than all treatments other than Select when steaks were sampled blind. Additionally, Prime had the highest ($P < 0.05$) percentage of samples rated acceptable for juiciness (92.7%) compared to all other treatments during blind testing. All treatments other than Prime had a similar ($P > 0.05$) percentage of samples rated acceptable for juiciness. Also, Prime and CAB had a similar ($P > 0.05$) percentage of samples rated as acceptable for tenderness, flavor, and overall liking with more than 87% of samples rated acceptable for both treatments for each of these traits when consumers sampled these steaks blind. No difference ($P > 0.05$) was found among Choice, Select, and Angus Select treatments for the percentage of samples rated acceptable for juiciness, overall liking, or flavor. Moreover, overall liking was only rated acceptable for 70.5% of Angus Select samples and 72.4% of the samples from Select steaks; indicating that these treatments failed to meet consumer eating expectations overall approximately 30% of the time in blind testing when grade was not informed.

When consumers were informed of the brand or grade of each treatment, a similar ($P > 0.05$) percentage of samples were considered acceptable for tenderness for Prime, CAB, and Choice, whereas only CAB samples were similar to Prime in blind testing. A higher ($P < 0.05$) percentage of CAB samples were considered acceptable for juiciness compared to all other treatments other than Prime. Conversely, in blind-testing, a similar ($P > 0.05$) percentage of CAB samples were rated acceptable for juiciness as Choice, Select, and Angus Select. Prime had the greatest ($P < 0.05$) percentage of samples rated acceptable for overall liking when brand was disclosed, whereas during blind testing, CAB had a similar ($P > 0.05$) percentage.

Results for the percentage change in acceptability of each palatability trait for consumer ratings are presented in Table 2.10. No differences ($P > 0.05$) were found for CAB, Choice, or Select samples for the change in the percentage of samples rated acceptable for all palatability traits by consumers. Also, there was no ($P > 0.05$) change in the percentage of samples rated acceptable for tenderness or juiciness for any of the treatments. However, the percentage of samples rated acceptable for flavor increased ($P < 0.05$) 10.9% for Prime samples and 14.4% for Angus Select samples. Additionally, consumers considered 9.9% more ($P < 0.05$) Angus Select samples acceptable for overall liking when the brand was disclosed. While Prime and CAB received few increases for percentage of samples rated as acceptable for each trait, these two treatments had a high percentage (> 80%) of samples rating acceptable during blind testing. Due to the high percentage of samples rating acceptable during blind testing, there was only a small increase that these two treatments could receive due to brand disclosure.

Perceived Quality of Strip Loin Steaks

Consumer perceived quality levels for each treatment during blind testing are reported in Table 2.11. Fewer ($P < 0.05$) CAB and Prime samples were rated as “unsatisfactory” quality

compared to Choice, Select, and Angus Select treatments which were all rated similar ($P > 0.05$) during blind testing. Additionally, during blind sampling, fewer ($P < 0.05$) Prime samples were rated as "everyday" quality by consumers than CAB and Select samples. Also, more ($P > 0.05$) Prime samples were rated as "better than everyday" compared to all other treatments except Choice when tested bind. Moreover, Select had the fewest ($P < 0.05$) samples rated as "premium" quality compared to all other treatments.

When consumers were informed of the treatment prior to testing, differences in perceived quality were observed for many treatments (Table 2.11). When brand or grade was disclosed, no Prime samples were classified as "unsatisfactory" quality; however, there was no difference ($P > 0.05$) between treatments for the amount of samples considered "unsatisfactory". During blind testing Prime, CAB, and Angus Select all had a similar ($P > 0.05$) amount of samples rated as "everyday" quality compared to Choice. Conversely, during informed testing, the amount of samples considered "everyday" quality were similar ($P > 0.05$) for Prime, CAB, and Angus Select and lower ($P < 0.05$) than both Choice and Select. Moreover, there was no difference ($P > 0.05$) in the amount of samples classified as "better than everyday" quality during informed testing for any of the treatments. Additionally, when brand or grade was disclosed, Prime had the greatest ($P < 0.05$) amount of samples considered "premium" quality when during blind testing, all treatments except Select had a similar ($P > 0.05$) amount of samples classified as "premium quality".

The change in the percentage of samples classified into perceived eating quality levels is presented in Table 2.12. For "unsatisfactory" quality the only treatment that changed in ratings was Angus Select, which had 7.1% fewer ($P < 0.05$) samples considered "unsatisfactory" during informed testing. There were 13.5%, 19.6%, and 12.5% fewer ($P < 0.05$) samples classified as

"everyday" quality for Prime, CAB, and Angus Select by consumers when brand and grade were disclosed. Conversely, Choice had 14.3% more ($P < 0.05$) samples rated as "everyday" quality when consumers were informed of the grade. Few differences were found among treatments for "better than everyday" quality during disclosed testing; however, 15.2% more ($P < 0.05$) CAB samples were considered "better than everyday" quality when consumers were aware of the brand. Prime had 18.0% more ($P < 0.05$) samples considered the highest perceived quality level of "premium" when grade was disclosed. Also, Angus Select had a clear shift from lower quality perception to higher quality, with 19.6% fewer ($P < 0.05$) samples rated in the bottom two categories of "unsatisfactory" and "everyday" quality and 9.8% more ($P < 0.05$) rated as "premium" quality due to brand awareness. Also, Select had no significant ($P > 0.05$) change in perceived quality at any level. The greatest ($P < 0.05$) change for "everyday quality" was observed for the Choice samples when brand was informed, with all other treatments having similar ($P > 0.05$) changes. For "premium quality" Prime had a greater ($P < 0.05$) change compared to all treatments, besides Angus Select. Additionally, all treatments other than Prime had a similar ($P > 0.05$) change in the percentage of samples classified as "premium quality" when treatment was informed.

Relationship of Sensory Traits and Objective Measurements

Correlations among consumer sensory traits and objective measurements are presented in Table 2.13. Fat percentage was correlated ($P < 0.01$) during blind testing to tenderness (r = 0.40), juiciness (r = 0.43), flavor liking (r = 0.41), and overall liking (r = 0.47). During informed testing the correlations ($P < 0.01$) between fat and palatability traits increased to r = 0.52, 0.47, 0.50, and 0.56 for tenderness, juiciness, flavor liking, and overall liking respectively. Additionally, all sensory traits were correlated ($P < 0.05$) to moisture content in both blind and

informed testing with the highest correlation between moisture and overall liking (r = 0.44) during informed testing. During blind testing, thawing loss was not correlated to juiciness, but during informed testing juiciness was correlated ($P < 0.01$) to thawing loss (r = -0.38). Juiciness was not correlated ($P > 0.05$) to thawing loss and flavor liking was not correlated ($P > 0.05$) to cooking loss during blind testing. However, all sensory traits were correlated ($P < 0.05$) to moisture loss measurements (thawing, cooking, and total) during informed testing with cook and total loss having the strongest relationship with juiciness (r = 0.46, 0.49) among all objective measures. The L* values were correlated ($P < 0.05$) to juiciness (r = 0.25), flavor liking (r = 0.33), and overall liking (r = 0.36) during blind testing; however, L* was correlated ($P < 0.05$) to only tenderness (r = 0.26) and overall liking (r = 0.23) during informed testing. No traits had a relationship ($P > 0.05$) with pH, protein, or a* during blind or informed testing. Marbling was highly correlated ($P < 0.01$) to moisture (r = -0.77), fat (r = 0.88), and L* values (r = 0.58). Values for WBSF were also correlated ($P < 0.05$) to many traits including moisture (r = 0.38), fat (r = -0.48), and L* (r = -0.45).

Relationships Among Consumer Panel Traits

All correlations among palatability traits, as well as marbling and WBSF were significantly ($P < 0.01$) correlated during blind and informed testing (Table 2.14). Marbling was correlated ($P < 0.01$) to tenderness, juiciness, and flavor liking (r = 0.40 to 0.41) with overall liking having the highest correlation (r = 0.49) during bling testing. During informed testing, the relationship ($P < 0.01$) between marbling and sensory traits increased for tenderness (r = 0.59), juiciness (r = 0.51), flavor liking (r = 0.56), and overall liking (r = 0.62). Overall liking, during blind testing, was highly correlated ($P < 0.01$) to tenderness (r = 0.72) and juiciness (r = 0.75), and these correlations increased for tenderness (r = 0.86) and juiciness (r = 0.90) during informed

testing. Flavor liking and overall liking had the highest correlation ($P < 0.01$) in both blind and informed testing and was increased from r = 0.88 to r = 0.91 when consumers had knowledge of the brand or grade. There was a relationship ($P < 0.01$) between WBSF and tenderness (r = -0.47), juiciness (r = -0.37), flavor liking (r = -0.47), and overall liking (r = -0.50) during blind testing. Conversely to other traits, this relationship decreased for tenderness (r = -0.46), juiciness (r = -0.31), flavor liking (r = -0.36), and overall liking (r = -0.45) when tested informed. Marbling also had a relationship ($P < 0.01$) with WBSF values (r = -0.56).

Discussion

Proximate and Objective Measurements

Fat levels for the treatments used in this study were slightly lower than other studies who have determined proximate analysis of strip loin steaks of the same quality grades (Savell et al., 1986; O'Quinn et al., 2012; Emerson et al., 2013; Corbin et al., 2015; Legako et al., 2015). However, results from the current study are similar to the percentages reported by authors who have used a CEM analysis (Hoelscher et al., 1988; Dow et al., 2011; Dikeman et al., 2013). Moisture of the samples analyzed in the study were similar in percentage to that of many other authors who assessed strip loin steaks of various USDA quality grades (Savell et al., 1986; O'Quinn et al., 2012; Hunt et al., 2014; Legako et al., 2015). No difference was found for protein within the differing treatments for this study, similar to Legako et al. (2015) and Hunt et al. (2014); however, Corbin et al. (2015) demonstrated increased protein percentages as quality grade decreased from Prime to Select. However, the authors in that study used NIR to determine protein percentage compared to the CEM method analysis used in the current study.

Consumer Demographics, Purchasing Motivators and Perception of Brands

Demographics of consumers varied widely and were similar to that of other beef consumer studies (O'Quinn et al., 2012; Hunt et al., 2014; Corbin et al., 2015; O'Quinn et al., 2015; Woolley, 2014). Consumers rated the importance of purchasing motivators similar to Woolley (2014) where consumers considered "steak color", "price", and "size, weight, and thickness" among the most important traits considered when purchasing beef steaks. However, consumers in that study considered "USDA grade" to be as important as these traits, contrary to the current study. Consumers in both the current study and Woolley (2014) rated intrinsic cues (steak color, size, weight and thickness, USDA grade, and marbling level) about beef greater than that of animal production and product claims. This indicates the value of visual appearance and steak quality to beef purchasers as compared to the claims presented with products. The current study, as well as others that have demonstrated importance of intrinsic and visual cues of products to consumers (Steenkamp and vanTrijp, 1996; Wachenheim et al., 2000; Robbins et al., 2003; Grunert et al., 2004; Reicks et al., 2011). This indicates consumers may choose products based primarily on their visual appearance.

When consumers were asked to indicate brand awareness, nearly a quarter recognized the fictional generic brand that was used exclusively for this study (Angus Select), while less than 10% of consumers recognized a brand native to Kansas (Creekstone Farms). Consumers also accurately identified higher quality grades such as Prime to be associated with a higher perceived quality over lower quality grades such as Select. Additionally the value of CAB was shown by consumers in the current study, who rated it among the highest perceived quality levels. Economically, CAB has shown its value as well, with consumers willing to pay premiums in order to trade a generic steak for that of a CAB steak (Feldkamp et al., 2005). Consumers in the

current study also associated the brands containing the word "Angus" to be high quality products. Over the past four years, the number of brands containing specifications for "Angus" cattle has increased by 34% and 2/3 of the certified branded beef programs monitored by USDA have contained an "Angus" specification since 2013 (USDA, 2016). With the increasing number of brands utilizing the "Angus" breed as a marketing claim, it is clear consumers demand "Angus" products and consider them to be high quality, similar to the consumers in this study.

Consumer Palatability Ratings

Consumers in the current study rated steaks in blind testing similar to other studies that have evaluated beef strip loin steaks from multiple USDA quality grades and have reported increased palatability with increased marbling levels (Dikeman, 1987; O'Quinn et al., 2012; Corbin et al., 2015). However, many consumer studies have not found statistical differences between each subsequent increase in marbling level, similar to the current study (McKenna et al., 2004; Powell et al., 2011; Legako et al., 2015; Woolley, 2014). Many changes were seen for the two branded products due to brand disclosure. During blind testing, CAB rated similar to Choice in many sensory traits. However, when brand was disclosed to consumers, CAB rated similar to Prime and greater than Choice. Interestingly, consumers considered Angus Select samples greater in flavor, juiciness, and overall liking when the brand was known even though there was no difference for fat level between Angus Select, Select, and Choice. Using the most generic form of an Angus brand, ratings increased closer to that of CAB and Prime when brand was informed, while Select and Choice steaks rated lower, similar to the perceived quality levels shown in Table 2.6. Angus Select was considered to be more of a premium product compared to Select, as well as had increases in flavor liking when Select did not have this increase. Many authors have studied the Angus breed and reported Angus to have a similar flavor to other breeds

(Cross et al., 1976; Koch et al., 1979; Cross et al., 1984; Wheeler et al., 1996; Chambaz et al., 2003; Wheeler et al., 2004). Although, some authors have demonstrated a flavor related benefit to the Angus breed (Tatum et al., 1990; Laborde et al., 2001; Sinclair et al., 2001). The consumers in the current study, when aware of the brand, rated the Angus Select brand greater than Select, even though the differences between Angus Select and Select were minimal in blind testing. Additionally, consumers did not rate Choice or Select greater in any palatability traits due to brand disclosure, while Prime, CAB, and Angus Select received increased ratings in multiple palatability traits by consumers when brand or grade were disclosed.

In blind testing, consumers classified strip loin steaks into similar categories reported in previous studies (Woolley, 2014). However, when brand or grade was informed, consumer perception of quality level changed. Consumers shifted their perception of Prime, CAB, and Angus Select from "everyday" quality products and considered them more of "premium" and "better than everyday" quality products when informed of the brand. Feldkamp et al. (2005) also demonstrated a high quality perception of CAB by reporting that 75% of consumers were willing to exchange a generic steak for a CAB steak. On the contrary, consumers in the current study did not consider Choice and Select of a different perceived quality level when informed of the grade, with more than 65% of samples rating in the bottom two quality levels. This lack of increase in palatability trait scores and perception of quality for Select and Choice indicates consumers considered these products to be of no better quality when USDA grade information was given. This provides evidence that USDA grade-based marketing of these products, to consumers, has no palatability-related benefit or value. Conversely, increases were reported for CAB, Angus Select, and Prime treatments indicating benefits to these brands and USDA grades on consumer palatability and perception.

Blind and Informed Ratings of Products

Our results are similar to those for other products that have been tested blind and informed, demonstrating products that are associated with high quality, generally, will be given increased liking ratings during informed sampling. Consumer sensory ratings of CAB ground beef products increased up to 36% when tested under informed settings compared to that of blind ratings (Chapter 3). Additionally, a study was performed to determine the effect sustainability labeling has on the palatability of chicken breast meat. The chicken meat used was all from the same sample and different claims were presented with certain samples. This study demonstrated that consumers who had knowledge of sustainability label claims had increased ratings for overall liking and juiciness for the Organic labeled chicken (Samant and Seo, 2016). However, consumers who did not have knowledge of label claims reported no differences in palatability for products (Samant and Seo, 2016). Overall liking of beer was reported to increase by 6% to 21% when consumers were presented with the bottle information when sampling (Allison and Uhl, 1964). Other products have had increased acceptability by 30% when the brand of nutritional supplements was known before testing (Skipper et al., 1999). Additionally, well-known brands, with high expected liking scores have had increased overall liking by consumers by 7% to 20% compared to blind testing (Di Monaco et al., 2004; Kim et al., 2015; Spinelli et al., 2015). Similar to the current study, some products benefitted by consumers having information about the brand; however, some products do not receive this "brand lift" during informed testing. In one study, certain brands of pasta received increases in overall liking by 15-20% when informed, but other brands were demonstrated to have 15% lower overall liking compared to blind sampling (Di Monaco et al., 2004). Additionally, other authors have reported no benefits to informing the consumers of the brand of orange juice, low calorie biscuits, frozen sweet corn,

and hazelnut chocolate bars prior to testing (Carrillo et al., 2012; Szőke et al., 2012; Kim and Lee, 2015). The complexity of consumer perception of products is not only demonstrated in the current study, but with other products and by other authors as well. Additionally, knowledge of labels and brands plays a large role in consumer's sensory perception of products. Branding of products will always be a key differentiating strategy for products, but may not always include a palatability or economic value. A brand identifies a known set of attributes at a known quality level to consumers (Owen et al., 2000) and a brand may not always indicate high quality. In the current study, and others, consumers associated certain brands with increased quality during informed testing, while others were not perceived to be of better quality. This indicates that palatability-related benefits to branding are not seen for all brands, but only brands associated with a high quality product.

Relationship among Sensory Traits

Considering a majority (49.6%) of consumers reported flavor to be their most preferred trait in beef, it is fitting that flavor liking had the most treatments receiving a large (15%) "brand lift" in this study. Flavor liking, during blind testing, was correlated to all sensory traits with the highest correlation being between flavor liking and overall liking (r = 0.88). When brand was informed to consumers, these correlations between flavor liking and sensory traits, increased for tenderness (r = 0.57 to 0.73), juiciness (r = 0.54 to 0.78) and overall liking (r = 0.88 to 0.91). Others have documented the importance of flavor in the liking and acceptance of beef, finding higher correlations with flavor and overall liking (r = 0.83 to 0.87) than other sensory traits such as tenderness (r = 0.73 to 0.76) and juiciness (r = 0.78 to 0.79) with overall liking (Killinger et al., 2004; Hunt et al., 2014; Legako et al., 2015). This difference in relationship among

palatability traits and overall liking also indicates the emphasis consumers place on flavor during the eating experience.

Correlations in the current study for fat percentage were slightly higher than O'Quinn et al. (2012), Hunt et al. (2014), and Legako et al. (2015) who demonstrated tenderness (r = 0.22 to 0.35), juiciness (r = 0.29 to 0.37), flavor (r = 0.25 to 0.37), and overall liking (r = 0.28 to 0.42) to be correlated to fat percentage. Although there was a relationship of sensory traits to marbling and fat percentage in bind testing, a greater relationship was seen during informed testing. The relationship between overall liking and fat percentage was reported at r = 0.47 during blind testing and increased to r = 0.56 when consumers were informed of the brand. Additionally, marbling was correlated to all sensory traits during blind testing and all relationships increased due to brand disclosure with overall liking and marbling increasing from r = 0.49 during blind testing to r = 0.62 for informed testing. This indicates that consumers were aware that a higher marbled product is related to a better eating experience.

Though little variation in WBSF values were observed among the treatments used in the current study, many other factors can influence the acceptance of tenderness. Due to the greater percentage of samples being rated as acceptable for tenderness with increased marbling, other factors including juiciness may have an interaction in tenderness perception by consumers. Marbling was correlated to WBSF in this study at r = -0.56 demonstrating a relationship between marbling and instrumental tenderness. Others have demonstrated this relationship between marbling and WBSF values; however they have been reported from r = -0.14 to -0.72 (Breidenstein et al., 1968; Jennings et al., 1978; Emerson et al., 2013; Hunt et al., 2014). Also, all palatability traits in this study were correlated to WBSF during blind consumer testing; however, all sensory traits had lower correlations with WBSF when informed of the brand or

grade. Consumer tenderness ratings and WBSF had a decreased correlation from r = -0.47 to r = -0.46 due to informing consumers of brand and grade. Others have reported consumers tenderness and WBSF to be correlated between r = -0.19 to -0.72 (Breidenstein et al., 1968; Jost et al., 1983; Destefanis et al., 2008; Yancey et al., 2010; Powell et al., 2011; Hunt et al., 2014; Lorenzen et al., 2003). Additionally, consumer knowledge influenced the relationship of WBSF and palatability traits, decreasing the relationship between the two and indicating the importance of consumer perception in sampling products.

Conclusion

These results indicate brand knowledge has an effect on consumer perception of beef palatability traits. Multiple traits were rated higher for Prime, CAB, and Angus Select products indicating these products received a "brand lift" in palatability when identified with the brand. However, when brand information was disclosed for Choice and Select steaks, no increases were shown, indicating the perception of palatability for these products was not increased, and no "brand lift" can be captured when beef steaks are branded with these grades to consumers.

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Table 2.1 Carcass data for varying treatments of beef strip loin steaks used for consumer panels

Treatment	Lean Maturity[1]	Skeletal Maturity[1]	Overall Maturity[1]	Marbling Score[2]	Preliminary Fat Thickness, cm	Adjusted Fat Thickness, cm	Ribeye Area, cm^2	Hot Carcass Weight, kg	Kidney, Pelvic, Heart Fat, %	Yield Grade
Prime	159	173	166	776^{a}	1.6^{a}	1.7^{a}	85.9^{ab}	374.4	2.6	3.6^{a}
CAB[3]	168	175	173	583^{b}	1.3^{ab}	1.5^{ab}	83.6^{b}	384.0	2.7	3.6^{a}
Choice	165	158	160	448^{c}	1.0^{bc}	1.1^{bc}	83.4^{b}	336.5	2.5	2.8^{b}
Select	170	165	166	348^{d}	1.1^{bc}	1.3^{abc}	89.3^{ab}	354.4	2.7	2.9^{b}
Angus Select	170	168	168	355^{d}	0.8^{c}	1.0^{c}	92.6^{a}	389.8	2.6	2.7^{b}
SE[4]	3.2	5.8	3.8	12.6	0.1	0.2	2.4	14.2	0.2	0.2
P - value	0.09	0.26	0.27	< 0.01	0.01	0.03	0.04	0.07	1.00	0.01

[1]100 = A^{00}; 200 = B^{00}

[2]200 = Traces; 300 = Slight; 400 = Small; 500 = Modest; 600 = Moderate; 700 = Slightly Abundant; 800 = Moderately Abundant

[3]Certified Angus Beef

[4]SE (largest) of the least squares means.

[abcd]Least squares means in the same column without a common superscript differ ($P < 0.05$).

Table 2.2 Treatment brand logos presented to consumer panelists during informed testing of strip loin steaks

Treatment	Brand Logo[1]
Prime	
Certified Angus Beef	
Choice	
Select	
Angus Select	

[1]Logo presented to consumer panelists during informed testing on ballot.

Table 2.3 Warner-Bratzler shear force values, proximate composition, L*, a*, b*, pH, and objective losses for strip loin steaks of differing treatments

Treatment	Warner-Bratzler Shear Force, kg	Moisture, %	Protein, %	Fat, %	Ash, %	L*[1]	a*[2]	b*[3]	pH	Thawing Loss[4]	Cooking Loss[5]	Total Loss[6]
Prime	2.1[c]	66.7[c]	22.0	8.9[a]	1.3	49.5[a]	25.9	19.3	5.6	1.8[c]	20.2[b]	22.4[b]
CAB[7]	2.7[b]	69.7[b]	22.5	5.4[b]	1.4	43.7[bc]	27.4	19.2	5.7	2.0[c]	21.9[ab]	24.2[ab]
Choice	2.7[b]	71.2[a]	23.0	3.7[c]	1.4	44.4[b]	26.8	19.0	5.6	2.2[bc]	23.0[a]	25.9[a]
Select	3.0[ab]	72.2[a]	22.3	2.7[c]	1.4	44.1[b]	26.6	18.4	5.6	2.8[a]	23.2[a]	26.2[a]
Angus Select	3.1[a]	71.9[a]	22.5	2.9[c]	1.4	40.8[c]	26.0	17.5	5.8	2.5[ab]	23.4[a]	26.0[a]
SE[8]	0.1	0.5	0.4	0.4	0.1	1.2	0.5	0.6	0.1	0.1	0.7	0.8
P - value	< 0.01	< 0.01	0.34	< 0.01	0.54	< 0.01	0.26	0.24	0.39	< 0.01	< 0.01	< 0.01

[1]L* = lightness (0 = black and 100 = white).

[2]a* = redness (-60 = green and 60 = red).

[3]b* = blueness (-60 = blue and 60 = yellow).

[4]Thaw Loss: [(raw weight – thaw weight) / raw weight] * 100

[5]Cook Loss: [(thaw weight – cooked weight) / thaw weight] * 100

[6]Total Loss: [(raw weight – cooked weight) / raw weight] * 100

[7]Certified Angus Beef

[8]SE (largest) of the least squares means.

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 2.4 Demographic characteristics of consumers (n = 112) who participated in steak sensory panels

Characteristic	Response	Percentage of consumers
Sex	Male	42.2
	Female	57.8
Household size	1 person	9.9
	2 people	17.1
	3 people	16.2
	4 people	32.4
	5 people	8.1
	6 people	13.5
	Over 6 people	2.7
Marital Status	Single	33.0
	Married	67.0
Age Group	Under 20	9.0
	20-29	29.0
	30-39	18.2
	40-49	21.8
	50-59	18.2
	Over 60	3.6
Ethnic origin	African-American	15.6
	Caucasian/White	72.5
	Hispanic	10.0
	Native American	1.8
Annual household income, $	25,000 to 24,999	14.4
	35,000 to 49,999	8.1
	50,000 to 74,999	23.4
	75,000 to 100,000	27.9
	More than 100,000	26.1
Highest level of education completed	High school graduate	9.5
	Some college/technical school	27.6
	College graduate	34.3
	Post graduate	28.6
Weekly beef consumption	1 to 3 times	47.8
	4 to 6 times	46.9
	7 or more times	5.4
Most important palatability trait when eating beef	Flavor	49.6
	Juiciness	9.9
	Tenderness	40.5
Meat product most preferred for flavor	Beef	63.1
	Chicken	18.0
	Fish	5.4
	Lamb	0.9
	Pork	5.4
	Shellfish	3.6
	Turkey	0.0
	Veal	0.9
	Venison	2.7

Table 2.5 Fresh beef steak purchasing motivators of consumers (n = 112) who participated in consumer sensory panels

Characteristic	Importance of each trait[1]
Price	74.4[a]
Steak color	74.2[a]
Size, weight and thickness	71.3[a]
USDA Grade	63.9[b]
Marbling level	62.9[b]
Familiarity of cut	58.7[bc]
Eating satisfaction claims (ex. Guaranteed Tender)	54.2[cd]
Nutrient content	52.7[cd]
Country of origin	51.6[d]
Animal welfare	49.2[de]
Local	49.1[de]
Antibiotic use in the animal	47.8[def]
Growth promotant use in the animal	42.4[ef]
Natural and Organic claims	41.3[f]
Brand of product	41.0[f]
SE[2]	2.5
P - value	< 0.01

[1]Purchasing motivators: 0 = extremely unimportant, 100 = extremely important.

[2]SE (largest) of the least squares means.

[abcdef]Least squares means lacking a common superscript differ ($P < 0.05$).

Table 2.6 Brand knowledge and perceived brand quality level of consumers (n = 112) who participated in sensory panels

Brand	Consumers with knowledge of brand, %	Perceived quality level by consumers who recognized the brand[1]
Angus Pride	6.3[d]	7.9[abc]
Angus Select	25.9[c]	7.5[bc]
Black Canyon Angus Beef	9.8[d]	6.9[cd]
Certified Angus Beef	83.0[a]	8.1[ab]
Choice	86.5[a]	6.4[d]
Creekstone Farms	7.2[d]	7.1[bcd]
Prime	80.4[a]	8.5[a]
Private Selection	66.1[b]	7.07[cd]
Select	79.3[a]	6.7[cd]
SE[2]	0.4	0.6
P - value	< 0.01	< 0.01

[1]Perceived quality level: 1 = very low quality, 10 = very high quality.
[2]SE (largest) of the least squares means.
[abcd]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 2.7 Consumer (n = 112) palatability ratings[1] for blind and informed testing of strip loin steaks of various treatments

Treatment	Tenderness	Juiciness	Flavor Liking	Overall Liking
Blind Testing				
Prime	73.7[a]	68.7[a]	66.9[a]	69.4[a]
CAB[2]	66.2[ab]	58.2[b]	63.2[ab]	64.2[ab]
Choice	65.0[b]	58.1[b]	60.7[bc]	61.0[bc]
Select	62.1[b]	55.9[b]	55.2[c]	56.0[c]
Angus Select	58.7[b]	54.8[b]	57.0[bc]	56.8[c]
SE[3]	2.9	2.8	2.2	2.2
P - value	< 0.01	< 0.01	< 0.01	< 0.01
Informed Testing				
Prime	77.9[a]	73.7[a]	74.4[a]	76.3[a]
CAB[2]	70.0[a]	64.1[b]	71.2[a]	69.8[b]
Choice	60.3[b]	53.9[c]	59.9[c]	58.6[cd]
Select	55.9[b]	56.3[c]	59.3[c]	57.0[d]
Angus Select	59.4[b]	60.2[bc]	65.7[b]	63.0[c]
SE[3]	3.1	3.2	2.0	2.3
P - value	< 0.01	< 0.01	< 0.01	< 0.01

[1]Sensory scores: 0 = not tender/juicy, dislike flavor/overall extremely; 50 = neither tough nor tender, dry nor juicy, or neither like or dislike flavor/overall; 100 = very tender/juicy, like flavor/overall extremely.

[2]Certified Angus Beef

[3]SE (largest) of the least squares means.

[abcd]Least squares means in the same section (blind or informed) of the same column and lacking a common superscript differ ($P < 0.05$).

Table 2.8 Percentage change[1] in consumer (n = 112) ratings of palatability traits due to brand disclosure before evaluation

	%			
Treatment	Tenderness	Juiciness	Flavor Liking	Overall Liking
Prime	7.0[a]	8.6	14.7*	12.4[a]*
CAB[2]	6.9[a]	13.6*	14.6*	9.8[a]*
Choice	-5.6[b]	-5.2	0.5	-3.0[b]
Select	-9.0[b]	2.8	9.9	3.7[ab]
Angus Select	2.5[ab]	15.2*	16.5*	12.9[a]*
SE[3]	4.8	6.1	5.0	4.1
P - value	0.03	0.06	0.16	0.03

[1]Percentage change: (consumer informed scores – consumer blind scores) / consumer blind scores

[2]Certified Angus Beef

[3]SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

[ab]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 2.9 Percentage of beef strip steaks of treatments considered acceptable for tenderness, juiciness, flavor, and overall liking by consumers (n = 112)

Treatment	Tenderness Acceptability	Juiciness Acceptability	Flavor Acceptability	Overall Liking Acceptability
Blind Testing				
Prime	98.2[a]	92.7[a]	87.2[a]	92.8[a]
CAB[1]	92.0[ab]	81.3[b]	90.0[a]	90.2[a]
Choice	88.3[b]	81.3[b]	83.1[ab]	79.5[b]
Select	86.4[bc]	75.7[b]	74.9[b]	72.1[b]
Angus Select	75.9[c]	74.8[b]	72.4[b]	70.5[b]
SE[2]	4.0	4.1	5.3	4.3
P - value	< 0.01	0.02	< 0.01	< 0.01
Informed Testing				
Prime	95.8[a]	98.2[a]	97.6[a]	99.2[a]
CAB[1]	95.8[a]	90.2[b]	95.0[ab]	93.2[b]
Choice	90.7[a]	75.0[c]	87.6[bc]	86.3[bc]
Select	80.3[b]	75.7[c]	80.4[c]	78.9[c]
Angus Select	78.2[b]	77.6[c]	86.6[c]	80.8[c]
SE[2]	4.6	4.8	5.3	5.0
P - value	< 0.01	< 0.01	< 0.01	< 0.01

[1]Certified Angus Beef

[2]SE of the least squares means.

[abc]Least squares means in the same section (blind or informed) of the same column and lacking a common superscript differ ($P < 0.05$).

Table 2.10 Change in the percentage of beef strip steaks of varying quality treatments considered acceptable for tenderness, juiciness, flavor, and overall liking by consumers (n = 112) due to brand disclosure

Treatment	Tenderness Acceptability	Juiciness Acceptability	Flavor Acceptability	Overall Acceptability
Prime	-2.6	5.5	10.9*	6.3
CAB[1]	3.7	8.9	5.5	2.6
Choice	1.9	-6.4	4.5	6.2
Select	-6.3	-0.1	4.6	5.4
Angus Select	1.9	3.5	14.4*	9.9*
SE[2]	4.0	4.6	4.0	4.3
P - value	0.34	0.14	0.28	0.82

[1]Certified Angus Beef

[2]SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

Table 2.11 Percentage of beef strip steaks of varying treatments categorized by perceived eating quality level by consumers (n = 112)

Treatment	Unsatisfactory Quality	Everyday Quality	Better than Everyday Quality	Premium Quality
Blind Testing				
Prime	2.7[b]	36.9[c]	42.3[a]	17.6[a]
CAB[1]	4.4[b]	54.5[ab]	27.6[bc]	13.1[a]
Choice	13.4[a]	42.9[bc]	33.8[ab]	9.6[a]
Select	15.1[a]	63.4[a]	19.5[c]	1.7[b]
Angus Select	18.7[a]	47.3[bc]	23.1[bc]	10.5[a]
SE[2]	3.8	4.7	4.9	4.1
P - value	< 0.01	< 0.01	< 0.01	0.02
Informed Testing				
Prime	0.0	23.4[b]	41.0	35.0[a]
CAB[1]	3.4	35.1[b]	42.8	18.0[b]
Choice	7.7	57.6[a]	30.3	4.2[c]
Select	14.7	54.0[a]	26.8	4.2[c]
Angus Select	11.2	35.1[b]	33.0	19.8[b]
SE[2]	3.7	5.0	4.7	5.5
P - value	0.08	< 0.01	0.06	< 0.01

[1]Certified Angus Beef

[2]SE of the least squares means.

[abc]Least squares means in the same section (blind or informed) of the same column and lacking a common superscript differ ($P < 0.05$).

Table 2.12 Change in the percentage of beef strip steaks of varying treatments categorized into perceived eating quality levels by consumers (n = 112) due to brand disclosure

Treatment	Unsatisfactory Quality	Everyday Quality	Better than Everyday Quality	Premium Quality
Prime	-2.7	-13.5[b]*	-1.8	18.0[a]*
CAB[1]	-0.9	-19.6[b]*	15.2*	5.4[bc]
Choice	-5.4	14.3[a]*	-3.6	-5.4[c]
Select	0.0	-9.8[b]	7.1	2.7[bc]
Angus Select	-7.1*	-12.5[b]*	9.8	9.8[ab]*
SE[2]	3.5	6.2	6.2	4.0
P - value	0.60	< 0.01	0.20	<0.01

[1]Certified Angus Beef

[2]SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 2.13 Pearson correlation coefficients among consumer panel sensory scores, moisture loss, proximate composition, WBSF, marbling and objective color measurements of beef strip loin steaks

Traits	Thawing Loss[1]	Cooking Loss[2]	Total Loss[3]	Moisture	Protein	Fat	Ash	L*[4]	a*[5]	b*[6]	pH
Blind Testing											
Tenderness	-0.43**	-0.34**	-0.42**	-0.27*	0.07	0.40**	-0.11	0.22	-0.06	0.07	-0.01
Juiciness	-0.21	-0.45**	-0.48**	-0.26*	0.06	0.43**	-0.22	0.25*	-0.09	0.06	0.04
Flavor Liking	-0.23*	-0.21	-0.26*	-0.34**	0.11	0.41**	-0.31**	0.33**	0.09	0.21	-0.20
Overall Liking	-0.28*	-0.30**	-0.35**	-0.34**	0.08	0.47**	-0.34**	0.36**	0.05	0.21	-0.13
Informed Testing											
Tenderness	-0.42**	-0.40**	-0.44**	-0.38**	-0.11	0.52**	-0.07	0.26*	-0.07	0.11	0.10
Juiciness	-0.38**	-0.46**	-0.49**	-0.37**	-0.03	0.47**	-0.18	0.16	-0.04	0.10	0.07
Flavor Liking	-0.33**	-0.26*	-0.31**	-0.40**	-0.10	0.50**	-0.19	0.17	-0.05	0.08	0.08
Overall Liking	-0.46**	-0.43**	-0.48**	-0.44**	-0.04	0.56**	-0.21	0.23*	-0.09	0.09	0.09
WBSF	0.44**	0.30**	0.38**	0.38**	-0.04	-0.48**	0.20	-0.45**	0.17	-0.09	0.01
Marbling	-0.41**	-0.19	-0.28*	-0.77**	-0.13	0.88**	-0.14	0.58**	-0.02	0.31**	-0.13

[1]Thaw Loss: [(raw weight – thaw weight) / raw weight] * 100

[2]Cook Loss: [(thaw weight – cooked weight) / thaw weight] * 100

[3]Total Loss: [(raw weight – cooked weight) / raw weight] * 100

[4]L* = lightness (0 = black and 100 = white).

[5]a* = redness (-60 = green and 60 = red).

[6]b* = blueness (-60 = blue and 60 = yellow).

*Correlation coefficient differs from 0 ($P < 0.05$).

**Correlation coefficient differs from 0 ($P < 0.01$).

Table 2.14 Pearson correlation coefficients among consumer panel sensory scores, marbling and Warner-Bratzler shear force (WBSF) of beef strip loin steaks

Traits	Tenderness	Juiciness	Flavor Liking	Overall Liking	Marbling
Blind Testing					
Juiciness	0.71				
Flavor Liking	0.57	0.54			
Overall Liking	0.72	0.75	0.88		
Marbling	0.41	0.40	0.41	0.49	
WBSF	-0.47	-0.37	-0.47	-0.50	-0.56
Informed Testing					
Juiciness	0.80				
Flavor Liking	0.73	0.78			
Overall Liking	0.86	0.90	0.91		
Marbling	0.59	0.51	0.56	0.62	
WBSF	-0.46	-0.31	-0.36	-0.45	

*All correlations coefficients differ from 0 ($P < 0.01$).

Chapter 3 - Determination of the effect of brand and product identification on consumer palatability ratings of ground beef patties

Abstract

The objective of this study was to determine the effect of brand and product identification on consumer palatability ratings of ground beef patties. Six treatments were used in the study and included: 90/10 Certified Angus Beef (**CAB**) ground sirloin, 90/10 ground beef, 80/20 CAB ground chuck, 80/20 ground chuck, 80/20 ground beef, and 70/30 CAB ground beef. Ground beef chubs were fabricated into 151.2 g patties using a patty former and were paired, with two consecutively formed patties assigned to blind consumer testing and the following two assigned to informed testing. Following cooking to 71˚C, patties were cut into quarters and served to consumers. Consumers (n = 112) evaluated samples in two rounds for tenderness, juiciness, flavor liking, texture liking, and overall liking. Each trait was also rated as either acceptable or unacceptable and consumers were asked to identify the sample as either unsatisfactory, everyday quality, better than everyday quality, or premium quality. In the first round, samples were evaluated blind, with no information given about the treatment; but, in the second round, product type and brand was disclosed prior to testing. Additionally, texture profile analysis, pressed juice percentage (**PJP**) and shear force analysis was performed. Few differences were observed for palatability traits in blind testing; however, during informed testing, 90/10 CAB ground sirloin rated greatest ($P < 0.05$) for all palatability traits besides juiciness. Also, 90/10 CAB ground sirloin had increased ratings for tenderness (17.4%), juiciness (36.5%), flavor liking (23.3%), texture liking (18.2%), and overall liking (24.7%). Increased ($P < 0.05$) ratings were found for CAB products in multiple traits while the only non-branded product that received increased ($P <$

0.05) ratings during informed testing was 90/10 ground beef. Texture results indicated that decreased fat level can increase hardness, cohesiveness, gumminess, and chewiness. The PJP was lower ($P < 0.05$) for 80/20 ground chuck than all treatments, except 80/20 CAB ground chuck. There were few differences among ground beef products when tested blind, indicating that during blind testing, brand, fat percentage, and subprimal source have little effect on ground beef palatability. However, when product and brand were identified, multiple treatments received increased ratings for palatability traits indicating branding and product type knowledge influence the palatability of ground beef.

Keywords: branding, consumer, ground beef, palatability, texture profile analysis

Introduction

Of the beef products on the market, ground beef is one of the least expensive beef products for U.S. consumers. Ground beef represents the largest volume in pounds of beef in foodservice, at 64%, and represents more than 37% of revenue for both foodservice and retail sales (Speer et al., 2015). To date, ground beef palatability has not been extensively researched, despite representing a large segment of the beef market. Additionally, there are many different lean points and subprimal blends as well as 25.3% of ground beef sold under a brand in the retail case (Reicks et al., 2008). Ground beef from branded beef programs, higher lean points, and primal-specific blends are traditionally sold at retail for a higher price (Martinez, 2008).

Branding can be used to indicate an increased quality level associated with the product, and, in some cases, encourages consumers to pay a premium in order to receive a superior product (Grunert et al., 2004). Many authors have stated that brands are used to help alter the perception or quality of meat and help represent a producer's promise to deliver a consistent

product (Cobbwalgren et al., 1995; Wachenheim et al., 2000; Grunert et al., 2004; Font-i-Furnols and Guerrero, 2014). Delivering a consistent product is important because consumers desire products that can deliver the same quality experienced in previous purchases (Bredahl, 2004).

There is no conclusive evidence of how ground beef palatability changes with fat levels, although some studies have demonstrated higher fat levels are perceived to be more juicy and have greater fat like scores (Berry, 1992; Troutt et al., 1992; Myers, 2012). It is common for meat to be evaluated blind for palatability differences, but consumers do not purchase and consume meat without being exposed to information about the product. Therefore, the objective of this study was to determine the effect of fat level, brand, and product identification on consumer palatability ratings of ground beef.

Materials and Methods

Ground Beef Treatments and Preparation

Six treatments (six – 4.54-kg chubs / treatment) were chosen to represent a variety of product types and fat levels and included: 90/10 Certified Angus Beef (**CAB**) ground sirloin, 90/10 ground beef, 80/20 CAB ground chuck, 80/20 ground chuck, 80/20 ground beef, and 73/27 CAB ground beef. Treatments were procured from a commercial processing facility and transported under refrigeration to the Kansas State University Meat Laboratory, in Manhattan, Kansas, and stored at 0 – 4 °C prior to patty formation.

Ground beef chubs were fabricated on an average of 8 d from packaging date into 151.2 g (approximately 13 cm diameter, 1 cm thick) patties using a patty former (Super Model 54 Food Portioning Unit, Hollymatic, Countryside, Il). Ground beef patties were assigned to consumer testing (patties 1 and 2), shear force analysis (patty 3) objective juiciness testing (patty 4),

proximate testing (patty 5) or texture profile analysis (patty 6). Ground beef patties were paired, with two consecutively formed patties assigned to blind consumer testing and the following two assigned to informed testing. Each chub was portioned in half (anterior and posterior) and patties for each analysis were collected from each half. Patties were then identified, vacuum-packaged, and frozen (-20 °C) until analysis.

Consumer Panel Testing

Consumer testing was conducted at the Kansas State University Animal Science building. Consumer panelists (n = 112) were recruited from Manhattan, KS and the surrounding areas and were paid for their participation. Consumers sampled ground beef patties under florescent lighting in a large lecture-style room. Five sessions of panels were conducted with 21 consumers present at each and one panel consisting of only seven consumers, each lasting about 1.5 h.

Patties were thawed at 2 – 4 °C for 24 h prior to consumer testing. Patties were cooked to 74 °C in a convection oven (DFG-100-3 Series, GS Blodgett Co., Inc. Burlington, VT) with endpoint temperature verified using a probe thermometer (Model 450-ATT, Omega Engineering, Stamford, CT). Following cooking, patties were cut into four equally sized wedges and one piece was immediately served to seven predetermined consumers.

Consumers were asked to complete a demographic questionnaire that provided information about gender, household size, income level, education level, ethnicity, beef consumption habits, and flavor preferences prior to testing. Along with demographics, consumers also completed a brand awareness and beef purchasing motivator questionnaire prior to sample evaluation. The brand awareness questionnaire asked consumers to indicate if they had knowledge of nine different beef brands and, if they were familiar with the brand, to rate their perceived quality level of the brand. Consumers also rated the importance of 15 different fresh

beef purchasing motivators that included beef product and production claims. Consumers were given utensils, an expectorant cup, ballot, and palate cleansers to use between samples (unsalted crackers and apple juice). Prior to testing, participants were given verbal instructions about the ballot, testing procedures, and the use of palate cleansers.

Ground beef samples were served in two rounds. In the first round, consumers were served all samples "blind" with no information provided to the consumers prior to evaluation. In the second round, immediately prior to sample evaluation, consumers were informed of the treatment information (brand, primal source, and lean point) with labels presented on ballots, including a full color CAB logo, as well as on a projector screen in the front of the room. In each round, consumers evaluated one sample from each of the six treatments, in a random order. Moreover, consumer ballots were collected following the first round of testing and consumers were provided separate ballots for the second round of testing. Samples evaluated in round two were paired with samples from the first round, allowing a direct comparison of consumer ratings and the effect of disclosing lean point, subprimal, and branding on palatability perception.

For both rounds of testing, samples were evaluated for tenderness, juiciness, texture liking, flavor liking, and overall liking on 100 mm line scales anchored with descriptive terms at the ends and mid-points: 100 = extremely juicy, tender, and like flavor/texture/overall extremely; 50 = neither juicy nor dry, tough nor tender, or neither like or dislike flavor/texture/overall; 0 = extremely tough, dry, and dislike flavor/texture/overall extremely. Additionally, consumers rated each trait as either acceptable or unacceptable as well as identified the sample as unsatisfactory, everyday quality, better than everyday quality, or premium quality.

Shear Force Testing

Patties for shear force testing were prepared and cooked as previously described for consumer testing. Methods from the "Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of meat" (AMSA, 2015) were used for shear force testing of ground beef patties. Briefly, following cooking, samples were allowed to cool to room temperature (21 - 23 °C) prior to testing. Shear force was measured on two strips (2.5 cm wide x patty thickness) that were removed from the center across the width of the patty. Each strip was sheared (crosshead speed of 250 mm/min) perpendicular to the cooked surface, three times, using a straight edge slice-shear force blade attached to an INSTRON Model 5569 testing machine (Instron, Canton, MA). Shear force values were recorded in kg and six readings were averaged for each patty.

Pressed Juice Percentage

Ground beef patties designated for instrumental juiciness were evaluated using a pressed juice percentage (**PJP**) method modified from Woolley (2014). Patties were thawed at 2 – 4 °C overnight prior to evaluation. Preparation and cooking methods were the same as consumer evaluation. After cooking, one 1-cm patty-width slice was removed across the diameter of the patty. From each patty-width slice, samples were removed to create three - 1 × 1 × 1 cm. Each sample was placed on two sheets of desiccated filter paper (VWR Filter Paper 415, 12.5 cm, VWR International, Radnor, PA) and was compressed for 30 s at 8-kg of force using an INSTRON Model 5569 testing machine. The percentage of weight lost through compression for each sample was calculated and quantified as the PJP. The three measurements for each patty were averaged.

Texture Profile Analysis

Texture profiling of ground beef patties was conducted using the methods described by AMSA (2015). Cooking of patties was done as described for consumer panel testing. Patties were allowed to cool to room temperature (21 - 23 °C) before three 2.54 cm cores were removed through the cooked surface in the center of each patty. Each core was then compressed to 70% of its original height in two cycles, using an INSTRON Model 5569 testing machine. Chewiness, springiness, gumminess, hardness, and cohesiveness were calculated using the methods of Bourne (1978).

Proximate Analysis

Patties used for proximate analysis were thawed for 24 h at 2 – 4 °C. Each sample was then frozen in liquid nitrogen and homogenized using a commercial 4-blade blender (Model 33BL 79, Waring Products, New Hartford, CT). The homogenate was transferred to Whirl-Pak bags (Nasco, Ft. Atkinson, WI) and stored in a -20 °C freezer until subsequent analysis. Moisture and fat were analyzed using an AOAC Official Method [985.14 (A2)] by microwave radiation (**CEM**). Protein was calculated following an AOAC Official Method (990.03, 2002) using a LECO TruMac N (St. Joseph, MI, USA) analyzer. Ash was analyzed using a muffle furnace following the methods of AOAC (2005).

Statistical Analysis

Statistical analyses were conducted using SAS (Version 9.4; SAS Inst. Inc., Cary, NC). Consumer panel data were analyzed using PROC GLIMMIX with an $\alpha = 0.05$. The model included the fixed effect of treatment and the random effect of panel session number. All acceptability data were analyzed with a model that included a binomial error term. For shear

force, PJP, and texture data, patty peak cooked temperature was included in the model as a covariate. All demographics were summarized using PROC FREQ. Pearson correlation coefficients were calculated and tested using PROC CORR. Moreover, the Kenward-Roger approximation was used for estimating denominator degrees of freedom for all analyses.

Results

Proximate Analysis, Shear Force, Pressed Juice Percentage, and Texture Profile Analysis

Significant differences ($P < 0.05$) were found for all proximate measurements (Table 3.1). As expected, fat analysis indicated 73/27 CAB ground beef had the greatest ($P < 0.05$) amount of fat, with 90/10 CAB ground sirloin having the least ($P < 0.05$) percentage of fat, which was lower ($P < 0.05$) than 90/10 ground beef. Additionally, all 80/20 treatments were similar ($P > 0.05$) in fat content. Moisture percentage decreased ($P < 0.05$) with each fat percentage decrease, with all treatments at the same fat level having a similar ($P > 0.05$) moisture content. Protein percentage was higher ($P < 0.05$) for 90/10 CAB ground sirloin compared to all other treatments, except 90/10 ground beef. All 80/20 ground beef treatments were similar ($P > 0.05$) and similar ($P < 0.05$) to 73/27 CAB ground beef for protein percentage. Ash was also the greatest ($P < 0.05$) for 90/10 CAB ground sirloin samples while 73/27 CAB ground beef had a lower ($P > 0.05$) ash percentage than all treatments except 80/20 ground beef.

The 90/10 ground beef had the greatest ($P < 0.05$) shear force compared to all other treatments (Table 3.1). All three 80/20 ground beef treatments were similar ($P > 0.05$) in shear force values for cooked patties, and greater ($P < 0.05$) than 73/27 CAB ground beef. Additionally, 90/10 CAB ground sirloin was similar ($P > 0.05$) to 73/27 CAB ground beef for shear force, and more tender ($P < 0.05$) than all other treatments.

Pressed juice percentage showed small, but significant ($P < 0.05$) differences among ground beef treatments (Table 3.1). All treatments, with the exception of 80/20 ground chuck, were similar ($P > 0.05$) for PJP and had close to 25% weight loss during compression. Additionally, 80/20 ground chuck had a lower ($P < 0.05$) mean PJP value than all treatments other than 80/20 CAB ground chuck.

Texture profile analysis indicated cohesiveness, hardness, gumminess, and chewiness generally decreased as fat level of ground beef increased (Table 3.2). Texture profile analysis results of the six treatments of ground beef indicated gumminess and chewiness were greatest ($P < 0.05$) for 90/10 ground beef and 90/10 CAB ground sirloin samples. Also, 90/10 ground beef was greater ($P < 0.05$) for hardness values than all other treatments except 90/10 CAB ground sirloin. Springiness was greater ($P < 0.05$) for 90/10 CAB ground sirloin, 80/20 CAB ground chuck, and 80/20 ground chuck than the other three treatments indicating these products recovered the greatest distance after the first compression. Cohesiveness was greater ($P < 0.05$) for 90/10 ground beef when compared to all other treatments other than 90/10 CAB ground sirloin. Additionally, 73/27 CAB ground beef and 80/20 CAB ground chuck were less ($P < 0.05$) cohesive than all of the treatments other than 80/20 ground chuck.

Demographics, Purchasing Motivators, and Brand Awareness

Consumer demographic information from the panelists who sampled ground beef can be found in Table 3.3. Panelists' genders were fairly evenly split, but a majority of panelists were male (52.8%). Moreover, the large majority were Caucasian/white (90.8%), were married (70.4%), and had a household size of three or more people (52.2%). More than half (53.2%) of consumers had an annual household income greater than $75,000 and half (50.5%) were at least college graduates. Beef was the most popular meat flavor preferred by consumers (58.3%),

followed by chicken (14.8%), and pork (9.3%). Most of the consumers (53.6%) consumed beef 4 to 6 times a week. Flavor was the preferred palatability trait by 69.7% of consumers, followed by tenderness (21.1%), and juiciness (9.2%).

Consumers who participated in ground beef panels considered "price" to be more ($P < 0.05$) important when purchasing fresh beef than all other traits evaluated except "size, weight, and thickness" (Table 3.4). Product related characteristics of "steak color", "familiarity of cut", "USDA grade", "marbling level", and "nutrient content" were more important ($P < 0.05$) than animal production claims, "country of origin", and "brand of the product". "Natural and organic claims" was one of the least important purchasing motivator to consumers but was rated similar ($P > 0.05$) to "brand of product" and "growth promotant use in the animal".

When consumers were asked to identify beef brands they were familiar with, all USDA grades and CAB had the greatest ($P < 0.05$) number of consumers with recognition, each being identified by over 77% of consumers (Table 3.5). Additionally, a majority (92.8%) of consumers had knowledge of USDA Choice, which was a greater ($P < 0.05$) amount than all other brands, besides USDA Prime (86.4%). Private Selection had more than half (60%) of consumers identify it, while the fewest ($P < 0.05$) consumers recognized Angus Pride and Creekstone Farms brands. When consumers were asked to rate the perceived quality level of the brands they had knowledge of, Prime was rated an average of 8.1 out of 10, which was similar ($P > 0.05$) to CAB (7.6) and Angus Pride (7.2). The brand CAB was rated higher ($P > 0.05$) quality than Black Canyon, USDA Choice, Private Selection, and USDA Select.

Consumer Palatability Ratings

Consumer palatability ratings for ground beef are presented in Table 3.6. Few differences were observed among treatments during blind testing for all palatability traits. For

tenderness, 90/10 ground beef rated lower ($P < 0.05$) than all other treatments, with no difference ($P > 0.05$) observed among the other five treatments. Both 90/10 ground beef and 90/10 CAB ground sirloin were rated lower ($P < 0.05$) than all treatments other than 80/20 CAB ground chuck for juiciness. Both 90/10 ground beef treatments (90/10 CAB ground sirloin, and 90/10 ground beef) were also considered "dry" by consumers when tested blind, with an average rating of less than 50 (50 = neither dry nor juicy) on the 100 point scale. No differences ($P > 0.05$) were observed for texture liking, flavor liking or overall liking among treatments when tested blind.

However, when treatment was revealed to consumers, large differences between treatments were observed (Table 3.6). During blind testing, 90/10 was rated more tender ($P < 0.05$) than only 90/10 ground beef and similar ($P > 0.05$) to all other treatments for tenderness. However, when product type was informed 90/10 CAB ground sirloin rated greater ($P < 0.05$) than all other treatments for tenderness. Juiciness was rated lower ($P < 0.05$) for 90/10 ground beef than all other products, besides 80/20 ground chuck when consumers were informed of the product type. Additionally, juiciness for 90/10 CAB ground sirloin was rated lower ($P < 0.05$) than 80/20 ground beef, 80/20 ground chuck, and 73/27 CAB ground beef for blind testing but rated similar ($P > 0.05$) to these products during informed testing. Flavor liking, texture liking, and overall liking were all rated the highest ($P < 0.05$) for 90/10 CAB ground sirloin during informed sampling when no differences were found among treatments during blind testing. Also, 90/10 CAB ground sirloin was rated greater ($P < 0.05$) than 90/10 ground beef in all palatability traits during informed testing, compared to only rating greater in tenderness during blind testing.

When informed of the treatment, consumer palatability ratings increased for multiple traits (Table 3.9). Very large increases ($P < 0.05$) were found for 90/10 CAB ground sirloin in tenderness (17.4%), juiciness (36.5%), flavor liking (23.3%), texture liking (18.2%), and overall

liking (24.7%). Similar increases ($P < 0.05$) were found for 80/20 CAB ground chuck with juiciness increasing 18.6%, flavor liking increasing 22.4%, and overall liking increasing by 11.5% when brand was informed. The only non-branded product to have increased change in sensory traits was 90/10 ground beef, with increased ($P < 0.05$) tenderness (13.8%) and juiciness (18.9%) ratings. Additionally, brand disclosure did not result in a decrease in the palatability traits of any of the brands and products evaluated. The change in flavor liking scores for 90/10 CAB ground sirloin and 80/20 CAB ground chuck were greater ($P < 0.05$) than all other products tested. Furthermore, 90/10 CAB ground sirloin samples also had a greater ($P < 0.05$) change in texture liking scores than all other treatments, except 73/27 CAB ground beef. Additionally, overall liking scores increased ($P < 0.05$) the most for 90/10 CAB ground sirloin samples.

Sensory Traits Rated Acceptable by Consumers

The results for samples rated as acceptable for palatability traits were consistent with sensory ratings (Table 3.8). The percentage of samples rated acceptable for tenderness was the lowest ($P < 0.05$) for 90/10 ground beef, with no differences ($P > 0.05$) found among any of the other treatments when samples were tested blind. For juiciness, 80/20 ground beef, 80/20 ground chuck, and 73/27 CAB ground beef had more ($P < 0.05$) samples rated acceptable than both 90/10 ground beef treatments. No difference ($P > 0.05$) in the samples rated as acceptable for flavor, texture, or overall liking were found for blind testing. However, during informed testing, 90/10 ground beef had fewer ($P < 0.05$) samples rated acceptable for tenderness than both 90/10 CAB ground sirloin and 73/27 CAB ground beef. All 80/20 ground beef treatments had a similar ($P > 0.05$) percentage of samples considered acceptable for tenderness, juiciness, and texture when informed of the brand. Also, more ($P < 0.05$) 90/10 CAB ground sirloin samples were

considered acceptable for texture compared to all other products, other than 73/27 CAB ground beef.

The 90/10 CAB ground sirloin had increases ($P < 0.05$) in the percentage of samples rated acceptable for juiciness (20.9%), flavor (18.2%), texture (18.0%), and overall acceptability (13.5%) due to brand disclosure (Table 3.9). Additionally, 80/20 CAB ground chuck had 11.0% more ($P < 0.05$) samples rated as acceptable for juiciness, 13.0% more for flavor, and 16.2% more rated acceptable overall. Also, there were 11.8% more ($P < 0.05$) 73/27 CAB samples were rated acceptable overall due to treatment disclosure. Under informed testing, the only unbranded product that had more ($P < 0.05$) samples rated as acceptable was 90/10 ground beef in tenderness (8.3%). There was a greater ($P < 0.05$) change in acceptability of flavor for 90/10 CAB ground sirloin and 80/20 CAB ground chuck when tested informed, compared to 80/20 ground beef. Also, the change for samples rated acceptable for texture was greater ($P < 0.05$) for 90/10 CAB ground sirloin compared to all non-branded products.

Perceived Quality of Ground Beef

All samples had a similar ($P < 0.05$) number of samples rated as each of the four perceived quality levels for each treatment when evaluated under blind conditions (Table 3.10). For each treatment, close to half (45.5 – 50.0%) of the samples were considered "everyday quality" during blind testing. When product type and brand was informed to consumers, fewer ($P < 0.05$) 90/10 CAB ground sirloin samples were rated as "everyday quality" than all other treatments. Also, more ($P < 0.05$) 90/10 CAB ground sirloin samples were considered "better than everyday" and "premium" quality than all other products tested when the consumers were informed of the treatment.

The perceived quality level of multiple treatments was affected by disclosure of product type during informed testing (Table 3.11). When informed of the treatments, 13.5% fewer ($P < 0.05$) 90/10 CAB ground sirloin and 10.8% fewer ($P < 0.05$) 80/20 CAB ground chuck samples were rated as "unsatisfactory" quality. Consumers considered 23.1% fewer ($P < 0.05$) 90/10 CAB ground sirloin samples to be "everyday quality". Four of the products, both 90/10 and 80/20 ground beef and 90/10 and 80/20 CAB treatments, had a greater ($P < 0.05$) percentage (> 11.7%) of samples considered "better than everyday quality" when informed of the product type. More ($P < 0.05$) 90/10 CAB samples were also rated as "premium quality", while fewer ($P < 0.05$) 80/20 ground beef samples were perceived to be "premium" quality due to treatment knowledge. The 90/10 CAB ground sirloin product had a greater ($P < 0.05$) decrease in samples rated as "everyday quality" than all other treatments other than 90/10 ground beef. The greatest ($P < 0.05$) positive change in "premium" quality was also seen for 90/10 CAB ground sirloin.

Objective Measurements and Consumer Panel Relationship

Correlations between sensory traits during blind and informed testing revealed associations that changed when consumers were informed of the brand and product type (Table 3.12). All palatability traits were highly correlated ($P < 0.01$) during both blind and informed sessions, but were higher in informed evaluations. Overall liking had the highest correlation ($P < 0.01$) to flavor liking (r = 0.88) during blind testing, while the highest correlation ($P < 0.01$) for overall liking was observed with texture liking (r = 0.86), when consumers were informed of the product type. Fat and moisture were both correlated ($P < 0.01$) with juiciness in blind testing (r = 0.32, -0.29, respectively); however, when treatment and product type was disclosed, juiciness was no longer correlated ($P > 0.05$) with fat percentage. Associations ($P < 0.01$) were also observed between fat and flavor liking (r = -0.29), texture liking (r = -0.25), and overall liking (r

= -0.27) when treatment was informed, although these relationships were not found in blind testing. Shear force was correlated ($P < 0.05$) to only tenderness (r = -0.20) in blind testing. But during informed testing, shear force was negatively associated ($P < 0.05$) with tenderness (r = -0.40), juiciness (r = -0.29), flavor liking (r = -0.25), texture liking (r = -0.32), and overall liking (r = -0.26). Fat and moisture percentage were related ($P < 0.05$) to shear force values at r = -0.23 and r = 0.24, respectively.

Table 3.13 presents the relationships between texture profile analysis and ground beef sensory traits. During blind testing, tenderness was correlated ($P < 0.01$) to hardness (r = -0.31), cohesiveness (r = -0.35), gumminess (r = -0.33), and chewiness (r = -0.29). However, tenderness was not correlated to any texture traits when consumers were informed of the brand and product type. Gumminess was the only texture trait correlated ($P < 0.05$) to overall liking in blind testing, but this relationship was not seen during informed sampling. Also, it is noteworthy that texture liking had no relationship ($P > 0.05$) with any of the objective measures for texture in this study.

Discussion

Proximate Measurements

Fat percentage was lower for most treatments than the original fat percentage of the formulation for ground beef patties. A lower fat percentage than listed as the formulation could be due to using the CEM method for proximate analysis for the samples when near infrared spectrophotometry is most commonly used to formulate fat percentage in commercial facilities. Fat percentages from strip loin steaks using CEM methods have been reported to be lower (Hoelscher et al., 1988; Dow et al., 2011; Dikeman et al., 2013) compared to the same quality grades, using near infrared spectrophotometry (O'Quinn et al., 2012; Hunt et al., 2014; Corbin et al., 2015).

Objective Texture Measurement and Shear Values

Texture profile analysis has been reported by others for ground beef patties using equations and calculations from Bourne (1978). Troutt et al. (1992a) demonstrated that lower fat formulations had increased hardness values using the texture profile analysis method, similar to the current study. Fat level has been reported to affect textural values with increased fat level having lower cohesiveness, gumminess, and chewiness while springiness remained similar as fat was increased from 4% to 20% (Berry, 1994). These trends for increased fat level were demonstrated in the current study as well, when fat was increased from 10% to 27%. Conversely, hardness and cohesiveness values for ground beef patties in Troutt et al. (1992b) followed an opposite trend than the current study when fat levels from 5% to 30% were evaluated; however, only a 30% compression was used in that study compared to the 70% used in our study. Texture measurements were reported to be correlated with tenderness ($r = -0.29$ to -0.35) in blind ratings; but instrumental texture measurements had no correlation to consumer sensory texture liking scores. Also, other authors have reported correlations close to $r = 0.50$ for hardness, springiness, and cohesiveness for trained panel firmness ratings (Troutt et al., 1992b). This indicates texture profile analysis may not be representative of consumer texture liking of ground beef patties.

The shear values in the current study were affected by fat level, similar to texture measurements. The 90/10 ground beef had the highest shear value which was 28% higher than that of 73/27 CAB ground beef. This trend of decreasing fat percentage and increasing shear force values has been well documented by many authors using ground beef with 5% fat up to 30% fat, spanning a wider range than that of the current study (Berry and Leddy, 1984a; Troutt et al., 1992a; Troutt et al., 1992b; Desmond et al., 1998). Ground beef shear force values have

been reported to be correlated (r = -0.22 to -0.72) to tenderness values utilizing trained panelists (Desmond et al., 1998; Highfill, 2012; McHenry, 2013; Troutt et al., 1992b). Additionally, in the current study, shear force values were seen to have a relationship with consumer tenderness (r = -0.40) ratings. This suggests shear force is not only an indicator of trained panel tenderness, but also of consumer tenderness ratings of ground beef.

Consumer Purchasing Motivators

Purchasing motivators have been evaluated by many authors to gain insight into how consumers select and evaluate meat during the retail shopping process. Although production information was among the lowest rated traits for importance in the current study, many authors have demonstrated its importance to the acceptance and value consumers place on beef products (Grannis et al., 2000; Mennecke et al., 2007; Grunert et al., 2011). There was a large difference in the importance of motivators evaluated by consumers, with most intrinsic traits such as color, size, and marbling rated as more important than attributes such as brand and production claims. Similarly, consumers have demonstrated that they consider visual quality cues to be of high importance when purchasing products (Steenkamp and vanTrijp, 1996; Wachenheim et al., 2000; Grunert et al., 2004; Woolley, 2014). Moreover, the large exception to this trend is price, an extrinsic factor, which was determined to be one of the most important traits to consumers when purchasing beef in the current study as well as many others (Claborn et al., 2011; Reicks et al., 2011; Woolley, 2014)

Effect of Fat Level on Palatability Ratings of Ground Beef

Consumer ratings of ground beef had few differences among samples with various fat percentages for tenderness, flavor, texture, and overall liking during blind testing. However,

juiciness was shown to be effected by fat level, with the two 90/10 treatments rating lower than three of the higher fat products when tested blind. While the current study demonstrated few differences during blind testing of ground beef patties varying in fat level, previous authors have reported differences in multiple palatability traits. However, these studies have utilized trained panelists in comparison to the consumers used in the current study. Higher fat ground beef has been observed to have greater tenderness compared to lower fat formulations (Cross et al., 1980; Berry and Leddy, 1984b; Kregel et al., 1986; Berry, 1992; Garzon et al., 2003). Also, similar to the current study, ground beef with higher fat has been well documented as having higher juiciness ratings than low-fat ground beef (Cross et al., 1980; Kregel et al., 1986; Huffman and Egbert, 1990; Berry, 1992; Troutt et al., 1992b; Miller et al., 1993; Desmond et al., 1998; Blackmon et al., 2015). Additionally, others have found no difference in ground beef patties for sensory texture ratings using fat percentages from 27% to 10% (Kendall, 1974; Desmond et al., 1998).

The 90/10 CAB ground sirloin had increases for every palatability trait, 17.4% for tenderness, 36.5% for juiciness, 23.3% for flavor liking, 18.2% for texture liking, and increased in overall liking ratings by 25%. Additionally, an increased percentage of samples were rated acceptable in all traits, and 36% more samples were rated as "better than everyday" quality and "premium" quality levels combined. Determining why consumers considered this product of such high quality could be attributed to many of the product claims. Some of the increases could be associated to the fat to lean ratio considering increases (13.8% for tenderness, 8.3% for tenderness acceptability, and 19.9% for juiciness) were also seen for the 90/10 ground beef product, indicating consumers associated the leaner products with a better eating experience. Conversely, only minimal (8.9% for texture liking) "brand lift" was reported for 73/27 CAB

ground beef, potentially due to the high fat to lean ratio. Ground beef with less fat is more expensive than that of higher fat with retail prices of lean and extra lean ground beef (90% to 95% lean) garnering a 31% premium in price compared to 75% to 80% lean ground beef (USDA, 2015b). Additionally, consumer survey by Lusk and Parker (2009) supports our findings and indicated that consumers consider 90/10 ground beef higher quality than 80/20 ground beef and consumers indicated they were willing to pay $2.00 more for the reduced fat product. Also, consumers in Law et al. (1965) reported leanness was a more important trait for purchasing ground beef than price.

Subprimal Effect on Palatability Ratings of Ground Beef

Subprimal sourced blends have been evaluated utilizing differing muscles and fat sources as a result of increasing demand for ground beef products and increased ground beef prices (Speer et al., 2015). Research has evaluated multiple aspects, determining the effect of fat source (Blackmon et al., 2015; Kerth et al., 2015), marbling and maturity levels (Myers, 2012; Highfill, 2012), and muscle specific or subprimal blends (Fruin and Van Duyne, 1961; Nielsen et al., 1967; Tigue, 2013; McHenry, 2013; Highfill, 2012). Much of this research demonstrated similar results to the current study, with very few differences in specific sourced blends for palatability characteristics. Within these studies, fat and lean sources played a minimal role in palatability of ground beef. However, McHenry (2013) reported ground beef patties from the chuck were more desirable in flavor attributes compared to ground beef from the brisket and sirloin caps when evaluated by trained panelists.

During blind and informed testing, very few differences in palatability ratings were seen between the subprimal blends utilized. Moreover, when consumers were informed of subprimal blend, no differences in palatability were seen between for the 80/20 chuck blends compared to

the 80/20 ground beef product. However, when treatments were disclosed for the 90/10 products, the 90/10 CAB ground sirloin rated greater than the 90/10 ground beef product for every palatability trait tested. This demonstrated that for the chuck subprimal, consumers did not indicate a palatability related benefit when informed of the product type. However, consumers rated the 90/10 CAB ground sirloin product greater than that of the 90/10 ground beef product when informed of the subprimal blend. Due to no inclusion of a commodity ground sirloin product, the ability to determine the change in ratings due to the subprimal blend of sirloin is limited.

Effect of Branding on Consumer Palatability Ratings of Ground Beef

Though some of the increase for 90/10 CAB ground sirloin can be accounted for by fat percentage and potentially the subprimal type, increases (18.6% for juiciness, 22.4% for flavor liking, 11.5% overall liking) were also seen for 80/20 CAB ground chuck as well as increases for all CAB products in overall liking (13.5% for 90/10 CAB ground sirloin, 16.2% for 80/20 CAB ground chuck, and 11.8% for 73/27% for CAB ground beef). This indicates a "brand lift" was given for these products when utilizing the CAB brand. Additionally, Banović et al. (2009) noted that brand is one of the most important indicators of product quality in beef.

Disclosing brand and product information has been reported to have an effect on many other products when evaluated by consumers. In Chapter 2, steak palatability was reported to be affected by branding information. Strip loin steaks from CAB carcasses had increases in juiciness (13.6%), flavor liking (14.6%), and overall liking (9.8%) when identified with the brand (Chapter 2). Additionally, Angus Select steaks received increases by 12.9% to 16.5% in juiciness, flavor liking, and overall liking. Conversely, Choice and Select samples did not garner these increases in palatability when tested under the informed scenario. Much like the current

study, not all brands and grades received a positive change in sensory ratings due to brand or grade disclosure.

Other products besides meat have been tested with information disclosed as well. Overall liking has been reported to increase up to 20% for well-known brands of beer, yogurt, chocolate hazelnut spreads, and spaghetti noodles (Allison and Uhl, 1964; Di Monaco et al., 2004; Kim et al., 2015; Spinelli et al., 2015). Certain products, such as nutritional supplements, have also been reported to have increased acceptability (30%) when consumed under informed settings compared to blind sampling. The complex relationship of consumer's perception of products has been demonstrated in multiple studies, as well as the current study and Chapter 2. Della Lucia et al. (2014) reported that when beer was sampled under informed settings branding had an effect on the palatability ratings. Others have reported no change when information about products was disclosed (Beriain et al., 2009; Carrillo et al., 2012; Szőke et al., 2012; Kim and Lee, 2015). Additionally, a study was performed to determine the effect of sustainability related label claims on consumer palatability ratings of chicken breast. Different claims were presented with samples of chicken meat; however, all the samples of meat were the same and only the labels changed (Samant and Seo, 2016). This study reported that consumers who had no knowledge of sustainability label claims reported no changes in palatability for the chicken meat samples (Samant and Seo, 2016). However, consumers who did have knowledge of label claims demonstrated increased ratings for overall liking and juiciness for the chicken presented with and Organic label claim (Samant and Seo, 2016). These studies, as well as the current study, demonstrate the importance of perception and knowledge of brands and labels as well as the complexity of the relationship between perception of brand and sensory perception.

Conclusion

These data indicate few palatability differences among ground beef treatments when tested blind, indicating that during blind testing, brand and subprimals specific blends have little effect on palatability. However, when product and brand were identified, multiple treatments received increased ratings for palatability traits. Therefore, branding and product awareness have a large effect on consumer perception of ground beef palatability

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Table 3.1 Average shear force, pressed juice percentage (PJP), and proximate composition for ground beef of differing brands, lean percentages, and subprimal sources

Treatment[1]	Shear Force, kg	PJP, %	Moisture, %	Protein, %	Fat, %	Ash, %
90/10 ground beef	4.4[a]	25.7[a]	70.3[a]	20.3[ab]	10.1[c]	1.0[b]
90/10 CAB[2] ground sirloin	3.0[c]	25.6[a]	69.4[a]	20.7[a]	8.7[d]	1.6[a]
80/20 ground beef	3.9[b]	25.5[a]	64.8[b]	19.3[bc]	16.9[b]	0.9[bc]
80/20 ground chuck	3.9[b]	23.1[b]	63.5[b]	19.1[bc]	17.0[b]	0.9[b]
80/20 CAB[2] ground chuck	3.8[b]	24.7[ab]	63.5[b]	18.8[c]	17.2[b]	1.0[b]
73/27 CAB[2] ground beef	3.2[c]	25.1[a]	57.8[c]	18.4[c]	25.2[a]	0.7[c]
SE[3]	0.1	0.7	0.8	0.5	0.3	0.1
P - value	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01

[1]Treatment lean content presented as: Percent lean / percent fat

[2]Certified Angus Beef

[3]SE (largest) of the least squares means.

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.2 Texture profile analysis[1] results for ground beef treatments

Treatment[2]	Hardness	Cohesiveness	Springiness	Gumminess	Chewiness
90/10 ground beef	20.0[a]	32.6[a]	66.5[c]	6.5[a]	4.3[a]
90/10 CAB[3] ground sirloin	18.9[ab]	32.5[ab]	69.2[ab]	6.2[a]	4.3[a]
80/20 ground beef	16.3[c]	31.3[bc]	64.8[d]	5.1[b]	3.3[bc]
80/20 ground chuck	16.9[c]	30.3[cd]	70.2[a]	5.2[b]	3.6[b]
80/20 CAB[3] ground chuck	17.2[bc]	29.8[d]	68.2[b]	5.1[b]	3.5[b]
73/27 CAB[3] ground beef	15.7[c]	30.0[d]	66.1[cd]	4.7[b]	3.1[c]
SE[4]	0.7	< 0.1	< 0.1	0.3	0.2
P - value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

[1]Texture profile methods as followed from Bourne (1978).

[2]Treatment lean content presented as: Percent lean / percent fat

[3]Certified Angus Beef

[4]SE (largest) of the least squares means.

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.3 Demographic characteristics of consumers (n = 112) who participated in ground beef sensory panels

Characteristic	Response	Percentage of consumers
Sex	Male	52.8
	Female	47.2
Household size	1 person	9.9
	2 people	31.5
	3 people	17.1
	4 people	19.8
	5 people	13.5
	6 people	1.8
	Over 6 people	6.3
Marital Status	Single	29.6
	Married	70.4
Age Group	Under 20	9.2
	20-29	18.4
	30-39	25.7
	40-49	22.0
	50-59	15.6
	Over 60	9.2
Ethnic origin	African-American	1.8
	Asian	3.7
	Caucasian/White	90.8
	Hispanic	3.7
Annual household income, $	25,000 to 24,999	11.0
	35,000 to 49,999	10.1
	50,000 to 74,999	25.7
	75,000 to 100,000	26.6
	More than 100,000	26.6
Highest level of education completed	Non-high school graduate	5.6
	High school graduate	9.4
	Some college/technical school	34.6
	College graduate	29.0
	Post graduate	21.5
Weekly beef consumption	1 to 3 times	42.7
	4 to 6 times	53.6
	7 or more times	3.6
Most important palatability trait when eating beef	Flavor	69.7
	Juiciness	9.2
	Tenderness	21.1
Meat product most preferred for flavor	Beef	58.3
	Chicken	14.8
	Fish	0.9
	Lamb	6.5
	Pork	9.3
	Shellfish	5.6
	Turkey	2.8
	Venison	1.9

Table 3.4 Fresh ground beef purchasing motivators of consumers (n = 112) who participated in consumer sensory panels

Characteristic	Importance of each trait[1]
Price	73.8[a]
Size, weight and thickness	68.6[ab]
Steak color	67.0[bc]
Familiarity of cut	62.2[bcd]
USDA grade	62.1[bcd]
Marbling level	60.8[cd]
Nutrient content	55.5[d]
Country of origin	48.4[e]
Local	46.1[e]
Eating satisfaction claims (Ex. Guaranteed Tender)	46.0[e]
Animal welfare	43.5[ef]
Antibiotic use in the animal	43.3[ef]
Brand of product	42.6[efg]
Growth promotant use in the animal	37.9[fg]
Natural and Organic claims	36.3[g]
SE[2]	2.4
P – value	< 0.01

[1]Purchasing motivators: 0 = extremely unimportant, 100 = extremely important.
[2]SE (largest) of the least squares means.
[abcdefg]Least squares means lacking a common superscript differ ($P < 0.05$).

Table 3.5 Responses indicating knowledge of brand and perceived quality level of each brand by consumers (n = 112) who participated in ground beef consumer sensory panels

Brand	Consumers with knowledge of brand, %	Perceived quality level by consumers who recognized the brand[1]
Angus Pride	12.2^{e}	7.2^{abc}
Angus Select	33.0^{d}	7.0^{bc}
Black Canyon Angus Beef	23.4^{d}	6.8^{c}
Certified Angus Beef	77.1^{b}	7.6^{ab}
Choice	92.8^{a}	6.8^{c}
Creekstone Farms	10.3^{e}	6.9^{bc}
Prime	86.4^{ab}	8.1^{a}
Private Selection	60.0^{c}	6.9^{c}
Select	82.6^{b}	6.3^{c}
SE[2]	0.4	0.5
P - value	< 0.01	< 0.01

[1]Perceived Quality Level: 1 = very low quality, 10 = very high quality.
[2]SE (largest) of the least squares means.
^{abcde}Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.6 Consumer (n = 112) palatability ratings[1] for blind and informed testing of ground beef patties

Treatment[2]	Tenderness	Juiciness	Flavor Liking	Texture Liking	Overall Liking
Blind Testing					
90/10 ground beef	52.1[b]	45.7[b]	57.1	55.4	55.7
90/10 CAB[3] ground sirloin	60.9[a]	47.2[b]	59.8	60.1	59.3
80/20 ground beef	61.8[a]	58.4[a]	60.8	59.3	61.7
80/20 ground chuck	61.6[a]	55.0[a]	61.2	58.7	59.5
80/20 CAB[3] ground chuck	58.5[a]	52.4[ab]	54.0	57.4	57.0
73/27 CAB[3] ground beef	62.2[a]	56.9[a]	57.3	56.5	58.8
SE[3]	2.3	3.0	2.7	2.2	2.5
P - value	0.01	< 0.01	0.25	0.62	0.56
Informed Testing					
90/10 ground beef	57.1[c]	51.6[b]	60.7[b]	57.7[b]	59.4[b]
90/10 CAB[3] ground sirloin	71.2[a]	62.0[a]	72.5[a]	69.7[a]	72.2[a]
80/20 ground beef	61.4[bc]	62.2[a]	61.6[b]	58.5[b]	61.6[b]
80/20 ground chuck	60.1[bc]	56.8[ab]	58.9[b]	57.9[b]	59.8[b]
80/20 CAB[3] ground chuck	61.7[bc]	58.7[a]	63.7[b]	60.1[b]	62.8[b]
73/27 CAB[3] ground beef	64.1[b]	62.4[a]	59.4[b]	59.7[b]	59.7[b]
SE[4]	2.3	2.3	2.2	1.8	1.9
P - value	< 0.01	0.01	< 0.01	< 0.01	< 0.01

[1]Sensory scores: 0 = not tender/juicy, dislike flavor/texture/overall extremely; 50 = neither tough nor tender, dry nor juicy, or neither like or dislike flavor/texture/overall; 100 = very tender/juicy, like flavor/texture/overall extremely.

[2]Treatment lean content presented as: Percent lean / percent fat

[3]Certified Angus Beef

[4]SE of the least squares means.

[abc]Least squares means in the same section (blind or informed) of the same column and lacking a common superscript differ ($P < 0.05$).

Table 3.7 Percentage change in consumer (n = 112) ratings[1] of palatability traits due to product and brand disclosure

	%				
Treatment[2]	Tenderness	Juiciness	Flavor Liking	Texture Liking	Overall Liking
90/10 ground beef	13.8*	18.9*	6.6[b]	5.2[b]	7.9[b]
90/10 CAB[3] ground sirloin	17.4*	36.5*	23.3[a]*	18.2[a]*	24.7[a]*
80/20 ground beef	3.1	10.5	4.6[b]	0.8[b]	2.0[b]
80/20 ground chuck	-0.8	5.8	-2.9[b]	-0.2[b]	2.0[b]
80/20 CAB[3] ground chuck	6.9	18.6*	22.4[a]*	6.0[b]	11.5[b]*
73/27 CAB[3] ground beef	4.5	12.8	6.8[b]	8.9[ab]*	4.3[b]
SE[4]	5.5	8.7	5.5	4.3	4.6
P - value	0.16	0.07	< 0.01	0.04	< 0.01

[1]Percent change: (consumer informed scores – consumer blind scores) / consumer blind scores

[2]Treatment lean content presented as: Percent lean / percent fat

[3]Certified Angus Beef

[4]SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.8 Percentage of ground beef patties of varying treatments considered acceptable for tenderness, juiciness, flavor, tenderness and overall liking by consumers (n = 112)

Treatment[1]	Tenderness Acceptability	Juiciness Acceptability	Flavor Acceptability	Texture Acceptability	Overall Liking Acceptability
Blind Testing					
90/10 ground beef	72.7[b]	63.1[b]	76.0	80.5	74.1
90/10 CAB[2] ground sirloin	87.3[a]	63.1[b]	77.8	79.6	81.4
80/20 ground beef	86.4[a]	78.7[a]	83.4	81.4	83.1
80/20 ground chuck	89.8[a]	77.4[a]	82.3	86.2	79.4
80/20 CAB[2] ground chuck	85.3[a]	69.0[ab]	72.6	81.9	72.0
73/27 CAB[2] ground beef	85.5[a]	80.5[a]	79.9	84.9	77.8
SE[3]	4.3	5.4	5.4	4.8	5.0
P - value	0.02	0.01	0.41	0.77	0.35
Informed Testing					
90/10 ground beef	82.2[c]	64.6[c]	80.6	82.4[c]	81.4
90/10 CAB[2] ground sirloin	95.7[a]	82.9[ab]	94.0	96.8[a]	94.9
80/20 ground beef	86.9[bc]	83.6[ab]	82.4	82.3[c]	82.5
80/20 ground chuck	87.7[bc]	77.3[b]	84.0	84.0[c]	86.9
80/20 CAB[2] ground chuck	89.6[abc]	79.3[b]	86.0	89.3[bc]	87.9
73/27 CAB[2] ground beef	93.9[ab]	90.0[a]	83.2	92.6[ab]	89.5
SE[3]	4.1	4.6	4.2	4.5	4.3
P - value	0.03	< 0.01	0.11	0.01	0.06

[1]Treatment lean content presented as: Percent lean / percent fat

[2]Certified Angus Beef

[3]SE of the least squares means.

[abc]Least squares means in the same section (blind or informed) of the same column and lacking a common superscript differ ($P < 0.05$).

Table 3.9 Change in the percentage of ground beef patties of varying treatments considered acceptable for tenderness, juiciness, flavor, texture and overall liking by consumers (n = 112) due to brand disclosure

Treatment[1]	Tenderness Acceptability	Juiciness Acceptability	Flavor Acceptability	Texture Acceptability	Overall Liking Acceptability
90/10 ground beef	8.3*	2.0	5.6^{abc}	1.8^{b}	6.4
90/10 CAB[2] ground sirloin	8.1	20.9*	18.2^{a}*	18.0^{a}*	13.5*
80/20 ground beef	0.0	5.6	-1.8^{c}	0.9^{b}	-0.9
80/20 ground chuck	-2.8	0.1	1.9^{bc}	-2.8^{b}	7.3
80/20 CAB[2] ground chuck	4.5	11.0*	13.0^{ab}*	8.2^{ab}	16.2*
73/27 CAB[2] ground beef	8.1	10.1	2.8^{bc}	8.1^{ab}	11.8*
SE[3]	4.2	5.5	4.8	4.4	4.6
P - value	0.26	0.05	0.03	0.01	0.11

[1]Treatment lean content presented as: Percent lean / percent fat

[2]Certified Angus Beef

[3]SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.10 Percentage of ground beef patties of varying treatments categorized by perceived eating quality level by consumers (n = 112)

Treatment[1]	Unsatisfactory Quality	Everyday Quality	Better than Everyday Quality	Premium Quality
Blind Testing				
90/10 ground beef	20.0	50.0	22.7	6.2
90/10 CAB[2] ground sirloin	16.4	45.5	32.7	4.6
80/20 commodity ground beef	14.5	49.1	20.0	14.4
80/20 commodity ground chuck	16.5	43.1	32.1	7.1
80/20 CAB[2] ground chuck	20.2	47.7	22.9	7.9
73/27 CAB[2] ground beef	14.5	46.4	31.8	6.2
SE[3]	3.9	4.8	4.5	4.4
P - value	0.78	0.92	0.12	0.10
Informed Testing				
90/10 ground beef	17.0	40.3[a]	36.9[b]	6.2[b]
90/10 CAB[2] ground sirloin	2.7	22.8[b]	51.4[a]	23.2[a]
80/20 ground beef	9.0	49.9[a]	34.6[b]	7.2[b]
80/20 ground chuck	10.9	49.9[a]	34.6[b]	5.4[b]
80/20 CAB[2] ground chuck	9.9	46.7[a]	34.2[b]	9.8[b]
73/27 CAB[2] ground beef	9.0	53.6[a]	29.1[b]	9.0[b]
SE[3]	3.7	5.5	4.7	4.3
P - value	0.05	< 0.01	0.03	< 0.01

[1]Treatment lean content presented as: Percent lean / percent fat

[2]Certified Angus Beef

[3]SE of the least squares means.

[abc]Least squares means in the same section (blind or informed) of the same column and lacking a common superscript differ ($P < 0.05$).

Table 3.11 Change in the percentage of ground beef patties of varying treatments categorized into perceived eating quality levels by consumers (n = 112) due to brand disclosure

Treatment[1]	Unsatisfactory Quality	Everyday Quality	Better than Everyday Quality	Premium Quality
90/10 ground beef	-2.7	-9.6[bc]	13.5**	-0.9[b]
90/10 CAB[2] ground sirloin	-13.5**	-23.1[c]**	18.9**	18.0[a]**
80/20 ground beef	-4.6	-0.6[ab]	14.6**	-9.1[b]**
80/20 ground chuck	-5.5	7.6[a]	0.9	-2.7[b]
80/20 CAB[2] ground chuck	-10.8**	-1.5[ab]	11.7**	0.9[b]
73/27 CAB[2] ground beef	-5.4	6.6[ab]	-1.8	0.9[b]
SE[3]	4.2	6.5	5.9	3.7
P - value	0.43	< 0.01	0.08	< 0.01

[1]Treatment lean content presented as: Percent lean / percent fat

[2]Certified Angus Beef

[3]SE (largest) of the least squares means.

**Mean differs from 0 ($P < 0.05$).

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

Table 3.12 Pearson correlation coefficients among consumer panel sensory scores, proximate composition, and shear force of ground beef

Traits	Tenderness	Juiciness	Flavor Liking	Texture Liking	Overall Liking	Shear Force	Moisture	Protein	Fat
Blind Testing									
Juiciness	0.62**								
Flavor Liking	0.56**	0.60**							
Texture Liking	0.58**	0.45**	0.71**						
Overall Liking	0.65**	0.67**	0.88**	0.81**					
Shear Force	-0.20*	-0.07	-0.02	-0.10	-0.08				
Moisture	-0.17	-0.29**	0.01	0.03	-0.07	0.24*			
Protein	-0.06	-0.01	0.01	-0.10	-0.01	0.21*	0.34**		
Fat	0.18	0.32**	-0.02	-0.02	0.07	-0.23*	-0.83**	-0.42**	
Ash	-0.06	-0.22*	-0.02	0.05	-0.06	-0.19	0.39**	0.20	-0.55**
Informed Testing									
Juiciness	0.72**								
Flavor Liking	0.66**	0.59**							
Texture Liking	0.81**	0.59**	0.73**						
Overall Liking	0.78**	0.61**	0.85**	0.86**					
Shear Force	-0.40**	-0.29**	-0.25*	-0.32**	-0.26*				
Moisture	0.02	-0.26**	0.19	0.18	0.17				
Protein	-0.10	-0.11	0.11	0.03	0.14				
Fat	-0.05	0.19	-0.29**	-0.25*	-0.27**				
Ash	0.15	-0.07	0.32**	0.37**	0.34**				

*Correlation coefficient differs from 0 ($P < 0.05$).

**Correlation coefficient differs from 0 ($P < 0.01$).

Table 3.13 Pearson correlation coefficients among consumer panel sensory scores and texture profile analysis measurements

Trait	Hardness	Cohesiveness	Springiness	Gumminess	Chewiness
Blind Testing					
Tenderness	-0.31**	-0.35**	0.15	-0.33**	-0.29**
Juiciness	-0.34**	-0.48**	-0.13	-0.40**	-0.42**
Flavor Liking	-0.11	-0.09	0.04	-0.11	-0.10
Texture Liking	-0.08	-0.12	0.05	-0.08	-0.07
Overall Liking	-0.23	-0.22	0.00	-0.24*	-0.23
Informed Testing					
Tenderness	-0.13	0.00	0.04	-0.10	0.08
Juiciness	-0.36**	-0.24*	-0.19	-0.35**	-0.37**
Flavor Liking	0.15	0.06	-0.01	0.14	0.14
Texture Liking	-0.02	0.03	0.07	0.00	0.03
Overall Liking	0.01	0.06	0.05	0.03	0.05

*Correlation coefficient differs from 0 ($P < 0.05$).

**Correlation coefficient differs from 0 ($P < 0.01$).

Appendix A -

Appendix B - Consumer Panel Evaluation Forms

INFORMED CONSENT STATEMENT

1. I volunteer to participate in research involving Sensory Evaluation of Meat. This research will be conducted by personnel in the Department of Animal Sciences and Industry at Kansas State University.

2. I fully understand the purpose of the research is for the evaluation of beef steaks, pork chops, lamb chops, goat meat, poultry meat, ground meat, and processed meat products from the previously mentioned species for the sensory traits of tenderness, juiciness, flavor intensity, connective tissue amount, off flavor presence, odor, and color and sensory evaluation will last approximately one hour.

3. I understand that there are minimal risks associated with participating and that those risks are related to possible food allergies. All meat products will be USDA inspected and all ingredients are GRAS (generally accepted as safe) by FDA.

4. I understand that my performance as an individual will be treated as research data and will in no way be associated with me for other than identification purposes, thereby assuring confidentiality of my performance and responses.

5. My participation in this study is purely voluntary; I understand that my refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled and that I may discontinue participation at any time without penalty or loss of benefits to which I am otherwise entitled.

6. If I have any questions concerning my rights as a research subject, injuries or emergencies resulting from my participation, I understand that I can contact the Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, at (785) 532-3224.

7. If I have questions about the rationale or method of the study, I understand that I may contact, Dr. Travis O'Quinn, 247 Weber Hall, Kansas State University, Manhattan, KS 66506, at (785) 532-3469 or Sally Stroda, 107 Weber Hall, at 785-532-1273.

I have read the Subject Orientation and Test Procedure statement and signed this informed consent statement, this _____ day of _____, _____.

_____ _____

Printed name Signature

About Yourself

(Please circle the answer that best describes you for each item)

Gender	**Household Size**	**Marital Status**	**Age**	**Ethnic Origin**
Male	1 person	Single	Under 20	African-American
Female	2 people	Married	20-29	Asian
	3 people		30-39	Caucasian/White
	4 people		40-49	Hispanic
	5 people		50-59	Native American
	6 people		Over 60	Other
	Over 6 people			

Annual Household Income	**Education Level**
$25,000 - $34,999	Non-high School graduate
$35,000 - $49,999	High school graduate
$50,000 - $74,999	Some College/Technical School
$75,000 to $100,000	College graduate
more than $100,000	Post graduate

How many times a week do you consume beef?

1 to 3 4 to 6 7 or more

When eating beef, which palatability trait is the <u>most important</u> to you (circle <u>one</u>)?

Flavor Juiciness Tenderness

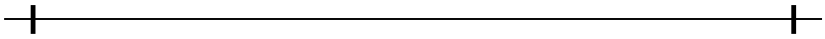
Which meat product do you prefer the <u>flavor</u> of the most (circle <u>one</u>)?

Beef Chicken Fish Lamb Mutton

Pork Shellfish Turkey Veal Venison

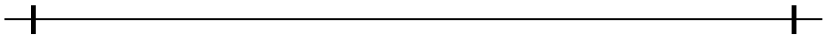
Please indicate the importance of each trait when purchasing fresh beef steaks:

Animal welfare



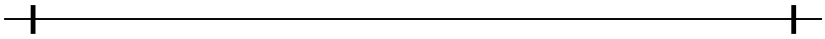
Extremely Unimportant Extremely Important

Antibiotic use in the animal



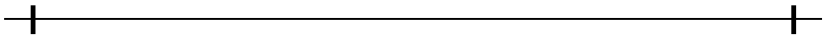
Extremely Unimportant Extremely Important

Brand of product



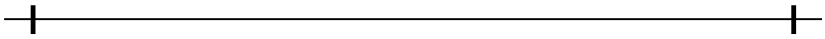
Extremely Unimportant Extremely Important

Country of Origin



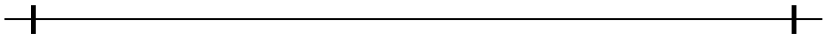
Extremely Unimportant Extremely Important

Eating satisfaction claims
(ex: Guaranteed Tender)



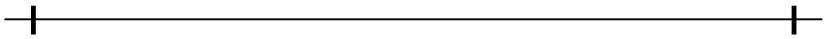
Extremely Unimportant Extremely Important

Familiarity with cut



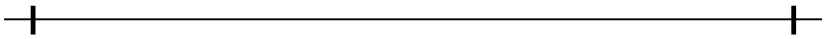
Extremely Unimportant Extremely Important

Growth promotant use
in the animal



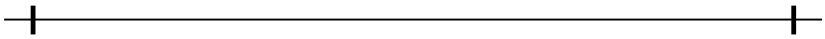
Extremely Unimportant Extremely Important

Marbling level



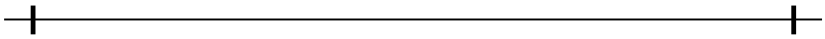
Extremely Unimportant Extremely Important

Natural or Organic claims



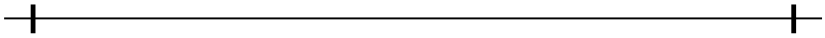
Extremely Unimportant Extremely Important

Nutrient content



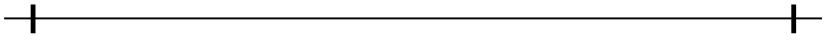
Extremely Unimportant Extremely Important

Local



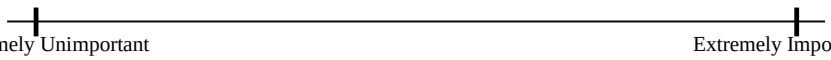
Extremely Unimportant Extremely Important

Price



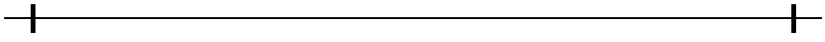
Extremely Unimportant Extremely Important

Size, weight, and thickness



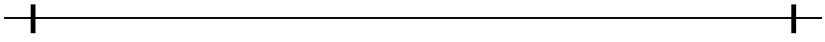
Extremely Unimportant Extremely Important

Steak Color



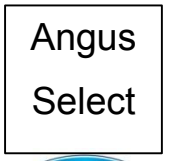
Extremely Unimportant Extremely Important

USDA Grade



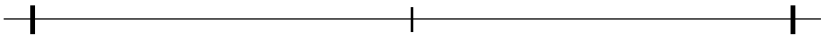
Extremely Unimportant Extremely Important

Please indicate the types, grades or brands of beef you are aware of and the quality level that each represents:

	Have you heard of this brand? (Yes/No)	**What level of quality does this brand represent?** (1-10; 1 = very low quality, 10 = very high quality)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)
	_____ (Yes/No)	_____ (1 – 10; NA if brand is unknown)

Consumer ID: _____ Night: _____ Round: _____ Sample ID: _____

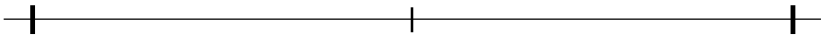
Tenderness:



Extremely Tough | Neither Tough nor Tender | Extremely Tender

Was the steak acceptable for tenderness? Yes _____ No _____

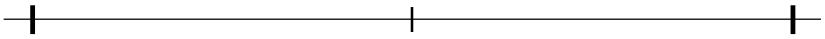
Juiciness:



Extremely Dry | Neither Dry nor Juicy | Extremely Juicy

Was the steak acceptable for juiciness? Yes _____ No _____

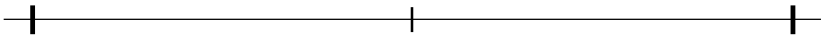
Flavor:



Dislike Extremely | Neither Dislike nor Like | Like Extremely

Was the steak acceptable for flavor? Yes _____ No _____

Overall Liking:



Dislike Extremely | Neither Dislike nor Like | Like Extremely

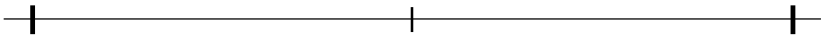
Was the steak acceptable for overall liking? Yes _____ No _____

Please check one of the following to **rate the quality** of the beef sample you have just eaten. Choose only **one** (you must make a choice).

Unsatisfactory	☐	Better than everyday quality	☐
Everyday quality	☐	Premium Quality	☐

Consumer ID: _____ Night: _____ Round: _____ Sample ID: _____

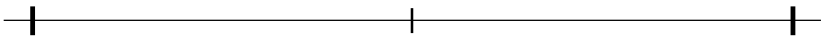
Tenderness:



Extremely Tough | Neither Tough nor Tender | Extremely Tender

Was the product acceptable for tenderness? Yes _____ No _____

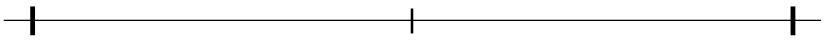
Juiciness:



Extremely Dry | Neither Dry nor Juicy | Extremely Juicy

Was the product acceptable for juiciness? Yes _____ No _____

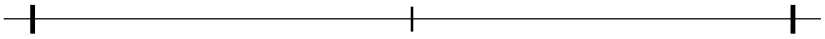
Flavor:



Dislike Extremely | Neither Dislike nor Like | Like Extremely

Was the product acceptable for flavor? Yes _____ No _____

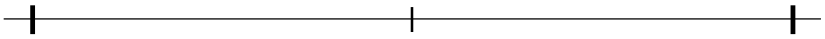
Texture:



Dislike Extremely | Neither Dislike nor Like | Like Extremely

Was the product acceptable for texture? Yes _____ No _____

Overall Liking:



Dislike Extremely | Neither Dislike nor Like | Like Extremely

Was the product acceptable for overall liking? Yes _____ No _____

Please check one of the following to **rate the quality** of the beef sample you have just eaten. Choose only **one** (you must make a choice).

Unsatisfactory	☐	Better than everyday quality	☐
Everyday quality	☐	Premium Quality	☐

Appendix C - Data Sheets

Color and pH

Strip Loin #	pH	L*	a*	b*

Steak Weights and Temperatures

Steak #	Raw Weight	Fat Weight	Cooked Weight	Peak Temperature

Pressed Juice Percentage

Steak #	Press #	Filter Paper Wt.	Filter Pater + Sample	Filter Paper + Juice
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			
	1			
	2			
	3			

Appendix D - Appendix Tables

Table C.1 Change in consumer (n = 112) ratings[1] of palatability traits when sample treatment was disclosed while testing ground beef patties

Treatment[2]	Tenderness	Juiciness	Flavor Liking	Texture Liking	Overall Liking
90/10 ground beef	4.96[ab]*	5.86[b]	3.48[bc]	2.34[b]	3.72[b]
90/10 CAB[3] ground sirloin	10.43[a]*	15.04[a]*	12.51[a]*	9.79[a]*	12.99[a]*
80/20 ground beef	0.03[bc]	4.52[b]	0.99[c]	-0.51[b]	0.10[b]
80/20 ground chuck	-1.47[c]	1.88[b]	-1.85[c]	-0.59[b]	-0.03[b]
80/20 CAB[3] ground chuck	3.27[bc]	6.80[b]	9.73[ab]*	3.16[b]	5.78[b]*
73/27 CAB[3] ground beef	1.80[bc]	5.76[b]	2.04[c]	3.04[b]	0.81[b]
SE[4]	2.47	3.28	2.60	2.21	2.37
P - value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

[abc]Least squares means in the same column lacking a common superscript differ.

[1] Sensory scores: 0 = not tender/juicy, dislike flavor/texture/overall extremely; 50 = neither tough nor tender, dry nor juicy, or neither like or dislike flavor/texture/overall; 100 = very tender/juicy, like flavor/texture/overall extremely.

[2]Treatment lean content presented as: Percent lean / percent fat

[3]Certified Angus Beef

[4] SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

Table C.2 Change in consumer (n = 112) ratings[1] of palatability traits when sample treatment was disclosed while testing beef strip loin steaks

Treatment[2]	Tenderness	Juiciness	Flavor Liking	Overall Liking
Prime	4.11[a]	5.06[a]	7.70[a]*	7.37[a]*
CAB[3]	3.85[a]	5.83[a]	8.21[a]*	5.88[ab]*
Choice	-4.80[bc]	-4.47[b]	-0.71[b]	-2.03[c]
Select	-6.35[c]*	0.13[ab]	4.43[ab]	1.08[bc]
Angus Select	0.75[ab]	5.22[a]	8.96[a]*	6.63[ab]*
SE[4]	2.59	3.16	2.17	2.13
P - value	< 0.01	< 0.01	0.01	< 0.01

[abc]Least squares means in the same column lacking a common superscript differ.

[1]Sensory scores: 0 = not tender/juicy, dislike flavor/overall extremely; 50 = neither tough nor tender, dry nor juicy, or neither like or dislike flavor/overall; 100 = very tender/juicy, like

[2]Treatment lean content presented as: Percent lean / percent fat

[3]Certified Angus Beef

[4]SE (largest) of the least squares means.

*Mean differs from 0 ($P < 0.05$).

Table C.3 Percentage of moisture losses from consumer panel steaks of differing treatments

Treatment	Thaw Loss[1]	Cook Loss[2]	Total Loss[3]
Blind Testing			
Prime	1.75[e]	21.55[a]	23.77[ab]
CAB[4]	1.95[de]	22.04[a]	24.40[a]
Choice	2.06[cde]	23.29[a]	25.55[a]
Select	2.62[ab]	23.85[a]	26.69[a]
Angus Select	2.50[abc]	23.10[a]	25.83[a]
Informed Testing			
Prime	1.88[de]	18.76[b]	21.04[b]
CAB[4]	1.96[de]	21.68[a]	24.05[a]
Choice	2.30[bcd]	22.79[a]	26.16[a]
Select	2.90[a]	22.59[a]	25.78[a]
Angus Select	2.41[abcd]	23.69[a]	26.23[a]
SE[5]	0.19	0.98	1.08
P - value	< 0.01	0.02	0.01

[abcde]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

[1]Thaw Loss: [(raw weight – thaw weight) / raw weight] * 100

[2]Cook Loss: [(thaw weight – cooked weight) / thaw weight] * 100

[3]Total Loss: [(raw weight – cooked weight) / raw weight] * 100

[4]Certified Angus Beef

[5]SE (largest) of the least squares means.