The effect of increased pork hot carcass weights on loin quality, consumer appearance and purchase intent ratings, and palatability ratings of top loin chops

by

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Abstract

The objective of this study was to evaluate the effect of increased pork hot carcass weights on consumer palatability and visual acceptability and purchase intent of top loin chops cut to various thicknesses in a price labeled versus unlabeled retail display scenario. Pork loins (*N* = 200) were collected from 4 different hot carcass weight groups: light (LT; less than 111.8 kg), medium-light (MLT; 111.8 to 119.1 kg), medium-heavy (MHVY; 119.1 to 124.4 kg), and heavy (HVY; 124.4 kg and greater). Loins were fabricated into 4 pairs of chops of specified thicknesses (cm). One chop from each specified thickness was then randomly assigned to be packaged with or without a label. Consumers assessed chops from each weight group × thickness combination in both labeled and unlabeled scenarios. Chops were assessed on a continuous line scale for desirability and purchase intent. After visual evaluation, chops were vacuum packaged and frozen at 10-days postmortem. Chops were then reallocated so that one chop from each loin was assigned to consumer sensory panels and one chop was assigned to trained sensory panels. For visual ratings there was a hot carcass weight × chop thickness interaction ($P < 0.05$) for the percentage of consumers who answered "yes" that the chop was desirable. Within all weight treatments, the lowest ($P < 0.05$) percentage of consumers indicated chops with a thickness of 1.27 cm were desirable. Both appearance and purchase intent ratings increased as hot carcass weight increased. Chops with a thickness of 2.54 and 3.18 cm had the greatest ($P < 0.05$) appearance ratings. Additionally, 1.27 cm thick chops had both the lowest ($P < 0.05$) purchase intent ratings, and the lowest ($P < 0.05$) percentage of consumers who would purchase them. For palatability ratings, consumer found chops from heavier carcasses to be more ($P < 0.05$) acceptable for juiciness and tenderness. Additionally, consumers gave chops from the LT hot carcass weight treatment the lowest ($P < 0.05$) tenderness ratings. Chops from the HVY and

MHVY weight treatment groups were similar ($P > 0.05$) but had the greatest ($P < 0.05$) consumer overall like ratings. Trained panelists gave similar results with chops from the HVY and MHVY hot carcass weight group receiving greater ($P < 0.05$) initial and sustained juiciness ratings compared to chops from lighter carcasses. Additionally, chops form HVY and MHVY carcasses were similar ($P > 0.05$) and had greater ($P < 0.05$) overall tenderness ratings compared to chops form LT carcasses from trained panelists. These results indicated that hot carcass weight and chop thickness can impact consumer purchasing decisions in a retail setting. Additionally, as hot carcass weight increased both tenderness and juiciness palatability characteristics.

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Dedication

I would like to dedicate this thesis to my parents Nicholas and Margaret Rice who have encouraged me throughout this process. I could not have done this without their continuous love and support.

Chapter 1 - Review of Literature

Visual

Factors that influence consumer purchasing decisions

There are many factors that affect consumer preference, behavior, and perception of meat products in a retail setting. In a review by Font-i-Furnols and Guerrero (2014) all the factors pertaining to consumer purchasing behaviors were assessed. These factors were then broken into three interlinked categories, each with multiple subfactors. The first category was titled psychological factors. Factors such as “attitudes and beliefs”, “expectations”, “lifestyle and values”, and “socio-cultural effect” were included in this category. These factors are typically founded on experiences or acquired knowledge and personal characteristics that determine consumer attitudes, buying intentions, and preferences (Font-i-Furnols and Guerrero, 2014). The second category is marketing factors. Marketing factors encompass the price, label, brand, and availability of a product. In a study to evaluate the influence of brand on consumer palatability ratings, Wilfong et al. (2016) reported that when branding information was given to consumers, their palatability scores were positively affected. This study specifically looked at Certified Angus Beef, and acknowledged that in order for there to be a positive effect on palatability scores, the brand should be associated with high quality products. This indicates that consumers rely on brands to help ensure that they are receiving a higher quality product. The third group is sensory factors. Sensory factors include overall visual appearance and palatability factors. Visual intrinsic cues are relied on heavily by consumers to predict meat palatability factors.

The impact of marbling on consumer purchase intent

Visual sensory factors are a cornerstone for the purchasing decisions consumers make at a fresh meat retail case. In a study by Forbes et al. (1974) 45% of consumers indicated that the amount of fat within a beef steak sample was the most important factor influencing their purchasing decisions, followed by color (22%). Savell et al. (1989) also reported that consumers preferred the leanness of USDA Select beef. In a later study, by Killinger et al. (2004a), these observations were reinforced by surveys that indicated a majority of consumers preferred leaner beef with less marbling. Consumer preferences for this study were assessed in both San Francisco, CA, and Chicago, IL. Consumers were asked to evaluate 2 pairs of steaks in a retail case representing different marbling (Moderate vs. Slight) and color (bright cherry red vs. dark red) levels. Although there were differences in magnitude based on city [San Francisco (67%) vs. Chicago (86.7%)].It was hypothesized that consumers who preferred the product with less marbling associated the product to be healthier (Killinger et al., 2004a). Most recently, in a survey that asked consumers to rate fresh beef purchasing motivators, Drey et al. (2018) reported that consumers rated marbling and color similarly ($P > 0.05$) and less ($P < 0.05$) important than price and size, weight, and steak thickness. However, most of these published reports evaluated the impact of appearance characteristics of beef products, with how consumers view these traits in pork relatively unknown.

In 2001, Brewer et al. (2001) produced results that indicated that consumers had a similar reaction to marbling in fresh pork. Consumers were asked to evaluate chops of different marbling levels and rate their purchase intent. Consumers placed 50% of chops categorized as high marbled in the "would not buy" purchase intent category, while only less than 12% of chops categorized as lean were assigned the same purchase intent category (Brewer et al., 2001). These results supported the findings of Fernandez et al. (1999), who concluded that as intramuscular fat levels in pork increased there was a corresponding decrease in the consumers' willingness to purchase and eat that product. Rincker et al. (2008) also saw consumers visually discriminate against chops with greater marbling scores even when they judged them to be more juicy, tender, and flavorful compared to leaner chops. Many of these authors concluded that this observed reaction was a reflection of current trends of health consciousness related to food.

The impact of lean color on consumer purchase intent

Consumers deemed color to be an important visual sensory criteria when purchasing fresh beef in a retail setting (Forbes et al., 1974; Savell et al., 1989). Consumers use beef lean color as a predictor of product freshness and potential palatability (Forbes et al., 1974). When selecting beef steaks, consumers prefer beef steaks with a bright cherry-red color compared to both lighter and darker colored beef (Jeremiah et al., 1972; Forbes et al., 1974; Killinger et al., 2004a).

Similarly, pork lean color is an important factor used by consumers to determine pork quality. Approximately 60% of respondents in a survey indicated that color was used to assess the likelihood of having a satisfactory eating experience (Lusk et al., 2016). However, consumers reacted differently to color when presented with fresh pork in a retail setting in comparison to beef. The slogan "Pork. The other white meat" was launched by the National Pork Board in 1987 as a way to advertise pork as a white meat and emphasize the health benefits that come with that label. This advertising is thought to be the reason that Melton et al. (1996) found that consumers preferred lighter colored pork when put in an auction scenario. Conflictingly, in 1999, Brewer and McKeith (1999) observed that consumers very clearly discriminated against pork that was perceived as "very light pink" by labeling it as "definitely would not purchase". Similarly, in a paper published by Norman et al. (2003) consumers were able to choose a package of pork top loin chops from three different lean color categories ranging from 1 to 6 on the National Pork Producers Council pork lean color scale (Council, 1999). A majority (58%) of consumers chose chops from the group ranging from a color score 5 to 6 confirming that consumers preferred chops that were a darker pink in color. Later in a report, Lusk et al. (2016) reported that an estimated 30 to 40% of consumers perceived lighter, lower quality pork chops to be higher quality. Additionally, it was estimated that 20 to 30% of consumers still selected the lighter lower quality pork chops even when they were labeled with a lower quality grade for the study. Therefore, it is noteworthy that a large population considers visually lighter colored pork as higher quality, but for other consumers, darker colored pork chops are preferred.

The impact of cut size and thickness on consumer selection

In addition to both color and marbling, studies (Sweeter et al., 2005; Leick et al., 2011, 2012) have found that consumers have found size, and thickness to be important factors for consumers when purchasing fresh beef steaks. A study by Sweeter et al. (2005) looked at how consumers reacted to increasing ribeye area in ribeye steaks due to increasing hot carcass weights. The first part of the study was held in a retail store where the authors monitored the amount of time steaks with different longissimus muscle sizes stayed in the retail case before being purchased by consumers. They reported that longissimus muscle size had no impact on the amount of time the steaks stayed in the retail case before being purchased by consumers (Sweeter et al., 2005). In the second section of the study consumers were given $15.00 to use to purchase packages of three different sized steaks to determine their willingness to purchase. It was reported that in a bidding scenario, consumers were willing to pay $1.50/kg premium for steaks from the largest hot carcass weight group with longissimus dorsi areas averaging 98.7 cm^2 (15.3 in^2) (Sweeter et al., 2005). This indicated that consumers preferred ribeye steaks with a larger surface area. Leick et al. (2011) looked at consumer selection of constant-weight ribeye, top loin, and sirloin steaks. Consumers were asked to evaluate all three steak types separately on different tables and were informed the steaks weighed the same. As the hot carcass weight for each subprimal began to increase, the steaks cut from each subprimal were consequently thinner to maintain the constant weight for portion-controlled cutting. There were no differences for the percentage of steaks selected by consumers for the different weight groups for both the top loin and sirloin steaks (Leick et al., 2011). However, consumers selected the greatest ($P < 0.05$) percentage of ribeye steaks form the heaviest carcass weight group (Leick et al., 2011). This is thought to be due to the increased steak surface area as a result of heavier hot carcass weights and is consistent with the results from Sweeter et al. (2005). When consumers were asked to rank visual traits (color, marbling, texture, thickness, and other) as the most important selection criteria, consumers indicated that marbling (36%) was the most important trait when selecting ribeye beef steaks, followed by thickness (26.9%) (Leick et al., 2011). However, for both top loin and sirloin steaks consumers indicated that thickness was the most important trait that they use for selection. Leick et al. (2012) hypothesized that consumers felt that they were getting more for their money with the thicker cut steaks, and that consumers placed more importance on visual cues when making purchasing decisions in a retail setting. To date there are no papers that assess the effect on increased hot carcass weight on consumer acceptability and purchase intent of retail cuts in pork.

The impact of price on consumer selection

Studies have shown that consumers are more willing to pay premium prices for beef steaks that have characteristics that they find important (Killinger et al., 2004a; Killinger et al., 2004b; Platter et al., 2005; Sweeter et al., 2005). In a follow up study, Leick et al. (2012) included price in the study to determine how consumers would react once price became a factor. Consumers where again asked to evaluate constant weight ribeye, top loin, and sirloin steaks from carcasses of different hot carcass weights, and choose 3 steaks from each subprimal that they would be most likely to purchase in a retail setting. When consumers were asked to rank color, marbling, price, texture, and thickness, for all 3 cuts (ribeye, sirloin, and top loin) color, marbling, and thickness were ranked as more important than price (Leick et al., 2012). Additionally, for sirloin steaks thickness was ranked as the most important trait affecting purchasing intent. In a study by Platter et al. (2005), beef top loin steaks of 4 quality grades (USDA Select, Low Choice, Upper 2/3 Choice, and Prime) were auctioned to consumers in a victory auction scenario with Warner-Bratzler shear force tenderness information included. Consumers were willing to pay a $2.47/kg premium for steaks that had Prime marbling. Although, as quality grade and corresponding price increased the mean number of bids by consumers decreased with Prime steaks having fewer bids than Select steaks. Additionally, there was a $2.09 increase in mean bid price for steaks that sheared less than 3.4 kg and were considered very tender. This indicates that price does play a role in consumer purchasing decisions; however, consumers are willing to pay a greater amount of money for products that meet their expectations visually.

Palatability

Palatability defined

Visual quality cues encourage consumers to make the initial purchase of a meat product, but consistent overall eating satisfaction encourages consumers to pay premiums and make repeat purchases (Shackelford et al., 2001; Lyford et al., 2010). Palatability is defined by three factors: tenderness, juiciness, and flavor, which all contribute to overall eating experience (Bratzler, 1971; Smith and Carpenter, 1974; Miller et al., 1995a; Platter et al., 2003a; Emerson et al., 2013; O'Quinn et al., 2018). Of the three palatability factors, until the early 2000s, many studies claimed tenderness to be the most important influencer of palatability (Miller et al., 1995b; Huffman et al., 1996; Platter et al., 2003b) and many studies reported approximately 50% of consumers rated tenderness to be the most important palatability factor to them. More recent research indicates that consumers are beginning to rate flavor as important or more important than tenderness. Woolley et al. (2015) reported that 44.6% of consumers found flavor to be the most important palatability trait when eating beef steaks. Most recently, Drey et al. (2018) reported over half (52%) found flavor to be the most important palatability trait. Additionally, a greater percentage of consumers are finding juiciness to be the most important palatability trait. Consumer juiciness importance ratings have not had as significant of an increase compared to flavor with only increasing from 10% (Miller et al., 1995b; Huffman et al., 1996) to only 14.1% (McKillip et al., 2017), and 13.1% (Drey et al., 2018) in the last 12 years.

Although consumers rate both tenderness and flavor to be more important than juiciness when assessing palatability, a product needs to meet expectations in more than just one of the 3 traits to be considered satisfactory (Savell and Cross, 1988; Aberle et al., 2001; O'Quinn et al., 2018). O'Quinn et al. (2018) assessed the importance of tenderness, juiciness, and flavor, and the risk to palatability if one or more of those traits were to fail. Using 11 previously conducted studies, they reported that if only one trait, tenderness, juiciness, or flavor, fail there is a 69%, 66%, and 77% chance that the overall palatability of that product will fail, respectively. When all three traits fail there is a 95% chance the steak will fail to be acceptable for palatability overall. Therefore, regardless of the performance of one palatability trait, the other palatability traits need to meet expectations for a product to be considered acceptable by consumers.

The effect of color on pork palatability

The pork industry uses lean color to determine potential eating quality. Color is also used as a selection criteria for many premium and export programs. Many studies have assessed color and its influence on palatability. In a study by Norman et al. (2003), the authors assessed the palatability ratings of pork top loin chops of different color scores according to the National Pork Producers Council color scores (A = 1 & 2, B = 3 & 4, C = 5 & 6). Consumers were given the opportunity to select a package of chops from the 3 different color categories to do an in-home evaluation. Consumers reported that they liked the tenderness and juiciness of chops from the darker colored C category more ($P < 0.05$) than paler colored chops (Norman et al., 2003). Similarly, trained panelists also gave greater ($P < 0.05$) tenderness and juiciness scores to chops from the darker color category (Norman et al., 2003). Since a darker color is typically indicative of a higher pH, increased juiciness and tenderness scores are the cause of increased water holding capacity (Brewer and McKeith, 1999). When consumers were asked to repeat chop selection after the in-home portion, a greater ($P < 0.05$) percentage of chops from the darker color category were selected (Norman et al., 2003). Moeller et al. (2010a) assessed the impact of L* values on trained panelist ratings. They concluded that greater L* values (61.9 to 65; lighter in color) were consistently associated with unfavorable responses. While L* values that were 49.9 or lower (darker chops) were had elevated juiciness, tenderness, and flavor ratings from trained panelists.

The effect of marbling on pork palatability

In beef, USDA quality grades are used to predict palatability. Greater degrees of marbling are typically associated with greater palatability scores for tenderness, juiciness, and flavor. Savell and Cross (1988) suggested that there be a minimum threshold of approximately

3% to obtain acceptable palatability. In pork, the effect of marbling on palatability has produced conflicting results. Some studies saw improvements in tenderness as pork top loin chops increased in marbling content (Dikeman, 1987; DeVol et al., 1988; Brewer et al., 2001; Cannata et al., 2010). Brewer et al. (2001) reported that chops with greater amount of marbling (3 to 3.5% intramuscular fat levels) were rated as more juicy, tender, and flavorful ($P < 0.05$) resulting in a more acceptable overall palatability. In a study by Cannata et al. (2010) researchers assessed the impact of raw and cooked intramuscular fat percentages of pork loins from different marbling score groups. For both raw and cooked intramuscular fat analysis as visual marbling score increased so did intramuscular fat percentages ($P < 0.05$) (Cannata et al., 2010). Additionally, there was a significant ($P < 0.05$) increase in trained panel tenderness and juiciness ratings (Cannata et al., 2010). Marbling score 1 chops had lower ($P < 0.05$) tenderness scores compared to marbling score 2 and 3 chops. Furthermore, marbling score 1 chops were less ($P < 0.05$) juicy than chops from marbling score 3 (Cannata et al., 2010). Moeller et al. (2010b) fed top loin chops with an intramuscular fat percentage from 1 to 6% to consumers and observed that as intramuscular fat percentage increased, there was a linear increase for consumer ratings (Moeller et al., 2010b). Chops with a intramuscular fat percentage of 6% had greater consumer ratings for overall like, juiciness like and level, tenderness like and level, flavor like and level, and likelihood to purchase (Moeller et al., 2010b). In a similar study Moeller et al. (2010a) assessed trained panel ratings and as intramuscular fat increased to 6% juiciness, tenderness, fat flavor, and lean flavor ratings all increased. The trained panelists also rated chop chewiness as lower as intramuscular fat increased (Moeller et al., 2010a).

However, Novakofski (1987) stated that once intramuscular fat levels exceed 3.25% there is no longer a linear beneficial effect. Rincker et al. (2014) looked at the influence of intramuscular fat on palatability and did see some statistical differences showing marbling did improve tenderness, and juiciness for consumer sensory ratings up to 4.5% intramuscular fat. however the differences ($P < 0.05$) detected did not continue after 4.5% intramuscular fat percentage. Additionally, there were no differences ($P > 0.05$) for Warner-Bratzler shear force tenderness values as intramuscular fat percentage increased (Rincker et al., 2014).

The effect of pork carcass weight on pork quality

In a review by Wu et al. (2017), the authors looked at the market weights of pigs in the United States and determined if yearly increases in markets weights continue, it is unknown how consumers will react to retail cuts form heavier pigs, or if there will be any quality defects associated with them. Overall pork quality relies heavily on the pork quality factors pH, color, drip loss percentage, Warner-Bratzler shear force tenderness, cook loss percentage, and marbling (Cannata et al., 2010). These quality factors are important for consumer preference, palatability, and the overall product functionality. Although there have been studies that assessed the impact of pork hot carcass weight on pork quality, there has been minimal work at the predicted carcass weights expected in the next 50 years.

Multiple studies have looked at pH differences of carcasses of increasing hot carcass weight. A lower pH can negatively affect color, drip loss, Warner-Bratzler shear force, and consumer palatability scores (van Laack et al., 2001). As pork hot carcass weights increased, Martin et al. (1980) and Beattie et al. (1999) showed a significant decrease in pH at 1 hour postmortem; however, they reported no significant differences at 24 hour or ultimate pH. A study by Virgili et al. (2003) compared pigs at 8 months of age and at 10 month of age with a weight difference of 38.2 kg. They observed a reduction in the pH of the semimembranosus muscle at 1 hour and 24 hours as market weight increased. Cisneros et al. (1996) and Park and Lee (2011) reported similar findings with a reduction in pH at 45 minute and 1 hour as well as at the 24 hour postmortem. Both reported a 0.02 unit reduction per 10 kg of body weight for 24 hour postmortem pH. Additionally, Harsh et al. (2017) reported a decrease in ultimate boneless loin pH as hot carcass weight increased. Conversely, Bertol et al. (2015) observed an 0.01 increase in pH per 10 kg as hot carcass weight increased.

There are conflicting data for instrumental color readings. For L*, both Durkin et al. (2012) and Park and Lee (2011) reported no differences in L* values as weight increased from 120 to over 170 kg and from 116 to 135 kg. Latorre et al. (2004) found an increase in L* values as weight increased from 116 to 133 kg, while Virgili et al. (2003) saw lower L* values in Italian pig carcasses. Additionally, Harsh et al. (2017) found that as hot carcass weight increased boneless loins became darker as evidenced by a lower L* value.

Similar to L*, a*, and b* values also produce conflicting results related to increased carcass weights. Latorre et al. (2004), Durkin et al. (2012), and Harsh et al. (2017) reported that as hot carcass weights increase, lean color becomes redder, with increasing a* values. Virgili et al. (2003) and Park and Lee (2011) reported no differences in a* values as carcass weight increased. Studies by Weatherup et al. (1998), Beattie et al. (1999), and Durkin et al. (2012) reported that b* values increased or had a more yellow lean color as carcass weight increased. While Virgili et al. (2003) and Latorre et al. (2004) reported decreases in b* values in lean color.

There are also conflicting results for drip loss percentage as hot carcass weight increases. Cisneros et al. (1996) and Park and Lee (2011) all reported an increase in drip loss as hot carcass weight increased. While Virgili et al. (2003) reported that drip loss percentage decreased as carcass weight increased.

For Warner-Bratzler shear force tenderness, Cisneros et al. (1996) reported a slight decrease is shear force tenderness values as hot carcass weight increased. Additionally, Harsh et al. (2017) found slice shear forces means lower for loins from heavier carcasses indicating a more tender product. However, Martin et al. (1980) reported an increase in Warner-Bratzler shear force tenderness means as hot carcass weights increased indicating a tougher product. Beattie et al. (1999) and Latorre et al. (2004) observed no significant differences in Warner-Bratzler shear force tenderness means as hot carcass weights increased.

Marbling is closely associated with palatability traits such as tenderness and juiciness, which both play a part in overall palatability (Cannata et al., 2010). Cisneros et al. (1996), Correa et al. (2006), and Harsh et al. (2017) reported no differences in subjective marbling score as hot carcass weight increased. However, Harsh et al. (2017) found that loins from heavier carcasses displayed a greater amount of marbling on the ventral side of the boneless loin. Other studies found an increase in subjective marbling scores as hot carcass weight increased (Cisneros et al., 1996; Huff-Lonergan et al., 2002; Park and Lee, 2011).

Few studies have looked at the sensory traits of heavy weight market pigs and with conflicting results. Cisneros et al. (1996) reported that as market weight increased from 100 to 160 kg they observed a decrease in both tenderness and juiciness scores. Inversely, Huff-Lonergan et al. (2002) reported an increase in juiciness ratings as carcass weight increased as well as an increase in off-flavor presence. Park and Lee (2011) reported a significant increase in off-flavor of raw pork loins as market weight increases, but no differences were detected in off flavor after cooking.

Therefore, the data for pork quality characteristics of heavy weight pork carcasses is very conflicting. Additionally, much of the data was taken on a live weight scale and from carcasses of genetic lines that are not common to the pork industry in the United States.

The effect of degree of doneness on pork palatability

Many studies in beef have demonstrated that internal degree of doneness can dramatically impact palatability. Lorenzen et al. (1999) cooked longissimus muscle beef steaks to different degrees of doneness (55, 60, 63, 71, 77, 82 °C) and reported that as internal temperature increased both tenderness and juiciness ratings were negatively impacted. In pork, similar results have been found. Moeller et al. (2010b) assessed the consumer palatability ratings of top loin chops at 4 different internal degrees of doneness (62.8, 68.3, 73.9, and 79.4 °C). These authors reported that as degree of doneness increased, consumer ratings for overall like, juiciness, tenderness, and flavor like all decreased (Moeller et al., 2010b). Similarly, juiciness, tenderness and flavor level ratings also decreased as well as likelihood to purchase with increased degrees of doneness. This indicates that consumers prefer the palatability characteristics of pork cooked at lower temperatures. In a complimentary study, Moeller et al. (2010a) reported the palatability ratings of trained panelists as degree of doneness increased. Again with trained panelists, they found that juiciness, tenderness, and flavor levels were all negatively impacted as degree of doneness increased (Moeller et al., 2010a).

In another study that assessed degree of doneness, Simmons et al. (1985) used pork top loin chops cooked to the internal temperatures of 60, 70, and 80°C. Using trained sensory panelists, Simmons et al. (1985) reported that as degree of doneness increased there was a decrease in both tenderness and juiciness for both oven and grill cooking methods. Additionally, they recorded an increase in cooking loss percentage with a subsequent loss in moisture percentage (Simmons et al., 1985). Although trained panelist ratings indicated there were palatability differences between different degrees of doneness, there were no differences in Warner-Bratzler shear force values (Simmons et al., 1985).

Slaughter chilling practices

Harvest practices can either positively or negatively impact palatability. Since muscle can only function under certain physiological conditions, once an animal is harvested, muscle will gradually lose its ability to function. This process of post mortem changes is the muscle to meat conversion process. After the animal is exsanguinated, the circulatory system can no longer perform actions such as transporting oxygen and nutrients, or removing waste products and heat. When oxygen in the muscle is depleted, the muscle can no longer use glycolysis to produce ATP, and anaerobic pathways are utilized in an attempt to maintain homeostasis (Huff-Lonergan and Page, 2001). When anaerobic pathways are used for energy production, lactate is produced as a by-product. Since the circulatory system is no longer capable of removing lactate from the muscle it builds up in the muscle until the until the glycogen reserves in the muscle are depleted (Huff-Lonergan and Page, 2001). This gradual buildup of Lactate results in a decline in muscle pH from the 7.4 pH of living muscle to approximately 5.6 within approximately a 24 h period. If an animal has an greater amount of stored glycogen, or a high rate of metabolism prior to slaughter this could affect both rate or extent of pH decline ultimately impacting meat quality. When the muscle to meat conversion process is normal, the gradual pH decline (7.4 to 5.6) there will be a decrease water holding capacity and an increase in shelf life. However if there is a rapid, severe decline of pH in muscle postmortem, this can result in the denaturation of the proteins in meat, especially myoglobin which is responsible for meat color (Huff-Lonergan and Page, 2001). This denaturation caused by pH can result in lighter color because severely denatured proteins tend to reflect rather than absorb light, as well as a reduced ability to bind water. Meat products that result from this condition are called pale, soft, and exudative (**PSE**). Pork with PSE conditions can also be the result of increased temperature of the muscle shortly after slaughter resulting from higher metabolic rates or stress prior to slaughter or a genetic predisposition (Halothane gene). After exsanguination, there is no way for the muscle to regulate temperature and remove heat (Huff-Lonergan and Page, 2001). As heat increases there is a subsequent increase of metabolism causing an accelerated pH decline. PSE conditions occur when the pH of meat drops below 5.8 while the muscle temperature exceeds 35°C (95°F) ultimately damaging the proteins in meat (Huff-Lonergan and Page, 2001).

In order to prevent PSE conditions due temperature and pH, Many processing facilities utilize blast chilling (Savell et al., 2005). Chilling pork carcasses quickly after exsanguination can effectively alter temperature and pH decline and reducing the chance of having high temperature and lower pH conditions by slowing the metabolic processes (Huff-Lonergan and Page, 2001). Although this rapid drop in temperature positively impact both color and water holding capacity, it can negatively affect product tenderness (Jeremiah et al., 1992; Jones et al., 1993). In the study by Jeremiah et al. (1992), they reported that there was a decrease in palatability ratings for both initial and overall tenderness as blast chill time increased from 1 hour to 2 hours. When the temperature of the muscle is dropped to very low temperatures early in the muscle to meat conversation process, it causes the sarcoplasmic reticulum to become destabilized (Huff-Lonergan and Page, 2001). When sarcoplasmic reticulum becomes destabilized it leaks calcium ultimately signaling the muscle to contract shortening the muscle. This shortening causes the muscle to become more dense leading to a less tender product. Cold shortening is the a decline in muscle temperature to less than 0 to 15°C before the onset of rigor mortis causing a shortened sarcomere length Herring et al. (1965) demonstrated that a decreased sarcomere length directly affected muscle fiber diameter and negatively impacted tenderness. Smaller diameter muscles closer to the exterior of the carcass are more susceptible to chilling induced toughening (Huff-Lonergan and Page, 2001). In beef it has been shown that increased fat cover can help to reduce the extent of cold shortening because it acts as insulation (Dolezal et al., 1982). Smith et al. (1976) observed that the increases in fat thickness, allowed carcasses to chill more slowly and allowed for more proteolytic enzyme activity to take place ultimately reducing the toughening effects in lamb carcasses and it was hypothesized that the increased fat cover acted as insulation.

Literature Cited

Aberle, E. D., J. C. Forrest, D. E. Gerrard, and E. W. Mills. 2001. Principles of Meat Science. 4th ed. Kendall/Hunt Publishing Company, Dubuque, IA.

Beattie, V. E., R. N. Weatherup, B. W. Moss, and N. Walker. 1999. The effect of increasing carcass weight of finishing boars and gilts on joint composition and meat quality. Meat Sci. 52:205-211. doi:10.1016/S0309-1740(98)00169-7

Bertol, T. M., E. A. Oliveira, A. Coldebella, V. L. Kawski, A. J. Scandolera, and M. B. Warpechowski. 2015. yield of pigs slaughtered over 100 kg live weight. Arq Bras Med Vet Zootec:1166-1174. doi:dx.doi.org/10.1592/1678-4162-8113

Bratzler, L. J. 1971. Palatability factors and evaluations. In: J. F. Price and B. S. Schiweigert, editors, The science of meat and meat products. W. H. Freeman and Company, San Francisco, Calif.

Brewer, M. S., and F. K. McKeith. 1999. Consumer-rated Quality Characteristics as Related to Purchase Intent of Fresh Pork. 64:171-174. doi:doi:10.1111/j.1365-2621.1999.tb09885.x

Brewer, M. S., L. G. Zhu, and F. K. McKeith. 2001. Marbling effects on quality characteristics of pork loin chops: consumer purchase intent, visual and sensory characteristics. Meat Sci. 59:153-163. doi:10.1016/S0309-1740(01)00065-1

Cannata, S., T. E. Engle, S. J. Moeller, H. N. Zerby, A. E. Radunz, M. D. Green, P. D. Bass, and K. E. Belk. 2010. Effect of visual marbling on sensory properties and quality traits of pork loin. Meat Sci. 85:428-434. doi:10.1016/j.meatsci.2010.02.011

Cisneros, F., M. Ellis, F. K. McKeith, J. McCaw, and R. L. Fernando. 1996. Influence of slaughter weight on growth and carcass characteristics, commercial cutting and curing yields, and meat quality of barrows and gilts from two genotypes. J. Anim. Sci. 74:925-933. doi:10.2527/1996.745925x

Correa, J. A., L. Faucitano, J. P. Laforest, J. Rivest, M. Marcoux, and C. Gariépy. 2006. Effects of slaughter weight on carcass composition and meat quality in pigs of two different growth rates. Meat Sci. 72:91-99. doi:10.1016/j.meatsci.2005.06.006

DeVol, D. L., F. K. McKeith, P. J. Bechtel, J. Novakofski, R. D. Shanks, and T. R. Carr. 1988. Variation in Composition and Palatability Traits and Relationships between Muscle Characteristics and Palatability in a Random Sample of Pork Carcasses1. J. Anim. Sci. 66:385-395. doi:10.2527/jas1988.662385x

Dikeman, M. E. 1987. Fat reduction in animals and the effects on palatability and consumer acceptance of meat products. Reciprocal Meat Conference. p 93-103.

Dolezal, H., G. Smith, J. Savell, and Z. Carpenter. 1982. Comparison of subcutaneous fat thickness, marbling and quality grade for predicting palatability of beef. J. Food Sci. 47:397-401.

Drey, L. N., L. L. Prill, B. A. Olson, E. A. Rice, J. M. Gonzalez, J. L. Vipham, T. A. Houser, E. A. E. Boyle, and T. G. O'Quinn. 2018. Evaluation of marbling and enhancement's abilities to compensate for reduced beef palatability at elevated degrees of doneness. J. Anim. Sci.:sky435-sky435. doi:10.1093/jas/sky435

Durkin I., Dadic M., Brkic D., Lukic B., Kusec G., Mikolin M., Jerkovic I. 2012. Influence of gender and slaughter weight on meat quality traits of heavy pigs. Acta Agric. Slov. 3:211–214.

Emerson, M. R., D. R. Woerner, K. E. Belk, and J. D. Tatum. 2013. Effectiveness of USDA instrument-based marbling measurements for categorizing beef carcasses according to differences in longissimus muscle sensory attributes. J. Anim. Sci. 91:1024-1034. doi:10.2527/jas.2012-5514

Fernandez, X., G. Monin, A. Talmant, J. Mourot, and B. Lebret. 1999. Influence of intramuscular fat content on the quality of pig meat — 2. Consumer acceptability of m. longissimus lumborum. Meat Sci. 53:67-72. doi:10.1016/S0309-1740(99)00038-8

Font-i-Furnols, M., and L. Guerrero. 2014. Consumer preference, behavior and perception about meat and meat products: An overview. Meat Sci. 98:361-371. doi:10.1016/j.meatsci.2014.06.025

Forbes, S. M. C., M. Vaisey, R. Diamant, and C. R. 1974. The Relationships Between Consumer Criteria for Choosing Beef and Beef Quality. Can. Inst. **Food** Sci. Technol. J. 7:130-135. doi:10.1016/S0315-5463(74)73878-0

Harsh, B. N., E. K. Arkfeld, D. A. Mohrhauser, D. A. King, T. L. Wheeler, A. C. Dilger, S. D. Shackelford, and D. D. Boler. 2017. Effect of hot carcass weight on loin, ham, and belly quality from pigs sourced from a commercial processing facility. J. Anim. Sci. 95:4958-4970. doi:10.2527/jas2017.1674

Herring, H. K., R. G. Cassens, and E. J. Rriskey. 1965. Further studies on bovine muscle tenderness as influenced by carcass position, sarcomere length, and fiber diameter. J. Food Sci. 30:1049-1054.

Huff-Lonergan, E., T. J. Baas, M. Malek, J. C. M. Dekkers, K. Prusa, and M. F. Rothschild. 2002. Correlations among selected pork quality traits. J. Anim. Sci. 80:617-627. doi:10.2527/2002.803617x

Huff-Lonergan, E., and J. Page. 2001. The role of carcass chilling in the development of pork quality. National Pork Producers Council, Des Moines, IA.

Huffman, K. L., M. F. Miller, L. C. Hoover, C. K. Wu, H. C. Brittin, and C. B. Ramsey. 1996. Effect of beef tenderness on consumer satisfaction with steaks consumed in the home and restaurant. J. Anim. Sci. 74:91-97.

Jeremiah, L. E., Z. L. Carpenter, and G. C. Smith. 1972. Beef color as related to consumer acceptance and palatability. 37:476-479. doi:doi:10.1111/j.1365-2621.1972.tb02667.x

Jeremiah, L. E., S. D. M. Jones, A. K. W. Tong, G. Kruger, and R. Gibson. 1992. The effects of gender and blast-chilling time and temperature on cooking properties and palatability of pork longissimus muscle. Can. J. Anim. Sci. 72:501-506. doi:10.4141/cjas92-062

Jones, S. D. M., L. E. Jeremiah, and W. M. Robertson. 1993. The effects of spray and blast-chilling on carcass shrinkage and pork muscle quality. Meat Sci. 34:351-362. doi:10.1016/0309-1740(93)90083-T

Killinger, K., C. R. Calkins, W. Umberger, D. M. Feuz, and K. M. Eskridge. 2004a. Consumer visual preference and value for beef steaks differing in marbling level and color. J. Anim. Sci. 82:3288-3293.

Killinger, K. M., C. R. Calkins, W. J. Umberger, D. M. Feuz, and K. M. Eskridge. 2004b. Consumer sensory acceptance and value for beef steaks of similar tenderness, but differing in marbling level. J. Anim. Sci. 82:3294-3301.

Latorre, M. A., R. Lázaro, D. G. Valencia, P. Medel, and G. G. Mateos. 2004. The effects of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs. J. Anim. Sci. 82:526-533. doi:10.1093/ansci/82.2.526

Leick, C. M., J. M. Behrends, T. B. Schmidt, and M. W. Schilling. 2011. Consumer selection of constant-weight ribeye, top loin, and sirloin steaks. Meat Sci. 87:66-72. doi:10.1016/j.meatsci.2010.09.004

Leick, C. M., J. M. Behrends, T. B. Schmidt, and M. W. Schilling. 2012. Impact of price and thickness on consumer selection of ribeye, sirloin, and top loin steaks. Meat Sci. 91:8-13. doi:10.1016/j.meatsci.2011.11.021

Lorenzen, C. L., T. R. Neely, R. K. Miller, J. D. Tatum, J. W. Wise, J. F. Taylor, M. J. Buyck, J. O. Reagan, and J. W. Savell. 1999. Beef customer satisfaction: cooking method and degree of doneness effects on the top loin steak. J. Anim. Sci. 77:637-644.

Lusk, J., G. Tonsor, T. Shroeder, and D. Hayes. 2016. Consumer Valuation of Pork Chop Quality Information. npb# 15-198. National Pork Board.

Lyford, C., J. Thompson, R. Polkinghorne, M. Miller, T. Nishimura, K. Neath, P. Allen, and E. Belasco. 2010. Is willingness to pay (WTP) for beef quality grades affected by consumer demographics and meat consumption preferences. Australasian Agribusiness Review 18:1-17.

Martin, A. H., A. P. Sather, H. T. Fredeen, and R. W. Jolly. 1980. Alternative Market Weights for Swine. II. Carcass Composition and Meat Quality. J. Anim. Sci. 50:699-705. doi:10.2527/jas1980.504699x

McKillip, K. V., A. K. Wilfong, J. M. Gonzalez, T. A. Houser, J. A. Unruh, E. A. E. Boyle, and T. G. O'Quinn. 2017. Sensory Evaluation of Enhanced Beef Strip Loin Steaks Cooked to 3 Degrees of Doneness. 1:227-241. doi:10.22175/mmb2017.06.0033

Melton, B. E., W. E. Huffman, and J. F. Shogren. 1996. Economic Values of Pork Attributes: Hedonic Price Analysis of Experimental Auction Data. Rev. Agr. Econ. 18:613-627. doi:10.2307/1349594

Miller, M. F., L. C. Hoover, K. D. Cook, A. L. Guerra, K. L. Huffman, K. S. Tinney, C. B. Ramsey, H. C. Brittin, and L. M. Huffman. 1995a. Consumer acceptability of beef steak tenderness in the home and restaurant. J. Food Sci. 60:963-965.

Miller, M. F., K. L. Huffman, S. Y. Gilbert, L. L. Hamman, and C. B. Ramsey. 1995b. Retail consumer acceptance of beef tenderized with calcium chloride. J. Anim. Sci. 73:2308-2314.

Moeller, S. J., R. K. Miller, T. L. Aldredge, K. E. Logan, K. K. Edwards, H. N. Zerby, M. Boggess, J. M. Box-Steffensmeier, and C. A. Stahl. 2010a. Trained sensory perception of pork eating quality as affected by fresh and cooked pork quality attributes and end-point cooked temperature. Meat Sci. 85:96-103. doi:10.1016/j.meatsci.2009.12.011

Moeller, S. J., R. K. Miller, K. K. Edwards, H. N. Zerby, K. E. Logan, T. L. Aldredge, C. A. Stahl, M. Boggess, and J. M. Box-Steffensmeier. 2010b. Consumer perceptions of pork eating quality as affected by pork quality attributes and end-point cooked temperature. Meat Sci. 84:14-22. doi:10.1016/j.meatsci.2009.06.023

National Pork Producers Council. 1999. Official color and marbling standards. NPPC, Des Moines, IA.

Norman, J. L., E. P. Berg, H. Heymann, and C. L. Lorenzen. 2003. Pork loin color relative to sensory and instrumental tenderness and consumer acceptance. Meat Sci. 65:927-933. doi:10.1016/S0309-1740(02)00310-8

Novakofski, J. 1987. Repartitioned pork. Sensory quality and consumer acceptance Proc. University of Illinois Pork Ind. Conf,. p 84.

O'Quinn, T. G., J. F. Legako, J. C. Brooks, and M. F. Miller. 2018. Evaluation of the contribution of tenderness, juiciness, and flavor to the overall consumer beef eating experience1. Transl. Anim. Sci. 2:26-36. doi:10.1093/tas/txx008

Park, B., and C. Lee. 2011. Feasibility of increasing the slaughter weight of finishing pigs. J. Anim. Sci. Technol. 53:211–222. doi:10.5187/JAST.2011.53.3.211

Platter, W. J., J. D. Tatum, K. E. Belk, P. L. Chapman, J. A. Scanga, and G. C. Smith. 2003a. Relationships of consumer sensory ratings, marbling score, and shear force value to consumer acceptance of beef strip loin steaks. J. Anim. Sci. 81:2741-2750.

Platter, W. J., J. D. Tatum, K. E. Belk, S. R. Koontz, P. L. Chapman, and G. C. Smith. 2005. Effects of marbling and shear force on consumers' willingness to pay for beef strip loin steaks. J. Anim. Sci. 83:890-899. doi:/2005.834890x

Platter, W. J., J. D. Tatum, K. E. Belk, J. A. Scanga, and G. C. Smith. 2003b. Effects of repetitive use of hormonal implants on beef carcass quality, tenderness, and consumer ratings of beef palatability. J. Anim. Sci. 81:984-996.

Rincker, P. J., J. Killefer, M. Ellis, M. S. Brewer, and F. K. McKeith. 2008. Intramuscular fat content has little influence on the eating quality of fresh pork loin chops1. J. Anim. Sci. 86:730-737. doi:10.2527/jas.2007-0490

Rincker, P. J., J. Killefer, M. Ellis, M. S. Brewer, and F. K. Mckeith. 2014. Intramuscular fat content has littler influence on eating quality of fresh pork loin chops. J. Anim. Sci. 86:730- 737. doi:10.2527/jas.2007-0490

Savell, J. W., and H. R. Cross. 1988. The role of fat in the palatability of beef, pork, and lamb. Designing Foods: Animal Product Options in the Marketplace. National Academy Press, Washington, D.C.

Savell, J. W., H. R. Cross, J. J. Francis, J. W. Wise, D. S. Hale, D. L. Wilkes, and G. C. Smith. 1989. National consumer retail beef study: Interaction of trim level, price and grade on consumer acceptance of beef steaks and roasts. J. Food Qual. 12:251-274.

Savell, J. W., S. L. Mueller, and B. E. Baird. 2005. The chilling of carcasses. Meat Sci. 70:449-459. doi:10.1016/j.meatsci.2004.06.027

Shackelford, S. D., T. L. Wheeler, M. K. Meade, J. O. Reagan, B. L. Byrnes, and M. Koohmaraie. 2001. Consumer impressions of Tender Select beef. J. Anim. Sci. 79:2605-2614.

Simmons, S. L., T. R. Carr, and F. K. McKeith. 1985. Effects of Internal Temperature and Thickness on Palatability of Pork Loin Chops. 50:313-315. doi:doi:10.1111/j.1365-2621.1985.tb13389.x

Smith, G. C., and Z. L. Carpenter. 1974. Eating quality of animal products and their fat content. Changing the fat content and composistion of animal products. National Academy Press, Washington, D.C. p 124-137.

Smith, G. C., T. R. Dutson, R. L. Hostetler, and Z. L. Carpenter. 1976. Fattness, Rate of chilling in lamb. 41:748-756. doi:doi:10.1111/j.1365-2621.1976.tb00717_41_4.x

Sweeter, K. K., D. M. Wulf, and R. J. Maddock. 2005. Determining the optimum beef longissimus muscle size for retail consumers. J. Anim. Sci. 83:2598-2604. doi:10.2527/2005.83112598x

van Laack, R. L. J. M., S. G. Stevens, and K. J. Stalder. 2001. The influence of ultimate pH and intramuscular fat content on pork tenderness and tenderization1. J. Anim. Sci. 79:392-397. doi:10.2527/2001.792392x %J Journal of Animal Science

Virgili, R., M. Degni, C. Schivazappa, V. Faeti, E. Poletti, G. Marchetto, M. T. Pacchioli, and A. Mordenti. 2003. Effect of age at slaughter on carcass traits and meat quality of Italian heavy pigs. J. Anim. Sci. 81:2448-2456. doi:10.2527/2003.81102448x

Weatherup, R. N., V. E. Beattie, B. W. Moss, D. J. Kilpatrick, and N. Walker. 1998. The effect of increasing slaughter weight on the production performance and meat quality of finishing pigs. Animal Science 67:591-600. doi:10.1017/S1357729800033038

Wilfong, A. K., K. V. McKillip, J. M. Gonzalez, T. A. Houser, J. A. Unruh, E. A. E. Boyle, and T. G. O’Quinn. 2016. The effect of branding on consumer palatability ratings of beef strip loin steaks. J. Anim. Sci. 94:4930-4942. doi:10.2527/jas.2016-0893

Woolley, L. D., T. G. O'Quinn, J. F. Legako, J. C. Brooks, and M. F. Miller. 2015. Evaluation of objective juiciness measurement techniques for prediction of subjective taste panel juiciness ratings. Meat Sci. 101:143-144. doi:10.1016/j.meatsci.2014.09.102

Wu, F., K. R. Vierck, J. M. DeRouchey, T. G. O’Quinn, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. C. Woodworth. 2017. A review of heavy weight market pigs: status of knowledge and future needs assessment. Transl. Anim. Sci. 1:1-15. doi:10.2527/tas2016.0004

Chapter 2 - The effect of increased pork hot carcass weights and varying chop thickness on consumer visual appearance and purchase intent ratings

Abstract

The objective of this study was to evaluate the effect of increased pork hot carcass weights on consumer visual acceptability and purchase intent ratings of top loin chops cut to various thicknesses in a price labeled versus unlabeled retail display scenario. Pork loins (N = 200) were collected from 4 different hot carcass weight groups: a light weight group (LT; less than 111.8 kg), medium-light weight group (MLT; 111.8 to 119. kg), medium-heavy weight group (MHVY; 119.1 to 124.4), and a heavy weight group (HVY; 124.4 and greater). Loins were fabricated into 4 pairs of chops of specified thicknesses (1.27, 1.91, 2.54, and 3.18 cm) at day 7, 8, and 9 postmortem. One chop from each specified thickness was then randomly assigned to be packaged with a label and the other to be packaged without a label. Consumers (N = 393; 8 / panel) from the Manhattan, KS, area assessed chops from each weight group × thickness combination in both labeled and unlabeled scenarios. Chops were assessed on a 1 to 100 continuous line scale for desirability and purchase intent. Consumers were also able to indicate if the chop was either desirable or undesirable and if they would or would not purchase. As hot carcass weight increased, there was an increase in loineye area and chop length with chops from HVY carcasses having greater ($P < 0.05$) loineye areas and lengths compared to all other weight treatments. For both appearance and purchase intent ratings, chops from HVY carcasses were given higher ($P < 0.05$) ratings compared to LT chops. Additionally, consumers gave greater ($P < 0.05$) appearance ratings to thicker cut chops. There was a hot carcass weight × chop thickness interaction ($P < 0.05$) for the percentage of consumers that indicated the chop was desirable overall. Regardless of hot carcass weight treatment, chops with a thickness of 1.27 cm had the lowest ($P < 0.05$) percentage of consumers indicate they were desirable overall. Within the LT, and MLT weight treatments chops with a thickness of 1.91 and 2.54 cm were similar ($P > 0.05$) with the greatest ($P < 0.05$) percentage of consumers who indicated they were desirable. Within the HVY weight treatment, chops with a thickness of 2.54 cm had the greatest ($P < 0.05$) percentage of consumers who indicated they were desirable. A greater ($P < 0.05$) percentage of consumers indicated "yes" they would purchase chops cut to a thickness of 2.54 cm compared to all other thicknesses. Additionally, there was a greater ($P < 0.05$) percentage of consumers who indicated they would purchase chops that were unlabeled compared to chops labeled with weight and pricing information. These results indicate that carcass weight and chop thickness can affect consumer preference and purchasing decisions and thus should be considered by retailers when marketing fresh pork loin chops.

Keywords: consumer preference, heavy pigs, hot carcass weight, pork quality, visual

Introduction

Hot carcass weights of pigs have been steadily increasing in the United States as the pork industry has been successful in their efforts to increase growth efficiency and improve genetic selection of lean-type pigs (Wu et al., 2017). These advancements have resulted in a trend for average hot carcass weight to increase 0.59 kg every year since 1995 (USDA, 2018). If this trend continues, it will impact hot carcass weight as well as the resulting size, weight, and thickness of pork top loin chops sold at retail. More importantly, it is unknown what effect these changes will have on consumer acceptance and purchase intent of pork top loin chops.

The preferences consumers have when purchasing fresh meat are important to the meat industry as consumers will not purchase a product that does not meet their expectations (Font-i-Furnols and Guerrero, 2014). Consumers are typically more willing to purchase fresh pork in a retail setting if the product has visual characteristics that they consider desirable (Dransfield et al., 2005). Current research indicates that consumers rely heavily on color and marbling when purchasing fresh pork in a retail setting (Brewer et al., 2001; Norman et al., 2003). Within the beef industry, research has shown consumers more readily select thicker cut steaks compared to thinner cut steaks (Sweeter et al., 2005). Furthermore, in some instances, consumers find thickness, rather than price, to be the most important factor in fresh beef steak selection (Leick et al., 2012). As previous studies indicate consumers rely heavily on thickness when making purchasing decisions, increased carcass weight can affect the thickness of portion-controlled cuts. As carcass weight increases it will ultimately result in thinner chops in portion-controlled cuts (Leick et al., 2011). This could ultimately negatively impact consumer purchase intent. However, currently there are no studies demonstrating how consumer purchase intent is affected by variability in pork top loin chop size and thickness in fresh pork. Therefore, the objective of this study was to determine the impact of increased carcass weight and varying chop thicknesses on consumer preference and purchase intent of pork loin chops.

Materials and Methods

The Kansas State University (**KSU**) Institutional Review Board approved the procedures used in this study (IRB 7440.4, November 2017).

Loin collection, fabrication, and packaging

The pigs used in this study were intentionally raised to reach heavier live weights compared to today's industry standard. Briefly, Lerner et al. (2018) describes how 976 pigs were fed to reach heavier market weights to determine the impact of space allotment on growth performance. At the conclusion of the 160-d trial, pigs were transported to a commercial Midwest processor where harvest took place on 2 separate days (*n* = 100 / d) over a 4-d period. At harvest, carcasses were sorted by hot carcass weight into a light group (**LT**; under 111.8 kg), medium light group (**MLT**; 111.8 to 119.1 kg), medium heavy group (**MHVY**; 119.1 to 124.4 kg), and heavy group (**HVY**; 119.1 to 124.4 kg).Twenty five whole boneless pork loins (Institutional Meat Purchase Specification #413; North American Meat Processors Association, 2014) from each weight treatment group were randomly selected on each harvest day (*N* = 200). They were then vacuum packaged and transported to the KSU Meat Laboratory and stored at 2 to 4°C until fabrication.

Loins were fabricated on day 7, 8, or 9 postmortem (32 to 36 loins/day) the morning prior to consumer visual panels. Loins were cut immediately posterior to the *spinalis dorsi* and the posterior end of the loin was used for all analyses. Loins were fabricated from anterior to posterior with consecutively cut chops paired. Each pair was cut to one of 4 predetermined chop thicknesses (1.27, 1.91, 2.54, and 3.18 cm) using a cutting guide with the order of the thicknesses randomized for each loin. After fabrication, chops were individually weighted, and pressed upon blotting paper (Whatman gel blotting paper, 46 × 57 cm, grade 601; Sigma-Aldrich, St. Louis, MO), with the blotted chop outline traced to later measure chop length, width, and loin eye area. Chop length and width were measured at the widest and longest points on the chop outline. Loin eye area was measured using a USDA grid with equally spaced dots measuring in 0.6 cm^2, excluding accessory muscles surrounding the longissimus dorsi. Length, width, and loineye area for each chop was measured by two different KSU team members and the values were averaged for each measurement.

One chop from each thickness pair was designated to labeled consumer analysis and the mirror chop was designated to unlabeled visual panels. Chops designated for unlabeled visual panels were individually placed on Styrofoam trays (#17S, white; Dyne-a-Pak, Toronto, Ontario) with an absorbent pad. Chops designated for labeled panels were individually placed on a larger Styrofoam tray (#34, white; Dyna-Pak, Toronto, Ontario) and absorbent pad to accommodate the label without covering the chop. Chops were then overwrapped with a PVC film (HIYG Gold Stretch Meat film, O_2 transmission rate = 1,191 cm^3/0.065 m^2/24 h, Berry Plastics Corporation, Evansville, IN). Additionally, for chops assigned to labeled visual panels a KSU Meat Laboratory label containing cut identifications, package weight, package price/kg., and total price was placed on the right side of the package to avoid covering the chop (Figure 2.1). Price per kg was determined by averaging prices at local grocery stores to obtain an average price ($9.94/kg) for the Manhattan, Kansas area. Both labeled and unlabeled packages were labeled with an individual 4-digit code. Chops were held at 2 to 4°C until consumer panels were conducted. Immediately prior to consumer visual evaluation, instrumental color readings and subjective color and marbling scores were determined. Instrumental color values were assessed through the packaging using a Hunter Lab Miniscan spectrophotometer (Illuminant A, 2.54-cm aperture, 10° observer, Hunter Lab Associates Laboratory, Reston, VA). Subjective color and marbling scores were assigned by a trained KSU team member according to the National Pork Producers Council subjective pork quality standards (National Pork Producers Council, 1999). Additionally, chops were vacuum packaged immediately after consumer panels, aged to 10 days postmortem, and frozen at -40°C prior to further analyses.

Consumer visual panels

Panelists (N = 393) were recruited from Manhattan, KS and surrounding areas and paid for their participation. Panels were conducted in the KSU Color Laboratory. Panelists were provided and electronic tablet (Model 5709 HP Stream 7; Hewlett-Packard, Palo Alto, CA) with a digital survey (Version 2417833; Qualtrics Software, Provo, UT) to evaluate chops. Appearance and purchase intent were evaluated on continuous line scales with anchors at 0 (extremely undesirable / extremely unlikely to purchase), 50 (neither desirable or undesirable / would neither purchase or not purchase), and 100 (extremely desirable / extremely likely to purchase). Consumers were also asked to determine if each chop was desirable or undesirable (yes/no) overall and if they would or would not purchase each individual chop. If the consumer indicated they would not purchase a chop, they were then prompted to indicate a reason why: color, firmness, chop size, chop thickness, marbling, external fat, or other. For labeled chops, consumers were given additional options of price/kg., total package price, and total package weight. If the consumer chose “other”, they had the opportunity to type an open-ended response.

Each panel consisted of 8 panelists. Both labeled and unlabeled chops were displayed in two separate coffin style cases (model DMF8; Tyler Refrigeration Corp., Niles, MI) at 2 to 4°C under fluorescent lights (32 W Del-Warm White 3000°K; Phillip Lighting Co., Somerset, NJ) which emitted an average intensity of 2,230 ± 34 lx to replicate a retail experience. Panelists were first asked to fill out a demographics survey and, after further instructions, were taken to a retail case containing the 16 unlabeled packages (one from each weight treatment × chop thickness combination). The survey program randomly assigned the order each chop was viewed by each consumer. After completing the evaluation of the first case, consumers were prompted by the survey to proceed to the second case containing labeled packages with the paired chops from the unlabeled evaluations and chops were evaluated using the procedures mentioned above.

Statistical analyses

Statistical analyses were performed using the PROC GLIMMIX procedure of SAS (SAS Version 9.4; SAS Inst. Inc., Cary, NC). Data was analyzed as a split-split plot design. The model included the whole plot factor of weight treatment and subplot factors of chop thickness and label type and all two-way interactions. For all acceptability data, a model with binomial error distribution was used. For all analyses, the Kenward-Roger approximation was used and α was set at 0.05. The PDIFF option was used to separate means when the overall treatment effect or effect of interactions were significant ($P < 0.05$). For interactions, the SLICE option was used to restrict comparisons to within a single factor

Results

The effect of hot carcass weight and chop thickness on chop size

There was a hot carcass weight × chop thickness interaction ($P < 0.05$) for chop weight represented in Figure 2.2. As chop thickness increased, the chops from all weight treatments became heavier ($P < 0.05$) compared to thinner chops. Additionally, within each thickness, chops from the HVY weight treatment were heavier ($P < 0.05$) than chops form the LT weight treatment. The main effects of hot carcass weight and chop thickness for chop size measurements are reported in Table 2.1. As hot carcass weight increased, there was an increase ($P < 0.05$) in loin eye area, with chops from the HVY weight treatments being larger than all other weight categories and chops from LT weight treatment being smaller ($P < 0.05$) than all other treatments other than MLT. Additionally, chops from the HVY hot carcass weight treatment were longer ($P < 0.05$) than all other weight treatments, which were all similar ($P > 0.05$) in length. However, no differences ($P > 0.05$) were found among all weight treatments for chop width. There was also an increase ($P < 0.05$) in chop size due to chop thickness. Chops with a thickness of 2.54 and 3.18 cm had a greater ($P < 0.05$) loin eye area compared to chops with a thickness of 1.27 cm, with chops cut to a thickness of 1.91 cm being similar ($P > 0.05$) in loin eye area to all thicknesses. There were no differences ($P > 0.05$) in chop width among all chop thickness treatments. For chop length, chops cut to a thickness of 1.27 and 2.54 cm were similar ($P > 0.05$) with greater ($P < 0.05$) chop lengths than chops cut to thickness of 1.91 and 3.81 cm. Although there were statistical differences for loin eye area and chop length when chops were cut to different thicknesses, these differences were minimal.

Chop color and marbling

There was a hot carcass weight × chop thickness interaction ($P < 0.05$; Table 2.2) for L* color readings. Chops cut to a thickness of 1.27 cm from the MLT carcasses had greater ($P < 0.05$) L* values compared to chops from the MHVY carcasses. Additionally, chops cut to a thickness of 1.91 cm within the MLT carcasses were lighter ($P < 0.05$) in color compared to chops from all other hot carcass weight treatments. No differences ($P > 0.05$) were found among weight treatment groups when chops were cut to either 2.54 or 3.18 cm. There was a label type × chop thickness interaction ($P < 0.05$; Table 2.3) for a* values (redness). With the exception of chops cut to a thickness of 2.54 cm, labeled chops had greater a* values compared to unlabeled chops.

There was a hot carcass weight × chop thickness interaction ($P < 0.05$; Table 2.4) for subjective marbling scores. When chops were cut to a thickness of 2.54 cm, chops from the HVY hot carcass weight treatment group had greater ($P < 0.05$) subjective marbling scores compared to chops from both the LT and MHVY weight treatment groups, with chops from the MLT weight treatment being similar ($P > 0.05$) to all other weight treatments. When the chops were cut to a thickness of 3.18 cm, chops from the MLT and HVY weight treatments were similar ($P > 0.05$) for subjective marbling scores and greater ($P < 0.05$) than chops from the LT and MHVY hot carcass weight treatments. No differences ($P > 0.05$) were found among weight treatments for subjective color scores when chops were cut to 1.27 or 1.91 cm thicknesses.

The main effect for instrumental chop color and subjective chop color and marbling are presented in Table 2.5. For instrumental color readings, no differences ($P > 0.05$) were found for both a* and b* color readings among hot carcass weight treatment groups. However, b* was affected by chop thickness as chops cut to a thickness of 1.27 also had greater ($P < 0.05$) b* (more yellow) readings compared to all other treatments. There were no differences ($P > 0.05$) between label types for L* values, but labelled chops possessed greater ($P < 0.05$) b* values compared to unlabeled chops.

There were no differences ($P > 0.05$) among hot carcass weight treatment groups for subjective color scores. However, chops cut to a thickness of 1.27 cm had a lower ($P < 0.05$) subjective color score compared to all other treatments, which were similar ($P > 0.05$). Additionally, labeled chops had a greater ($P < 0.05$) subjective color score compared to unlabeled chops, while no differences ($P > 0.05$) were found between label types for subjective marbling scores.

Consumer demographics

The data obtained from the demographics portion of the survey is summarized in Table 2.6. Of the 393 consumers who participated, over half (52%) were female, and a majority were Caucasian (82.4%). Additionally, 60.2% were between the ages of 20 to 39 years and 29.6% were over the age of 40. A majority (53.0%) of consumers indicated they had obtained a college degree or had completed post-graduate work. Of these consumers, 90.7% ate pork from 1 to 5 times a week, and 82% preferred their pork cooked from medium to well done. Consumers indicated the most important palatability trait when consuming pork was flavor (42.9%).

Additionally, consumers were asked what quality trait was most important to them when purchasing fresh pork in a retail setting. The greatest percentage (32.8%) of consumers indicated that price/kg was the most important purchasing motivator followed closely by color (30.3%). The third most important motivator was chop size (13.7%).

Visual consumer ratings

Consumers were asked to indicate on a continuous line scale an overall appearance rating and their purchase intent for each sample (Table 2.7). Both appearance and purchase intent ratings were affected by hot carcass weight treatment. For both appearance and purchase intent ratings, chops from the HVY and MHVY hot carcass weight treatment groups were similar ($P > 0.05$) and had greater ($P < 0.05$) ratings than chops from the LT hot carcass weight treatment. Chops from the MLT hot carcass weight treatment were similar ($P > 0.05$) to both the MHVY and LT. As chop thickness increased, there was an increase ($P < 0.05$) in consumer appearance ratings, with chops cut to thicknesses of 2.54 and 3.18 cm being similar ($P > 0.05$) and having greater ($P < 0.05$) appearance ratings compared to all other thicknesses. Chops cut to thicknesses of 2.54 and 1.91 cm were similar ($P > 0.05$) and had greater ($P < 0.05$) purchase intent ratings compared to chops cut to a thickness of 1.27 cm. Chops cut to thicknesses of 1.91 and 3.18 cm were similar ($P > 0.05$) for consumer purchase intent ratings. Chops cut to a thickness of 1.27 cm had both the lowest ($P < 0.05$) consumer appearance ratings and consumer purchase intent ratings. There were no differences ($P > 0.05$) between label types for both appearance and purchase intent ratings.

In addition, consumer were asked to indicate "yes" or "no" on whether the appearance was desirable and if they would purchase the package. There was a hot carcass weight treatment × chop thickness interaction ($P < 0.05$; Table 2.8) for the percentage of consumers who indicated "yes" the overall chop appearance was desirable. Within all weight treatments, the lowest ($P < 0.05$) percentage of consumers rated chops with a thickness of 1.27 cm as "yes" they were desirable overall. Additionally, chops with a thickness of 3.18 cm had a lesser ($P < 0.05$) percentage of consumer who indicated they were desirable compared 1.91 and 2.54 cm chops in both the MLT and MHVY weight treatments. For the percentage of consumers who indicated "yes" they would purchase, no differences ($P < 0.05$) were found among hot carcass weight treatments. A greater ($P < 0.05$) percentage of consumers (73.9%) indicated "yes" they would purchase chops cut to a thickness of 2.54 cm compared to all other thicknesses, with the lowest ($P < 0.05$) percentage of consumers (45.9%) indicating "yes" they would purchase chops cut to a thickness of 1.27 cm. Additionally, a greater ($P < 0.05$) percentage of consumers indicated "yes" they would purchase chops in unlabeled packages compared to chops in labeled packages.

If a consumer indicated "no" they would not purchase a certain chop, the survey would then prompt the consumer to give more information as to why they would not purchase. There was a hot carcass weight × chop thickness interaction ($P < 0.05$) for the percentage of consumers who indicated "no" they would not purchase due to chop size presented in Table 2.9. A greater ($P < 0.05$) percentage of consumers indicated "no" they would not purchase chops cut to a thickness of 1.27 cm due to chop size within the LT, MLT, and MHVY hot carcass weight treatments. No differences ($P > 0.05$) were found among chop thicknesses for the percentage of consumers who indicated "no" they would not purchase due to chop size within the HVY hot carcass weight treatment. There was also a chop thickness × label type interaction ($P < 0.05$;

Table 2.10) for the percentage of consumers who indicated “no” they would not purchase due to color. For chops cut to thicknesses of 1.27 and 1.91 cm, a greater ($P < 0.05$) percentage of consumers indicated they would not purchase due to color for unlabeled chops. However, there was an opposite effect for chops with a thickness of 3.18 cm, with a greater ($P < 0.05$) percentage of consumers that indicated “no” they would not purchase labeled chops due to color. No differences ($P > 0.05$) were found between label types for chops cut to a thickness of 2.54 cm.

The main effect data for the reasons stated by consumers for not intending to purchase are presented in Table 2.11. There were no differences ($P > 0.05$) among hot carcass weight treatments for the percentage of consumers who indicated “no” they would not purchase due to chop firmness, marbling, thickness, external fat, shape, purge, price / kg, total package weight, total package price, or other.

Chop thickness did impact the reason consumers indicated they would not purchase chops. A greater ($P < 0.05$) percentage of consumers indicated “no” they would not purchase chops cut to a thickness of 1.91 cm compared to 1.27 cm thick chops for firmness. However, chops cut to a thickness of 2.54 and 3.18 cm were similar ($P > 0.05$) to all other thicknesses for the percentage of consumers who would not purchase due to firmness. For marbling, chops with a thickness of 1.91 and 2.54 cm were similar ($P > 0.05$) with a greater ($P < 0.05$) percentage of consumers who indicated they would not purchase due to marbling compared to chops cut to a thickness of 1.27 and 3.18 cm. For chop thickness, chops cut to the thicknesses of 1.27 and 3.18 cm were similar ($P > 0.05$), with the greatest ($P < 0.05$) percentage of consumers who indicated they would not purchase due to chop thickness. Additionally, chops cut to a thickness of 1.91 cm had the lowest ($P < 0.05$) percentage of consumers who indicated they would not purchase due to chop thickness. For total package weight, a greater ($P < 0.05$) percentage of consumers indicated they would not purchase chops cut to a thickness of 3.18 cm compared to chops cut to both 1.91 and 2.54 cm. For total package price, a greater ($P < 0.05$) percentage of consumers indicated they would not purchase chops cut to a thickness of 3.18 cm compared to chops cut to both 1.91 and 1.27 cm. There were no differences ($P > 0.05$) found between label types for the percentage of consumers who indicated "no" they would not purchase a chop for chop firmness, marbling, thickness, external fat, chop shape, purge, and other

Discussion

As hot carcass weights in the United States pork industry increase, there should be an expected increase in size of the retail cuts that come from those animals. This relationship between hot carcass weights and yield was demonstrated in pork by Cisneros et al. (1996) who observed an increase in the weight of boneless trimmed cuts as slaughter weight increased. Additionally, other studies in beef have yielded similar results (Abraham et al., 1980; Leick et al., 2011). Many different factors can affect consumer purchasing decisions. Although there are many subfactors, visual sensory characteristics such as lean color, marbling, cut size and thickness in addition to price have been shown to drive consumer purchasing decisions (Font-i-Furnols and Guerrero, 2014). In a study by Leick et al. (2012) that evaluated ribeye, sirloin, and top loin beef steaks of varying hot carcass weights and steak thicknesses, the authors asked consumers to rank factors such as color, marbling, steak thickness, price, and texture for beef ribeye, strip loin, and sirloin steaks. For all cuts they reported consumers ranked sensory factors such as color, marbling, and steak thickness to be more important when making purchasing decisions than price (Leick et al., 2012). Additionally consumers placed a great deal of value in the steak thickness, indicating thickness was the most important purchasing factor when selecting sirloin steaks (Leick et al., 2012). There is less data available for pork, but studies have suggested consumers rely heavily on color and marbling when making their purchasing decisions (Brewer et al., 2001; Norman et al., 2003). Therefore, it is important that as market weights increase in the United States swine industry, the subsequent increase in size of top loin chops will not lead to negative effects on the quality traits of color and marbling. It is also important that consumers find the resulting increase in the size of retail cuts acceptable.

The effect of hot carcass weight and thickness on chop size measurements

It is well documented that as hot carcass weight increases, there is a subsequent increase in the size of retail cuts (Abraham et al., 1980; Cisneros et al., 1996; Leick et al., 2011). Ultimately this size increase can result in thinner chops within a portion control cutting setting (Dunn et al., 2000). As expected, in this study there was a hot carcass weight × chop thickness interaction for chop weight. As chop thickness increased, the chops from all weight treatments became heavier compared to chops from the thinner thicknesses. In a study by Cisneros et al. (1996), they looked at the effect of pig slaughter weight, sex, and breed type on yield. They reported as slaughter weight increased, there was also an increase in loin weight, however loineye area was not compared across weight treatments. Similar results were reported by Leick et al. (2011) where they used portion controlled cutting on beef carcasses from different hot carcass weight treatments and reported there was an increase in longissimus muscle area as hot carcass weights increased. Additionally, they also reported that as longissimus muscle area increased, there was a decrease in thickness due to portion controlled cutting (Leick et al., 2011).

The effect of hot carcass weight, chop thickness, and label type on chop color and marbling

The pork industry uses lean color and marbling to determine potential eating quality. There have been conflicting results in the studies that have assessed both instrumental color and subjective color and marbling of pork carcasses with increasing hot carcass weights. Studies, such as Park and Lee (2011) and Durkin et al. (2012), assessed the impact of increased hot carcass weight on color and observed no differences in L* values. In the current study, as weight increased, there was a hot carcass weight × chop thickness interaction for L* color readings. These differences were very small and do not reflect the other studies that reported greater differences in L* values due to increased weight in pigs (Virgili et al., 2003; Latorre et al., 2004; Harsh et al., 2017).

There was also label type × chop thickness interaction for a* values (redness). With the exception of chops cut to a thickness of 2.54 cm, labelled chops had greater a* values compared to unlabeled chops. Though these differences were minor, this interaction may be explained by the methods in our study. Although all chops were allowed an adequate amount of time to bloom before color readings were taken (at least 45 minutes), color readings were measured on all unlabeled chops before labeled chops, as the labels were being applied to the labeled treatment. We believe that the extra time needed to label packages could have allowed labeled chops a greater amount of time to bloom and possibly could explain the observed differences in a* value as well as the label type difference main effect for b* and subjective color scores. Another study that utilized a scanning spectrophotometer measured color differences of chicken breast samples cut to 0.5, 1.0, and 1.5 cm and reported that differences in thickness could affect L*, a*, and b* values (Sandusky and Heath, 1996). Although the current study used pork, the thickness differences could account for the instrumental color differences detected between the thicknesses for both a* and b*.

There were no differences detected between hot carcass weight treatment groups for subjective color, but there were differences in subjective color readings between chop thicknesses, however this difference was very small being only 0.1 with all thicknesses averaging with a color score of 4. In addition to color, marbling has been found to be an important visual cue for consumers when purchasing fresh pork in a retail setting (Fernandez et al., 1999; Brewer et al., 2001; Rincker et al., 2008). Although there were differences found for subjective marbling scores in the current study, these differences did not favor either lighter or heavier hot carcass weights, and are only within two of the chop thickness treatments. Additionally, the differences are very small with at most a 0.4 difference between weight treatments. These results are contradictory to similar studies that reported increased marbling scores as hot carcass weight increased (Cisneros et al., 1996; Huff-Lonergan et al., 2002; Park and Lee, 2011; Harsh et al., 2017).

The effect of hot carcass weight and chop thickness on visual consumer ratings

Visual sensory factors are a cornerstone for the purchasing decisions consumers make at the fresh meat retail case. These visual factors include lean color, marbling, chop size, and cut thickness (Font-i-Furnols and Guerrero, 2014). As hot carcass weights increased there were significant differences in some of these visual factors that consumers were able to detect in the current study. When consumers were asked to evaluate the overall appearance of chops and purchase intent on a line scale, for both appearance and purchase intent, consumers gave higher ratings as hot carcass weight treatment increased indicating that consumers found the chops from the heavier carcasses to be more appealing overall and had a greater intent to purchase them.

This is contradictory to a study by Sweeter et al. (2005) that assessed how increased ribeye area in beef steaks affected consumer purchasing decisions in a retail store by determining how long it took for each steak to be purchased at a local grocery store. They reported that there were no differences in the amount of time the steaks of difference sizes stayed on the shelf. (Sweeter et al., 2005). They concluded that hot carcass weight did not impact consumer purchasing decisions, unlike the current study where consumers preferred chops from heavier carcasses.

In addition to hot carcass weight, chop thickness impacted consumer ratings. Consumers found thicker chops to be more appealing, however, they were more willing to purchase chops with a thickness of 2.54 cm. This indicates that consumers prefer chops that are thicker, and is consistent with similar studies conducted in beef. Leick et al. (2011) asked consumers participating in their visual study with portion controlled cut beef steaks from different hot carcass treatments, which visual trait was most important when purchasing beef steaks in a retail setting. For both top loin and sirloin steaks, consumers indicated that cut thickness was the most important trait, and they hypothesized that consumers felt they were getting more for their money with thicker cut steaks, even though the steaks were all cut to the same weight (Leick et al., 2011). In a follow-up study, Leick et al. (2012), performed a similar study but added price as a factor. Again, when consumers were asked to rank the most important factors when purchasing beef steaks, and for all three cuts, color, marbling, and thickness were all ranked higher than price, and indicated consumers placed a greater importance on visual cues, and less on price. Additionally, they reported that consumers in the greater household income brackets in their survey selected a greater percentage of the least expensive ribeye steaks in comparison to consumers in the lesser income brackets (Leick et al., 2012). This lead them to believe that a factor other than price impacted consumer selections of ribeye steaks. The overall appearance and purchase intent ratings in the current study also indicate this as there were no differences between chops that were labeled with pricing information and unlabeled chops.

In addition to the appearance and purchase intent, consumers in the current study were asked a “yes” or “no” question on if the chop’s overall appearance was desirable, and if they would purchase the chop. Within all hot carcass weight treatment groups, chops cut to a thickness of 1.27 cm, had the lowest percentage of consumers who indicated “yes” they were desirable. Similarly, in beef Maples et al. (2018) used a digital survey to assess how beef steak thickness impacted consumer purchasing decisions and reported that a majority of consumers disliked thinner steaks. Although hot carcass weight did not impact the percentage of consumer who indicated “ yes” they would purchase a chop, chop thickness was affected. A greater percentage of consumers indicated “yes” they would purchase chops from the middle thicknesses (1.91 and 2.54 cm), compared to chops cut both the thinnest or the thickest thickness. This indicates that when making a purchasing decision, although consumers like the appearance of the thicker chops, they can be cut too thick as well as too thin for the consumers to actually purchase them. Additionally, when asked if they would or wouldn’t purchase a chop, a greater percentage of consumer indicated “yes” they would purchase samples that were unlabeled. This could indicate that consumers were more willing to purchase chops that had no pricing information and demonstrating that price could play a greater role in consumer purchasing decisions when purchasing fresh pork.

If a consumer in the current study indicated “no” they would not purchase a chop, the survey would then prompt the consumer to give more information as to why they would not purchase. There was a chop thickness × label type interaction for the percentage of consumers who indicated “no” they would not purchase due to color. Chops with the thicknesses of 1.27 and

1.91 cm had a greater percentage of consumers who indicated they would not purchase unlabeled chops due to color, and the opposite effect was seen in chops cut to a thickness of 3.18 cm. We are uncertain why this interaction occurred. However, this could in part be due to the differences in L* values as chop thickness increased.

There was a hot carcass weight × chop thickness interaction for the percentage of consumer who indicated “no” they would not purchase a chop due to chop size. Within all hot carcass weight treatments except HVY, of the consumers who indicated they would not purchase, the greatest percentage indicated they would not purchase chops with a thickness of 1.27 due to chop size. This indicates that consumer purchase decisions are heavily impacted by chop thickness. These results are similar to the results published by Leick et al. (2011). Although the beef steaks used in their study were not purposefully cut to different thicknesses, they used portion controlled cutting which ultimately resulted in different steak thicknesses. They reported that consumers gave greater ratings to thicker cut steaks, and hypothesized it was due to consumers thinking they were getting more compared to thinner steaks with a greater eye area (Leick et al., 2011). For the percentage of consumers who indicated “no” they would not purchase due to chop thickness, there was a main effect for the treatment chop thickness. Both the thinnest (1.27 cm) and the thickest (3.18 cm) cut chops had the greatest percentage of consumers who would not purchase them due to their thickness. This shows that chops can be cut both too thin and too thick from consumer preferences. Additionally, chop thickness had an effect on the percentage of consumers who said they would not purchase due to package weight and package price. As chop thickness increased there was an increase in package weight which subsequently increased the package price. Chops cut to a thickness of 3.18 cm had a greater percentage of consumers who indicated “no” they would not purchase due to total package weight compared to chops cut to a thickness of 1.91 and 2.54 cm. Additionally, as chop thickness increased, a greater percentage of consumers indicated "no" they would not purchase due to package price. Therefore, as both package weight and price increased it negatively impacted purchasing decisions. This data is in line with the data collected in the demographics portion of the survey where a majority (42.7%) of consumers answered that they found pricing to be the most important when purchasing fresh pork in a retail setting. This is not consistent with the demographic purchasing preference information published by Leick et al. (2012). They reported that for all three beef cuts (ribeye, sirloin, and top loin) they recorded that consumers ranked color, marbling and thickness as more important than price, and for sirloins thickness was ranked the most important. However, in a different study by Platter et al. (2005), they used an auction scenario, where the number of bids and the highest bid was recorded. Consumers were willing to pay more for higher quality steaks, but the number of bids by consumers was greater for the less expensive steaks. Ultimately this indicates that price does play a role in consumer purchasing decisions. As there are no quality grades in pork to add value, it plays more of a role in consumer purchasing decisions of pork than it does beef.

Overall, carcass weight, chop thickness, and label type affected consumer overall desirability and purchase intent for fresh pork. Consumers indicated that chops from heavier carcasses and chops that were thicker were more desirable. However, as carcass weight increased, thicker chops became less desirable to consumers. Additionally, consumers were more likely to purchase chops with a thickness of 2.54 cm, indicating that chops could become too thick as well as too thin for consumers. In beef, consumers rank overall appearance as more important than price when making purchasing decisions (Savell et al., 1989). Similar to the work in beef, in our study, consumers' valuation of price was not dependent on appearance (hot carcass weight or thickness). Thus, consumers did not negatively discriminate against chops from heavy weight groups due to increased price.

Literature Cited

Abraham, H. C., C. E. Murphey, H. R. Cross, G. C. Smith, and W. J. Franks, Jr. 1980. Factors Affecting Beef Carcass Cutability: an Evaluation of the USDA Yield Grades for Beef. J. Anim. Sci. 50:841-851. doi:10.2527/jas1980.505841x

Brewer, M. S., L. G. Zhu, and F. K. McKeith. 2001. Marbling effects on quality characteristics of pork loin chops: consumer purchase intent, visual and sensory characteristics. Meat Sci. 59:153-163. doi:10.1016/S0309-1740(01)00065-1

Cisneros, F., M. Ellis, F. K. McKeith, J. McCaw, and R. L. Fernando. 1996. Influence of slaughter weight on growth and carcass characteristics, commercial cutting and curing yields, and meat quality of barrows and gilts from two genotypes. J. Anim. Sci. 74:925-933. doi:10.2527/1996.745925x

Dransfield, E., T. M. Ngapo, N. A. Nielsen, L. Bredahl, P. O. Sjödén, M. Magnusson, M. M. Campo, and G. R. Nute. 2005. Consumer choice and suggested price for pork as influenced by its appearance, taste and information concerning country of origin and organic pig production. Meat Sci. 69:61-70. doi:10.1016/j.meatsci.2004.06.006

Dunn, J. L., S. E. Williams, J. D. Tatum, J. K. Bertrand, and T. D. Pringle. 2000. Identification of optimal ranges in ribeye area for portion cutting of beef steaks1. J. Anim. Sci. 78:966-975. doi:10.2527/2000.784966x

Durkin I., Dadic M., Brkic D., Lukic B., Kusec G., Mikolin M., Jerkovic I. 2012. Influence of gender and slaughter weight on meat quality traits of heavy pigs. Acta Agric. Slov. 3:211–214.

Fernandez, X., G. Monin, A. Talmant, J. Mourot, and B. Lebret. 1999. Influence of intramuscular fat content on the quality of pig meat — 2. Consumer acceptability of m. longissimus lumborum. Meat Sci. 53:67-72. doi:10.1016/S0309-1740(99)00038-8

Font-i-Furnols, M., and L. Guerrero. 2014. Consumer preference, behavior and perception about meat and meat products: An overview. Meat Sci. 98:361-371.

Harsh, B. N., E. K. Arkfeld, D. A. Mohrhauser, D. A. King, T. L. Wheeler, A. C. Dilger, S. D. Shackelford, and D. D. Boler. 2017. Effect of hot carcass weight on loin, ham, and belly quality from pigs sourced from a commercial processing facility. J. Anim. Sci. 95:4958-4970. doi:10.2527/jas2017.1674

Huff-Lonergan, E., T. J. Baas, M. Malek, J. C. M. Dekkers, K. Prusa, and M. F. Rothschild. 2002. Correlations among selected pork quality traits. J. Anim. Sci. 80:617-627. doi:10.2527/2002.803617x

Latorre, M. A., R. Lázaro, D. G. Valencia, P. Medel, and G. G. Mateos. 2004. The effects of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs. J. Anim. Sci. 82:526-533. doi:10.1093/ansci/82.2.526

Leick, C. M., J. M. Behrends, T. B. Schmidt, and M. W. Schilling. 2011. Consumer selection of constant-weight ribeye, top loin, and sirloin steaks. Meat Sci. 87:66-72. doi:10.1016/j.meatsci.2010.09.004

Leick, C. M., J. M. Behrends, T. B. Schmidt, and M. W. Schilling. 2012. Impact of price and thickness on consumer selection of ribeye, sirloin, and top loin steaks. Meat Sci. 91:8-13. doi:10.1016/j.meatsci.2011.11.021

Lerner, A. B., M. D. Tokach, J. M. DeRouchey, S. S. Dritz, R. D. Goodband, T. G. O'Quinn, J. M. Gonzales, E. A. Rice, M. W. Allerson, H. E. Price, and J. C. Woodworth. 2018.

Effects of Space Allowance and Marketing Strategy on Growth Performance of Pigs Raised to Heavy Market Weights. Kansas Agricultural Experiment Station Research Reports 4. doi:10.4148/2378-5977.7687

Maples, J. G., J. L. Lusk, and D. S. Peel. 2018. Unintended consequences of the quest for increased efficiency in beef cattle: When bigger isn't better. Food Policy 74:65-73. doi:10.1016/j.foodpol.2017.11.005

National Pork Producers Council. 1999. Official color and marbling standards. NPPC, Des Moines, IA.

Norman, J. L., E. P. Berg, H. Heymann, and C. L. Lorenzen. 2003. Pork loin color relative to sensory and instrumental tenderness and consumer acceptance. Meat Sci. 65:927-933. doi:10.1016/S0309-1740(02)00310-8

Park, B., and C. Lee. 2011. Feasibility of increasing the slaughter weight of finishing pigs. J. Anim. Sci. Technol. 53:211–222. doi:10.5187/JAST.2011.53.3.211

Platter, W. J., J. D. Tatum, K. E. Belk, S. R. Koontz, P. L. Chapman, and G. C. Smith. 2005. Effects of marbling and shear force on consumers' willingness to pay for beef strip loin steaks. J. Anim. Sci. 83:890-899. doi:/2005.834890x

Rincker, P. J., J. Killefer, M. Ellis, M. S. Brewer, and F. K. McKeith. 2008. Intramuscular fat content has little influence on the eating quality of fresh pork loin chops1. J. Anim. Sci. 86:730-737. doi:10.2527/jas.2007-0490

Sandusky, C. L., and J. L. Heath. 1996. Effect of Background Color, Sample Thickness, and Illuminant on the Measurement of Broiler Meat Color1. Poult. Sci. 75:1437-1442. doi:10.3382/ps.0751437 %J Poultry Science

Savell, J. W., H. R. Cross, J. J. Francis, J. W. Wise, D. S. Hale, D. L. Wilkes, and G. C. Smith. 1989. National consumer retail beef study: Interaction of trim level, price and grade on consumer acceptance of beef steaks and roasts. J. Food Qual. 12:251-274.

Sweeter, K. K., D. M. Wulf, and R. J. Maddock. 2005. Determining the optimum beef longissimus muscle size for retail consumers. J. Anim. Sci. 83:2598-2604. doi:10.2527/2005.83112598x

USDA. 2018. Hogs: Federally Inspected Slaughter Average Dressed Weight by Month and Year, US https://www.nass.usda.gov/Charts_and_Maps/Livestock_Slaughter/hgdrwgx8.php (Accessed 6 June, 2018.

Virgili, R., M. Degni, C. Schivazappa, V. Faeti, E. Poletti, G. Marchetto, M. T. Pacchioli, and A. Mordenti. 2003. Effect of age at slaughter on carcass traits and meat quality of Italian heavy pigs. J. Anim. Sci. 81:2448-2456. doi:10.2527/2003.81102448x

Wu, F., K. R. Vierck, J. M. DeRouchey, T. G. O'Quinn, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. C. Woodworth. 2017. A review of heavy weight market pigs: status of knowledge and future needs assessment. Transl. Anim. Sci. 1:1-15. doi:10.2527/tas2016.0004

Table 2.1 Least squares means for size measurements and subjective color and marbling scores of pork top loin chops

	Loin eye area, cm^2	Width, cm	Length, cm
Carcass weight[1]			
LT	72.4[c]	7.3	12.0[b]
MLT	75.1[bc]	7.4	12.0[b]
MHVY	76.2[b]	7.5	12.2[b]
HVY	80.9[a]	7.7	12.6[a]
SEM[2]	1.17	0.1	0.1
P - value	< 0.01	0.07	< 0.01
Chop thickness, cm			
1.27	74.9[b]	7.5	12.3[a]
1.91	75.9[ab]	7.4	12.1[b]
2.54	77.1[a]	7.5	12.4[a]
3.18	76.4[a]	7.5	12.1[b]
SEM[2]	0.71	0.09	0.06
P - value	< 0.01	0.84	< 0.01

[abc]Least squares means within weight treatment or chop thickness differ ($P < 0.05$).

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and greater.

[2]SEM (largest) of the least square means in the same section of the same column.

Table 2.2 Hot carcass weight × chop thickness interaction (P = 0.04) for L*[1] color readings

Carcass weight[2]	Chop thickness, cm			
	1.27	1.91	2.54	3.18
LT	58.7[ab]	58.1[b]	58.4	58.4
MLT	58.8[a]	58.7[a]	58.5	58.3
MHVY	58.0[b]	58.1[b]	58.0	57.9
HVY	58.6[ab]	58.0[b]	58.1	58.4
SEM[3]	0.50	0.50	0.50	0.50
P - value	0.02	0.04	0.08	0.06

[ab]Least squares means within a chop thickness differ ($P < 0.05$).

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

[2]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and greater.

[3]SEM (largest) of the least square means in the same column.

Table 2.3 Label type × chop thickness interaction (*P* = 0.03) for a*[1] color readings of pork top loin chops from carcasses of various weights cut to 4 chop thicknesses.

Label type[2]	Chop thickness, cm			
	1.27	1.91	2.54	3.18
Labelled	18.7[a]	17.7[a]	17.5	17.5[a]
Unlabeled	18.2[b]	17.5[b]	17.4	17.3[b]
SEM[3]	0.08	0.08	0.08	0.08
P - value	< 0.01	0.03	0.06	< 0.01

[ab]Least squares means within a chop thickness differ ($P < 0.05$).

[1]a* (redness; ; – 60 = green and 60 = red)

[2]Package label: labeled contained price and weight information and unlabeled packages did not contain a label

[3]SEM (largest) of the least square means in the same column.

Table 2.4 Hot carcass weight × chop thickness interaction (*P* = 0.02) for subjective marbling scores[1] for pork top loin chops from varying hot carcass weights with 4 different chop thicknesses.

Carcass weight[1]	Chop thickness, cm			
	1.27	1.91	2.54	3.18
LT	2.4	2.3	2.2[b]	2.2[b]
MLT	2.4	2.5	2.5[ab]	2.6[a]
MHVY	2.3	2.4	2.3[b]	2.2[b]
HVY	2.5	2.5	2.6[a]	2.6[a]
SEM[3]	0.10	0.10	0.10	0.10
P - value	0.20	0.10	< 0.01	< 0.01

[ab]Least squares means within a chop thickness differ ($P < 0.05$).

[1]Marbling Score: 1 to 10 according to the National Pork Board marbling standards.

[2]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and greater.

[3]SEM (largest) of the least squares means in the same column.

Table 2.5 Least squares means for the main effect of L*, a*, and b* and subjective color and marbling scores for pork top loin chops of varying thicknesses from different hot carcass weight group.

Treatment	L*[1]	a*[2]	b*[3]	Color[4]	Marbling[5]
Carcass weight[6]					
LT		17.7	16.1	4.0	2.2[c]
MLT		17.6	16.0	4.1	2.5[ab]
MHVY		17.8	16.0	4.1	2.3[bc]
HVY		17.8	16.1	4.2	2.6[a]
SEM[7]		0.17	0.17	0.77	0.09
P - value		0.86	0.91	0.37	0.02
Chop thickness, cm					
1.27			16.4[a]	4.0[b]	2.4
1.91			15.9[b]	4.1[a]	2.4
2.54			15.9[b]	4.1[a]	2.4
3.18			15.9[b]	4.1[a]	2.4
SEM[7]			0.09	0.04	0.05
P - value			< 0.01	< 0.01	0.11
Package label[8]					
Labeled	58.3		16.2[a]	4.2[a]	2.4
Unlabeled	58.2		15.9[b]	4.0[b]	2.4
SEM[7]	0.17		0.09	0.04	0.05
P - value	0.18		< 0.01	< 0.01	0.89

[abc]Least squares means within carcass weight, chop thickness, or package label type differ ($P < 0.05$).

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

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

[3]b* (yellowness; – 60 blue and 60 = yellow).

[4]Color Scale: 1 to 6 according to the National Pork Board Color Standards

[5]Marbling score: 1 to 10 according to the National Pork Board Marbling Standards

[6]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and greater.

[7]SEM (largest) of the least square means in the same section of the same column.

[8]Package label: labeled contained price and weight information and unlabeled packages did not contain a label.

Table 2.6 Demographic characteristics of consumers (*N* = 393) who participated in consumer visual panels

Characteristic	Response	Percentage of consumers
Gender	Male	48.0
	Female	52.0
Household size	1 person	15.1
	2 people	24.2
	3 people	18.4
	4 people	25.0
	5 people	7.9
	6 people	9.4
Marital status	Married	43.1
	Single	56.9
Age	Under 20	10.2
	20-29	46.9
	30-39	13.3
	40-49	12.8
	50-59	9.7
	Over 60	7.1
Ethnic origin	African-American	1.8
	Asian	4.1
	Caucasian/White	82.4
	Hispanic	5.1
	Mixed Race	4.1
	Native American	0.5
	Other	2.0
Income	Under $25,000	26.1
	$25,000-$34,999	10.0
	$35,000-$49,999	11.3
	$50,000-$74,999	13.3
	$75,000-$99,999	13.0
	$100,000-$149,999	14.6
	$150,000-$199,999	7.4
	> $199,999	4.1
Education level	Did not graduate high school	0.3
	High school graduate	9.2
	Some college/technical school	37.5
	College graduate	31.3
	Post college graduate	21.7
Most important palatability trait when consuming pork	Tenderness	31.6
	Juiciness	25.4
	Flavor	42.9
Most important visual trait when purchasing fresh pork	Chop color	30.3
	Chop firmness	2.3
	Chop size	13.7
	Marbling	9.7
	Price/kg	32.8
	Total price	9.9
	Other	1.3
Preferred degree of doneness when consuming pork	Rare	1.4
	Medium rare	12.0
	Medium	26.1
	Medium well	28.1
	Well done	27.8
	Very well done	4.6
Weekly pork consumption	1 to 5 times	90.7
	6 to 10 times	7.7
	11 or more times	1.6

Table 2.7 Least squares means for consumer (*N* = 393) visual ratings for appearance and purchase intent for chops of various thicknesses from carcasses of various weight categories.

Treatment	Appearance rating[1]	Purchase intent rating[2]	Percentage that would purchase[3]
Carcass weight[4]			
LT	61.1[c]	58.9[c]	62.0
MLT	62.1[bc]	59.7[bc]	63.7
MHVY	63.1[ab]	60.9[ab]	65.9
HVY	64.5[a]	62.2[a]	66.8
SEM[5]	0.90	0.10	0.80
P - value	< 0.01	< 0.01	0.08
Chop thickness, cm.			
1.27	54.8[c]	51.9[c]	45.9[d]
1.91	64.1[b]	63.2[ab]	71.5[b]
2.54	66.3[a]	64.3[a]	73.9[a]
3.18	65.7[a]	62.3[b]	65.0[c]
SEM[5]	0.80	0.91	0.77
P - value	< 0.01	< 0.01	< 0.01
Package label[6]			
Labeled	62.8	60.2	63.2[b]
Unlabeled	62.7	60.7	66.0[a]
SEM[5]	0.74	0.84	0.66
P - value	0.83	0.36	< 0.01

[abc]Least squares means within the same main effect (carcass weight, chop thickness, and package label) differ ($P < 0.05$).

[1]Consumer appearance and purchase intent ratings: 0 = extremely undesirable; 100 = extremely desirable.

[2]Consumer purchase intent ratings: 0 = extremely unlikely to purchase; 100 = extremely likely to purchase the chop.

[3]Percentage of consumers who indicated “Yes” they would purchase the chop.

[4]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

[5]SEM (largest) of the least squares means in the same section of the same column.

[6]Package label: labeled contained price and weight information and unlabeled packages did not contain a label.

Table 2.8 Hot carcass weight × chop thickness interaction (*P* = 0.02) for the percentage of consumers who indicated "yes" the chop was overall desirable.

Chop thickness, cm.	Carcass weight[1]			
	LT	MLT	MHVY	HVY
1.27	54.0[c]	55.9[c]	57.2[b]	61.8[c]
1.91	73.1[a]	73.6[a]	73.9[a]	70.3[b]
2.54	70.5[ab]	73.5[a]	73.6[a]	78.5[a]
3.18	65.8[b]	66.4[b]	71.6[a]	69.7[b]
SEM[2]	2.20	2.20	2.20	2.10
P - value	< 0.01	< 0.01	< 0.01	< 0.01

[abc]Least squares means within the same column differ ($P < 0.05$).

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and greater.

[2]SEM (largest) of the least squares means in the same column.

Table 2.9 Hot carcass weight × chop thickness interaction (*P* = 0.02) for the percentage of consumers who indicated they would not purchase due to chop size.

Chop Thickness, cm	Carcass weight[1]			
	LT	MLT	MHVY	HVY
1.27	22.9[a]	19.0[a]	20.0[a]	12.2
1.91	16.4[b]	12.4[b]	9.8[b]	7.6
2.54	8.6[c]	14.3[ab]	8.1[b]	10.7
3.18	10.6[c]	9.8[b]	10.7[b]	11.8
SEM[2]	2.60	2.68	2.31	2.47
P - value	< 0.01	0.03	0.01	0.07

[abc]Least squares means within hot carcass weight differ ($P < 0.05$).

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

[2]SEM (largest) of the least squares means in the same column

Table 2.10 Chop thickness × label type interaction ($P < 0.01$) for the percentage of consumers who indicated "no" they would not purchase a chop due to color.

	Chop thickness, cm			
Label type[1]	1.27	1.91	2.54	3.18
Labelled	7.8[b]	19.4[b]	19.6	13.6[a]
Unlabeled	12.8[a]	25.8[a]	23.1	8.6[b]
SEM[2]	1.24	2.23	2.29	1.42
P - value	< 0.01	0.03	0.23	< 0.01

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

[1]Package label: labeled contained price and weight information and unlabeled packages did not contain a label.

[2]SEM (largest) of the least squares means in the same column.

Table 2.11 Least squares means for the percentage of consumers (*N* = 393) that responded "No" they would not purchase the chop for various reasons.

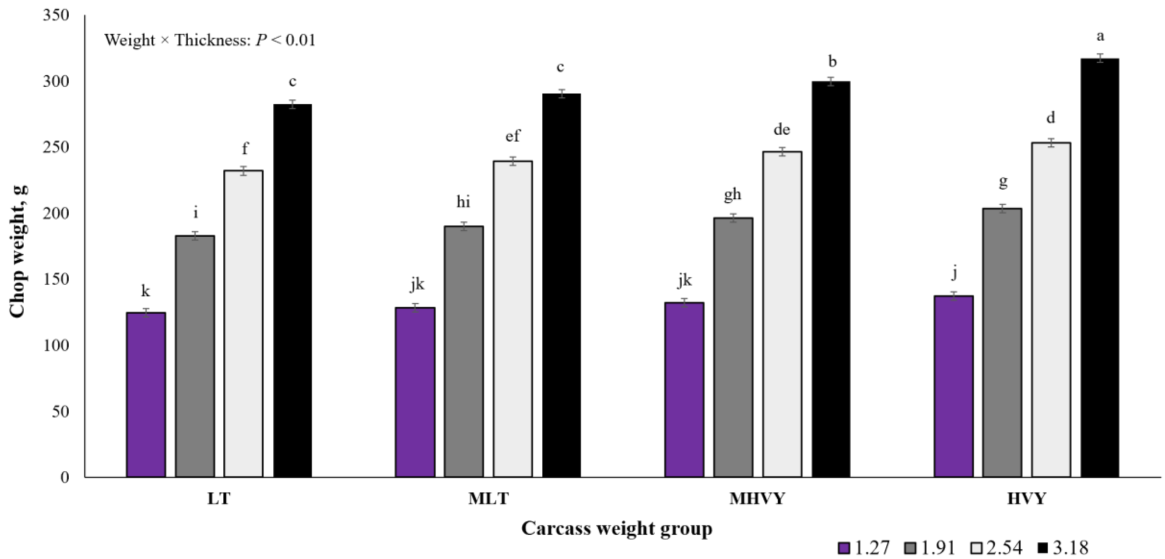
Treatment	Firmness	Marbling	Thickness	External fat	Purge	Price / kg.[1]	Package weight, kg.	Package price	Other
Carcass weight[2]									
LT	2.1	20.4	30.7	1.3	< 0.1	2.8	1.1	1.4	2.8
MLT	2.8	20.7	28.5	1.6	< 0.1	2.6	1.3	2.0	1.9
MHVY	2.6	22.1	33.5	1.9	0.3	3.4	2.2	2.9	1.8
HVY	3.1	21.6	36.3	1.9	< 0.0	4.4	1.5	1.7	1.5
SEM[3]	0.64	1.36	1.07	0.54	0.13	0.70	0.67	0.67	0.62
P - value	0.72	0.93	0.09	0.84	0.48	0.39	0.63	0.38	0.52
Chop thickness, cm									
1.27	1.6[b]	13.7[b]	48.7[a]	< 0.1	< 0.1	2.1	2.1[ab]	0.2[c]	1.0[c]
1.91	4.1[a]	30.4[a]	16.5[c]	1.6	< 0.1	3.1	< 0.0[b]	1.6[bc]	2.9[a]
2.54	2.8[ab]	28.6[a]	22.6[b]	2.3	< 0.1	3.8	< 0.0[b]	2.3[ab]	1.5[bc]
3.18	2.6[ab]	15.8[b]	48.1[a]	1.8	0.3	4.6	2.5[a]	3.7[a]	2.6[ab]
SEM[3]	0.71	1.15	0.99	0.48	0.13	0.98	0.58	0.67	0.55
P - value	< 0.01	<0.01	<0.01	0.23	0.52	0.06	0.04	<0.01	0.02
Package label[4]									
Labeled	2.3	20.1	33.0	1.3	0.2				2.1
Unlabeled	3.0	22.3	31.3	2.0	< 0.1				1.9
SEM[3]	0.41	0.96	0.65	0.35	0.09				0.40
P - value	0.14	0.29	0.08	0.16	0.19				0.61

[abc]Least squares means in the same main effect (carcass weight, chop thickness, and package label) in the same column differ ($P < 0.05$).
[1]Total price for each package at $9.94/kg.
[2]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above
[3]SEM (largest) of the least square means in the same section of the same column.
[4]Package label: labeled packages contained price and weight information and unlabeled packages did not contain a label.

Figure 2.1 Kansas State University label used on labeled pork chops in consumer visual sensory panels

Figure 2.2 Hot carcass weight × chop thickness interaction (*P* < 0.01) for pork top loin chop weight (g) of chops from 4 different hot carcass weight groups and 4 different chop thicknesses.

[abcdefghijk]Least squares means lacking a common superscript differ (*P* < 0.05). Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above



Chapter 3 - The effect of increased pork hot carcass weights on loin quality and palatability ratings of pork top loin chops

Abstract

The objective of this study was to evaluate the effects of pork hot carcass weight on loin quality and palatability of top loin chops. Pork loins (N = 200) were collected from 4 different hot carcass weight groups: a light weight group (LT; less than 111.8 kg), medium-light weight group (MLT; 111.8 to 119.1 kg), medium-heavy weight group (MHVY; 119.1 to 124.4), and a heavyweight group (HVY; 124.4 and greater). Purge loss percentage, instrumental color, subjective color and marbling, and pH were taken for each loin prior to fabrication. Following fabrication, chops were assigned to fat and moisture analysis, Warner-Bratzler shear force (WBSF), consumer sensory panels, or trained sensory panels. Loins from all weight groups differed ($P < 0.05$) in weight (LT < MLT < MHVY < HVY). No carcass weight effects ($P > 0.05$) were found for loin instrumental color, subjective color, subjective marbling, purge loss percentage, pH, WBSF, moisture percentage, intramuscular fat percentage, and drip loss. Carcass weight did not affect ($P > 0.05$) juiciness or flavor like ratings, but did affect ($P < 0.05$) tenderness ratings and overall like ratings. Chops from the HVY group were rated as more ($P < 0.05$) tender compared to chops from the LT weight group. Additionally, chops from the HVY weight group had greater ($P < 0.05$) consumer overall like rating compared to chops from both the LT and MLT weight treatments. Hot carcass weight treatment did not contribute ($P > 0.05$) to the percentage of chops rated acceptable for flavor and overall like. The greatest ($P < 0.05$) percentage of samples were rated acceptable for juiciness for chops from the HVY weight group, and the lowest ($P < 0.05$) percentage of acceptable ratings for tenderness were for chops from the LT weight group. Trained sensory results also reflected tenderness and juiciness differences

between carcass weight treatments. For both initial and sustained juiciness, chops from MHVY carcasses were rated as more ($P < 0.05$) juicy compared to chops from both MLT and LT carcasses. Additionally, chops from the LT hot carcass weight treatment had the lowest ($P < 0.05$) myofibrillar tenderness ratings. Chops from MHVY and HVY carcasses were similar ($P > 0.05$) with greater ($P < 0.05$) overall tenderness ratings compared to chops from LT carcasses. These results indicate top loin chops from heavier weight carcasses have improved tenderness and juiciness compared to chops from lighter carcasses.

Keywords: consumer, heavy pigs, hot carcass weight, palatability, pork quality

Introduction

The average hot carcass weight of pork carcasses in the United States have steadily increased year to year (USDA, 2018). With a continued increase of 0.59 kg per year the average hot carcass weight for market pigs in the United States could reach 118 kg by the year 2052 (USDA, 2018). To date, little research has evaluated the quality and eating characteristics of pork from these elevated carcass weights. It is unclear what the impact of increased carcass weight may be on pork quality and palatability traits.

In order for consumers to have a satisfactory eating experience, their expectations for tenderness, juiciness, and flavor must be met (O'Quinn et al., 2018). Tenderness has previously been reported to be the most crucial factor in pork palatability (Wood et al., 2004). Previous work that has evaluated pork quality and palatability traits of carcasses of differing weights has produced conflicting results (Cisneros et al., 1996; Beattie et al., 1999; Virgili et al., 2003; Harsh et al., 2017). Most of the studies were conducted with pigs with live weights that range from 90 to 130 kg. Currently, the average live market weight for pigs in the United States is about 128 kg, which makes it difficult to predict what will happen to pork quality as market weights continue to increase (USDA, 2019). Additionally, differences animal genetics and study objectives limit the ability to draw meaningful conclusions from much of this past work as it relates to the industry today.

As United States pork hot carcass weights continue to increase, it is unclear what the impact on tenderness, juiciness, and favor will be. Although studies have assessed the impact of hot carcass weight on pork quality, there is little research that exists that has evaluated the impact of increased hot carcass weights on consumer or trained sensory panel ratings (Wu et al., 2017). Therefore, the objective of this study was to determine the impact of increased hot carcass weight on pork tenderness, juiciness, and flavor as well as its impact on pork loin quality characteristics.

Materials and Methods

The Kansas State University (**KSU**) Institutional Review Board approved the procedures used in this study (IRB 7440.4, November 2017).

Loin collection and fabrication

Swine production procedures for this study are described in detail by Lerner et al. (2018). Briefly, pigs for this study were intentionally raised to reach heavy live weights exceeding normal industry standards. Following harvest, carcasses were grouped into 4 separate hot carcass weight categories for meat quality analyses. Harvest took place on 2 separate days (*n* = 100/d; *n* = 25/treatment) at a commercial harvest facility. At harvest, carcasses were sorted by hot carcass weight into a light group (**LT**; under 111.8 kg;), medium light group (**MLT**; 111.8 to 119.1 kg), medium heavy group (**MHVY**; 119.1 to 124.4 kg), and heavy group (**HVY**; greater than 124.4 kg). Whole boneless pork loins (*N* = 200; Institutional Meat Purchase Specification #413; North American Meat Processors Association, 2014) were randomly selected within each hot carcass weight treatment. Loins were then vacuum packaged and transported to the KSU Meat Laboratory for fabrication.

Prior to fabrication, loins were weighed in the package to obtain an initial weight and were then blotted dry and reweighed after unpackaging. Following opening, the vacuum bags for each loin were washed, dried, and weighed to use in the calculation of the percentage of purge lost during storage. Percentage of purge loss was calculated using the equation [1- unpackaged weight / (packaged weight – dry bag weight)]. Loins were then allowed a 30 min bloom time prior to measurement of instrumental color readings. L*, a*, and b* measurements were taken using Hunter Lab Miniscan spectrophotometer (Illuminant A, 2.54-cm aperture, 10° observer, Hunter Lab Associates Laboratory, Reston, VA). Three readings were taken on each loin, with one at the anterior, one in the middle and one on the posterior end of the ventral side of each loin and averaged to obtain a single measurement. Additionally, a trained KSU research team member assessed each loin for subjective color and marbling according to the National Pork Producers Council pork quality standards (National Pork Producers Council, 1999). Also, 3 pH readings were taken using a pH meter (HI 99163, Hanna Instruments, Smithfield, RI) at the anterior, middle, and posterior sections of the loin and averaged to obtain a single value for each loin. Loins were then cut immediately posterior to the *spinalis dorsi* and the posterior end of the loin was used for all analyses. Loin fabrication, retail display, and visual evaluation is described in detail in Chapter 2. The most anterior 2.54 cm chop was assigned to 24 and 48 h drip loss percentage. Following consumer visual evaluation, one 2.54 cm thick chop from each loin was randomly assigned to consumer sensory evaluation and one 3.18 cm chop was assigned to Warner-Bratzler shear force analysis (**WBSF**). One 2.54 cm chop was assigned to trained sensory evaluation, one 2.54 cm chop was assigned to trained sensory evaluation, and one 1.27

cm chop was assigned to raw fat and moisture analysis. Chops were then vacuum packaged and frozen at –40 °C after a 10 d of aging period.

Consumer sensory evaluation

Consumers (*N* = 197) used for sensory evaluation were recruited from Manhattan, KS and the surrounding areas and monetarily rewarded for their participation in the study. Sensory panels took place in a lecture style classroom at KSU in groups of 24 panelists. Chops were thawed at 2 to 4°C for 24 h prior to consumer sensory panels. Chops were cooked on clam-shell style grills (Cuisinart Griddler Deluxe, Model GR-150, East Windsor, NJ) and removed from the heat with the internal temperature rising to a peak internal temperature of 71°C. Temperature was monitored using a Thermapen thermometer (Mk7; ThermoWorks, American Forks, UT). All external fat was removed and only the longissimus muscle was cut into 2.54-cm thick × 1-cm × 1-cm cuboids, and 2 cuboids were immediately served to each panelist for evaluation. Each panelist was provided with a napkin, plastic fork, expectorant cup, and apple juice, water, and saltine crackers to use as palate cleansers.

Each panelist evaluated 8 samples (2 / treatment) in a random order and recorded ratings on an electronic tablet (Model 5709 HP Stream 7; Hewlett-Packard, Palo Alto, CA) using a digital survey (Version 2417833; Qualtrics Software, Provo UT). Panelists evaluated each sample for juiciness, tenderness, flavor like, and overall like on continuous line scales anchored at both ends and the midpoint with: 0 = extremely dry, extremely tough, and dislike extremely; 50 = neither dry nor juicy, neither tough nor tender, neither like nor dislike flavor, and neither like nor dislike overall; and 100 = extremely juicy, extremely tender, and like extremely. Consumers were also asked to rate each palatability trait as either acceptable or unacceptable with yes/no questions. Additionally, consumers were asked to rate the quality they perceived each sample, as either unsatisfactory, everyday quality, better than everyday quality, or premium quality.

Trained sensory analysis

Panelists were trained using protocols described by the American Meat Science Association (**AMSA**) sensory guidelines (American Meat Science Association, 2015). Six sensory trainings were held in the 2 weeks prior to starting panels. In each training session, panelists were trained by evaluating pork top loin chop samples cooked to different degrees of doneness [rare (60 °C), medium (71°C), and well-done (77 °C), and very well-done (82 °C)] in order to represent different juiciness, tenderness, and flavor levels. The references for the scales used for all traits evaluated are presented in Table 3.1.

Chops were thawed at 2 to 4°C for 24 h prior to sensory panel evaluation. Chops were prepared using the same procedures previously described for consumer sensory panels. Each panel consisted of 8 members with a total of 25 panel sessions used in the study. A warmup sample was provided for panel calibration at the beginning of each panel. Each panelist evaluated 8 samples (2 from each treatment) in a random order on an electronic tablet (Model 5709 HP Steam 7; Hewlett-Packard, Palo Alto, CA) with online digital survey (Version 2417833; Qualtrics Software, Provo, UT). Each sample was evaluated for initial juiciness, sustained juiciness, myofibrillar tenderness, overall tenderness, pork flavor intensity, and off flavor intensity on continuous line scales. Anchors were set at 0 to 100 with a midpoint at 50. The 0-anchor was labeled as: extremely dry, extremely tough, no connective tissue, extremely bland. The 50-anchor was labeled as: neither juicy nor dry, neither tough nor tender, and neither like nor dislike. The 100-anchor was labeled as: extremely juicy, extremely tender, abundant connective tissue, intense flavor. For off-flavor, panelists had a “not applicable” option if no off flavors were detected. Panelists were served in individual booths under red, low intensity (< 107.64 lumens), incandescent lights. Each panelist was provided deionized water, cut apple slices, and unsalted crackers as palate cleansers, as well as an expectorant cup and napkin.

Warner-Bratzler shear force analysis

Warner Bratzler shear force analyses were performed using protocols described by the AMSA in research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of meat (American Meat Science Association, 2015). Chops were cooked as previously described for sensory analyses. Chops were chilled for 24 hours at 2 to 4°C following cooking. Six cores (1.27 cm diameter) were removed parallel to the muscle fiber orientation and sheared perpendicular to the muscle fiber orientation. Shears were performed using an INSTRON Model 5569 (Instron, Canton, MA) with a crosshead speed of 250 mm/min and a load cell of 100 kg. The 6 values were averaged to determine the average peak force (kg) for each chop.

Fat and moisture content and drip loss analysis

Chops assigned to fat and moisture analyses were thawed at 2 to 4°C for 24 hours prior to homogenization. All exterior fat and accessory muscles were removed and the longissimus muscle was diced into smaller pieces before being immersed in liquid nitrogen. When completely frozen, samples were then homogenized (Model S1BL32; Waring Products Division; Hartford, CT) and stored in VWR Sterile Sample Bags (VWR International LLC, Pittsburgh, PA) in a -80°C freezer until analysis. Using protocols described by Folch et al. (1957), total intramuscular fat was measured using a chloroform:methanol extraction method. Analyses were performed in duplicates. Total moisture was measured using the methods described by the AOAC (1995).

Drip loss was determined using the EZ-driploss protocol described by Correa et al. (2007). Immediately after fabrication, two 2.54 cm cores were removed from each chop, weighed and place in an air tight container and stored at 2 to 4°C. Cores were reweighed at 24 and 48 hours. Drip loss percentage was determined by the formula: [(initial weight – hr weight)/initial weight × 100].

Statistical Analysis

Statistical analysis was performed using the PROC GLIMMIX procedure of SAS (SAS Version 9.4; SAS Inst. IN., Cary NC). Loin was used as the experimental unit and the 4 weight groups as treatments. Sensory panel data was evaluated as a completely randomized design with panel session included as a random effect. For all acceptability data, a model with binomial error distribution was used. For all analyses, the Kenward-Roger approximation was used and α was set at 0.05. Consumer demographic information was summarized using PROC FREQ.

Results

Loin quality

The loin quality characteristics (loin weight, purge loss percentage, pH, moisture percentage, fat percentage, 24 and 48 h drip loss percentage, and cook loss percentage) are presented in Table 3.2. With the exception of loin weight, there were no differences ($P > 0.05$) found for any of the loin quality traits among the weight treatment groups. As hot carcass weight increased from LT to HVY there was an increase ($P < 0.05$) in loin weight (LT < MLT < MHVY < HVY; $P < 0.05$). Additionally, there were no differences ($P > 0.05$) in WBSF tenderness values as hot carcass weights increased.

Loin instrumental color, subjective color, and subjective marbling scores are displayed in Table 3.3. There were no differences ($P > 0.05$) among weight groups for L*, a*, b* color readings. Additionally, there were no differences ($P > 0.05$) in subjective color and marbling scores among weight groups.

Consumer demographics

The consumer demographics for the 197 participants of the sensory portion are presented in Table 3.4. Of the consumers used for this study, just over half where female (54.8%) and predominately Caucasian (72.1%). Additionally, 60.4% were between the ages of 20 to 39 years, while 17.3% were over the age of 50 years. Furthermore, 60.9% of consumers were college graduates, and 63.8% had an annual household income of more than $50,000.00 per year. A majority of consumers indicated that flavor (59.4%) was the most important palatability factor when consuming fresh pork, and 32.0 % indicated that package price/kg was the most important factor when purchasing fresh pork followed by chop color (20.1%) and chop size (19.1%). The preferred degree of doneness when consuming pork was well done (35.5%) followed by medium well (28.9%) and medium (20.8%), and most consumers consumed pork 1 to 5 times per week (71.2%).

Consumer sensory evaluation

Consumer sensory ratings (Table 3.5.) indicated there were no differences ($P > 0.05$) among the 4 hot carcass weight treatment groups for juiciness or flavor ratings. However, juiciness tended ($P = 0.05$) to differ among treatments with increased carcass weight being juicier than the lower carcass weights. Consumers did find differences among the treatment groups for tenderness ratings and overall like ratings. Consumers ratings indicated that carcasses from the HVY, MHVY, MLT hot carcass weight groups were all similar ($P > 0.05$) and more tender ($P < 0.05$) than carcasses from the LT hot carcass weight group. Additionally, consumer overall like ratings indicated that consumers preferred ($P < 0.05$) chops from carcasses in the

HVY hot carcass weight treatment group compared to chops from both the MLT and LT hot carcass weight groups.

Consumers were also asked to indicate if each sample was acceptable for each palatability trait (Table 3.6). There were no differences ($P > 0.05$) among hot carcass weight treatments for the percentage of consumers who indicated samples were acceptable for flavor, and overall acceptability. There were differences ($P < 0.05$) for the percentage of consumers who rated the samples acceptable for juiciness and tenderness. A greater ($P < 0.05$) percentage of consumers rated chops from HVY weight carcasses as acceptable for juiciness compared to all other hot carcass weight treatments, which were similar ($P > 0.05$). Chops from the LT hot carcass weight treatment had the lowest ($P < 0.05$) percentage of consumers that rated them as acceptable for tenderness compared to all other weight treatments, which were similar ($P > 0.05$).

Finally, consumers indicated the quality at which they perceived each sample (Table 3.7). There were no differences ($P > 0.05$) in the percentage of chops from each hot carcass weight group that consumers perceived as everyday quality, better than everyday quality, or premium quality. Consumers perceived fewer ($P < 0.05$) chops from the HVY weight group as unsatisfactory compared to chops from the LT and MHVY hot carcass weight groups.

Trained sensory evaluation

The results for trained sensory panel evaluations are presented in Table 3-8. For both initial and sustained juiciness, trained panelists indicated chops from the MHVY group were juicier ($P > 0.05$) than chops from the MLT and LT carcasses with chops from heavy carcasses being intermediate. Trained panelists rated chops from HVY, MHVY, and MLT carcasses similar ($P > 0.05$) for myofibrillar tenderness, and greater ($P < 0.05$) than chops from LT weight carcasses. Additionally, HVY and MHVY carcasses were similar (*P* > 0.05) for overall tenderness, and were more tender (*P* < 0.05) compared to carcasses from the LT hot carcass weight group. Trained sensory panelists did not detect any differences (*P* > 0.05) among the 4 hot carcass weight groups for connective tissue amount or flavor characteristics

Discussion

As market weights for pigs in the United States continue to increase, it is important that the lean quality of heavier carcasses not decrease and negatively impact pork eating quality and product functionality (Harsh et al., 2017). Although there have been studies that assessed the impact of increasing hot carcass weight on pork quality, very few have used hot carcass weights within U.S. swine genetic lines as great as those used in the current study.

The effect of increased hot carcass weight on loin quality

In our study, increased hot carcass weight did not affect ultimate loin pH. Accordingly, there were also no subjective or instrumental color differences found. Our results are consistent with the results for ultimate pH by Martin et al. (1980) and Beattie et al. (1999) where the authors found no differences among carcasses of increasing weight groups This contradictory to the data presented by Harsh et al. (2017) where the authors reported a decrease in ultimate pH as hot carcass weight increased. However it is important to note that the design of the experiment performed by Harsh et al. (2017) was different in the sense that the authors did a regression (R^2 = 0.0123) analysis in order to predict the change in pork quality characteristics as hot carcass weight increased. When using the regression [y = 5.86 – 0.0018 (hot carcass weight, kg)] provided by Harsh et al. (2017) with the weights used in the current study (111.8 to 124.4 kg) the pH average would be expected to be 5.7 to 5.6, which is consistent with the pH values of the current study, where we found no differences.

Additionally, other studies (Virgili et al., 2003; Harsh et al., 2017) reported a lower L* value as hot carcass weight increased, indicative of a darker lean color, which is not consistent with the current study. It is important to note that the study by Virgili et al. (2003) used an Italian pig breed that is not consistent with current commercial genetics in the United States. Harsh et al. (2017) stated that even though differences in both ultimate pH and 20 d L* values were found in their study, hot carcass weight only accounted for a small percentage (R^2 = 0.0123 and R^2 = 0.0098) of the variability and concluded the observed differences were likely attributed to other factors. Additionally, when using the regressions [y = 61.63 – 0.0287 (hot carcass weight, kg)] provided by Harsh et al. (2017) for L* values with the weight groupings from the current study, a 1 L* value difference in values would be predicted from this study. The consistent L* and a* values between weight treatments in the present study do support results reported Park and Lee (2011), in which no differences in L* values were reported as hot carcass weight increased. However, in their study they utilized pigs at market weights that were smaller (116.2 to 133.5 kg live market weight) than the pigs in the current study.

Multiple studies (Latorre et al., 2004; Durkin et al., 2012; Harsh et al., 2017) have reported increasing a* values resulting in a redder product as hot carcass weight increased. The studies by both Latorre et al. (2004) and Durkin et al. (2012) were conducted with the intent of testing the effect of sex and increased slaughter weights on carcass quality traits. Both studies utilized pigs that were lighter (116 to 133 kg and 120 to > 170 kg live market weight) than the pigs used in the current study. However, Harsh et al. (2017) only reported this increase with day 1 a* color readings with a small amount of variation (R^2 = 0.0071) associated with hot carcass weight and they did not find any differences in a* values with day 20 color readings with carcasses that ranged from 53.2 to 129 kg. Their day 20 results are similar to the current study where there were no differences in a* values as hot carcass weight increased.

The visual color measurements and instrumental color measurements in the current study were consistent with each other, and both indicated there were no color differences among weight groups. Correa et al. (2006) reported similar results, although the pigs used in the study had live weights that ranged from 107 to 125 kg and were significantly lighter than the pigs used for their current study. In contrast, Harsh et al. (2017) reported an improvement in subjective color scores statistically, but again acknowledged the regression line they calculated only slightly differed from 0 with an $R^2 = 0.0016$ for their day 1 color scores and an $R^2 = 0.0123$ for their day 20 color scores.

The findings in our study for subjective marbling scores are consistent with previous studies that evaluated loin marbling of increasing hot carcass weights. Correa et al. (2006), and Harsh et al. (2017) reported no significant differences in subjective marbling scores as hot carcass weight increased. This is consistent with the intramuscular fat percentages for the current study which did not differ between hot carcass weight treatments similar to Correa et al. (2006) who also reported no differences in intramuscular fat percentages as market weight increased from 107 to 125 kg. Conversely, Cisneros et al. (1996) which evaluated pigs with live weights ranging from 100 to 160 kg reported an increase of approximately 0.3% intramuscular fat as live weight increased by 10 kg.

With there being no differences in pH and intramuscular fat among weight treatments in our study, as would be expected, both drip loss percentages and cook loss percentages did not differ among weight treatments. Our drip loss means are contradictory to results published in previous studies (Cisneros et al., 1996; Virgili et al., 2003; Park and Lee, 2011). Both Cisneros et al. (1996) and Park and Lee (2011) reported that as hot carcass weight increased, there was an increase in drip loss percentage, while Virgili et al. (2003) reported a decrease in drip loss percentage with increased carcass weights.

There were no differences among carcass weight groups for Warner-Bratzler shear force tenderness. These results are similar to data reported by both Beattie et al. (1999) and Latorre et al. (2004), even though the carcasses in both studies did not reach the weights of the current study. Harsh et al. (2017) reported a decrease in slice shear force tenderness values as hot carcass weights increased which is similar to the sensory analysis portion of the current study. While Martin et al. (1980) observed an opposite effect with an increase in Warner-Bratzler shear force values with live slaughter weight that ranged from 73 to 137 kg. However, the WBSF data is contradictory to sensory analysis data from this study. Similarly, Cisneros et al. (1996) saw differences in tenderness and juiciness as live market weight increased however, there was no significance in their linear regression for WBSF values as live market weight increased.

The effect of increased hot carcass weight on palatability ratings

Although no differences were found among loin quality traits, tenderness improved as hot carcass weight increased for both consumer and trained sensory panelists. This is contradictory to the WBSF data in this study were no differences were found between hot carcass weight treatment groups. To date only three studies have assessed the sensory attributes of pork carcasses as hot carcass weight increased, but with conflicting results (Cisneros et al., 1996; Huff-Lonergan et al., 2002; Park and Lee, 2011). Similar to our study, Huff-Lonergan et al. (2002) observed positive responses for juiciness (r = 0.09) as well as off flavor (r = 0.14) as carcass weight increased. The authors attributed these responses to both increased fat deposition as hot carcass weight increased as well as increased polyunsaturated fatty acid concentrations in the fat (Correa et al., 2006). However, in the current study there were no differences in intramuscular fat deposition as hot carcass weight increased, perhaps indicating why the results differed. In another study, Park and Lee (2011) reported an increase in off flavor of raw pork as slaughter weight increased however, these results were not found in the cooked pork analysis in that study nor in the current study. The third study, Cisneros et al. (1996) reported contradictory results to the current study, where the authors reported a decrease in juiciness and tenderness at 0.1 and 0.04% for every 10 kg increase in market weight. This could be due to a positive overall linear expression of approximately 0.3% intramuscular fat percentage for every 10 kg increase in live market weight. However, similar to the current study, there was no linear significance in the regression for WBSF values.

For this study, consumer panelists gave greater ratings for tenderness, and overall like to carcasses from the heavier weight groups. Consumers rated a greater percentage of the chops from the HVY weight group as acceptable for juiciness. Similarly, ratings from trained panelists also showed improved juiciness and tenderness palatability ratings for heavier carcasses although there were no objective tenderness differences. The improved palatability ratings for tenderness and juiciness observed in the current study are believed to be the result of different chilling rates at harvest. The current practice in the United States pork industry is to blast chill pork carcasses as quickly as possible to avoid unfavorable pale, soft, and exudative (**PSE**) meat quality (Savell et al., 2005). The sudden decrease in temperature helps to slow the pH decline resulting in a lower incidence of PSE pork (Huff-Lonergan and Page, 2001). When the temperature of the muscle is dropped to extremely low temperatures, such as blast chilling, prior to reaching the ultimate pH, this can result in tougher products due to cold shortening (Jeremiah et al., 1992; Huff-Lonergan and Page, 2001). The low temperatures as a result of blast chilling destabilizes calcium storage sites and causes calcium to be released signaling the muscle to contract, ultimately shortening the sarcomere length causing the muscle to become more dense (Huff-Lonergan and Page, 2001). Herring et al. (1965) demonstrated that a shortening in sarcomere length will result in a tough product in beef due to increased fiber diameter. However, there is evidence that as fat thickness or mass of a carcass increases, it takes more time to reduce carcass temperatures during chilling, ultimately reducing the extent of cold shortening due to a prolonged time at an elevated muscle temperature (Dolezal et al., 1982). Smaller diameter muscles are more susceptible to cold shortening conditions compared to muscles that have a greater diameter (Huff-Lonergan and Page, 2001). This resistance to chilling caused by increased mass represented in the heavier carcass weights is what we believe to have potentially caused the increased palatability ratings due to less severe cold shortening as a result of a prolonged chilling time.

The results of this study indicate that pork quality will not be negatively affected by increasing hot carcass weights that are currently the trend in the U.S. swine industry. Additionally, as hot carcass weight increases, both consumer and trained sensory ratings indicate that the tenderness and juiciness of chops from heavy weight carcasses is improved. This study shows that as hot carcass weight increases, consumers will find chops to be more tender and juicy and will prefer them more overall.

Literature Cited

American Meat Science Association. 2015. Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of meat. 2 ed. American Meat Science Association, Champaign, IL.

AOAC. 1995. Removal of Moisture, Official Method 8.2.1.1. 16th ed. Assoc. Off. Anal. Chem., Arlington, VA.

Beattie, V. E., R. N. Weatherup, B. W. Moss, and N. Walker. 1999. The effect of increasing carcass weight of finishing boars and gilts on joint composition and meat quality. Meat Sci. 52:205-211. doi:10.1016/S0309-1740(98)00169-7

Chu, S. K. 2015. Development of an intact muscle pork flavor lexicon. Master's Thesis, Texas A&M Univeristy. http://hdl.handle.net/1969.1/155014

Cisneros, F., M. Ellis, F. K. McKeith, J. McCaw, and R. L. Fernando. 1996. Influence of slaughter weight on growth and carcass characteristics, commercial cutting and curing yields, and meat quality of barrows and gilts from two genotypes. J. Anim. Sci. 74:925-933. doi:10.2527/1996.745925x

Correa, J. A., L. Faucitano, J. P. Laforest, J. Rivest, M. Marcoux, and C. Gariépy. 2006. Effects of slaughter weight on carcass composition and meat quality in pigs of two different growth rates. Meat Sci. 72:91-99. doi:10.1016/j.meatsci.2005.06.006

Correa, J. A., S. MÉThot, and L. Faucitano. 2007. A modified meat juice container (EZ-driploss) procedure for a more reliable assessment of drip loss and related quality changes in pork meat. J. Mus. Foods 18:67-77. doi:10.1111/j.1745-4573.2007.00066.x

Dolezal, H., G. Smith, J. Savell, and Z. Carpenter. 1982. Comparison of subcutaneous fat thickness, marbling and quality grade for predicting palatability of beef. J. Food Sci. 47:397-401.

Durkin, I., M. Dadic, D. Brkic, B. Lukic, G. Kusec, M. Mikolin, and I. Jerkovic. 2012. Influence of gender and slaughter weight on meat quality traits of heavy pigs. Acta Agric: 3.

Folch, J., M. Lees, and G. H. Sloane Stanley. 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 266:497-509.

Harsh, B. N., E. K. Arkfeld, D. A. Mohrhauser, D. A. King, T. L. Wheeler, A. C. Dilger, S. D. Shackelford, and D. D. Boler. 2017. Effect of hot carcass weight on loin, ham, and belly quality from pigs sourced from a commercial processing facility. J. Anim. Sci. 95:4958-4970. doi:10.2527/jas2017.1674

Herring, H. K., R. G. Cassens, and E. J. Rriskey. 1965. Further studies on bovine muscle tenderness as influenced by carcass position, sarcomere length, and fiber diameter. J. Food Sci. 30:1049-1054.

Huff-Lonergan, E., T. J. Baas, M. Malek, J. C. M. Dekkers, K. Prusa, and M. F. Rothschild. 2002. Correlations among selected pork quality traits. J. Anim. Sci. 80:617-627. doi:10.2527/2002.803617x

Huff-Lonergan, E., and J. Page. 2001. The role of carcass chilling in the development of pork quality. National Pork Producers Council, Des Moines, IA.

Jeremiah, L. E., S. D. M. Jones, A. K. W. Tong, G. Kruger, and R. Gibson. 1992. The effects of gender and blast-chilling time and temperature on cooking properties and palatability of pork longissimus muscle. Can. J. Anim. Sci. 72:501-506. doi:10.4141/cjas92-062

Latorre, M. A., R. Lázaro, D. G. Valencia, P. Medel, and G. G. Mateos. 2004. The effects of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs. J. Anim. Sci. 82:526-533. doi:10.1093/ansci/82.2.526

Lerner, A. B., M. D. Tokach, J. M. DeRouchey, S. S. Dritz, R. D. Goodband, T. G. O'Quinn, J. M. Gonzales, E. A. Rice, M. W. Allerson, H. E. Price, and J. C. Woodworth. 2018. Effects of Space Allowance and Marketing Strategy on Growth Performance of Pigs Raised to Heavy Market Weights. Kansas Agricultural Experiment Station Research Reports 4. doi:10.4148/2378-5977.7687

Martin, A. H., A. P. Sather, H. T. Fredeen, and R. W. Jolly. 1980. Alternative Market Weights for Swine. II. Carcass Composition and Meat Quality. J. Anim. Sci. 50:699-705. doi:10.2527/jas1980.504699x

National Pork Producers Council. 1999. Official color and marbling standards. NPPC, Des Moines, IA.

O'Quinn, T. G., J. F. Legako, J. C. Brooks, and M. F. Miller. 2018. Evaluation of the contribution of tenderness, juiciness, and flavor to the overall consumer beef eating experience1. Transl. Anim. Sci. 2:26-36. doi:10.1093/tas/txx008

Park, B., and C. Lee. 2011. Feasibility of increasing the slaughter weight of finishing pigs. J. Anim. Sci. Technol. 53:211–222. doi:10.5187/JAST.2011.53.3.211

USDA. 2018. Hogs: Federally Inspected Slaughter Average Dressed Weight by Month and Year, US https://www.nass.usda.gov/Charts_and_Maps/Livestock_Slaughter/hgdrwgx8.php (Accessed 6 June, 2018.)

USDA. 2019. Daily Pork Reports. https://www.ams.usda.gov/market-news/daily-pork-reports.

Virgili, R., M. Degni, C. Schivazappa, V. Faeti, E. Poletti, G. Marchetto, M. T. Pacchioli, and A. Mordenti. 2003. Effect of age at slaughter on carcass traits and meat quality of Italian heavy pigs. J. Anim. Sci. 81:2448-2456. doi:10.2527/2003.81102448x

Wood, J. D., G. R. Nute, R. I. Richardson, F. M. Whittington, O. Southwood, G. Plastow, R. Mansbridge, N. da Costa, and K. C. Chang. 2004. Effects of breed, diet and muscle on fat deposition and eating quality in pigs. Meat Sci. 67:651-667. doi:10.1016/j.meatsci.2004.01.007

Wu, F., K. R. Vierck, J. M. DeRouchey, T. G. O'Quinn, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. C. Woodworth. 2017. A review of heavy weight market pigs: status of knowledge and future needs assessment. Transl. Anim. Sci. 1:1-15. doi:10.2527/tas2016.0004

Table 3.1 Definitions and selected references for pork palatability traits evaluated by trained sensory panelists

Attribute	Definition	Reference
Initial juiciness	Juiciness level within the first 1-3 chews	Non-enhanced boneless pork top loin chop cooked to 71°C = 55
Sustained juiciness	Juiciness level maintained by the sample throughout the chewing process	Non-enhanced boneless pork top loin chop cooked to 71°C = 50
Myofibrillar tenderness	The tenderness of myofibrillar tissue excluding connective tissue	Non-enhanced boneless pork top loin chop cooked to 71°C = 65
Connective tissue	The amount of connective tissue within the sample	Non-enhanced boneless pork top loin chop cooked to 71°C = 2
Overall tenderness	The overall tenderness of the sample	Non-enhanced boneless pork top loin chop cooked to 71°C = 65
Pork flavor intensity[1]	Amount of pork flavor identity in the sample	Non-enhanced boneless pork top loin chop cooked to 71°C = 30

[1]Adapted from pork identity lexicon described by Chu (2015).

Table 3.2 Least squares means for loin (N = 200) quality characteristics of 4 weight groupings of pork hot carcasses

Carcass weight[1]	Loin weight, kg.	Purge loss, %[2]	pH	WBSF, kg	Moisture, %	Fat, %	24 h drip loss, %[3]	48 h drip loss, %[4]	Cook loss, %[5]
LT	4.0[a]	2.7	5.7	2.7	73.1	2.7	1.3	1.8	16.2
MLT	4.5[b]	2.6	5.7	2.6	75.4	2.8	1.1	1.5	15.8
MHVY	4.6[c]	2.6	5.7	2.5	73.1	2.6	1.1	1.5	15.5
HVY	4.9[d]	2.4	5.7	2.5	73.1	2.8	1.1	1.5	15.0
SEM[6]	0.13	0.16	0.01	0.06	0.26	0.14	0.07	0.10	0.57
P-value	< 0.01	0.48	0.35	0.22	0.17	0.60	0.05	0.10	0.56

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

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

[2]Purge loss percentage = [1 – loin weight / (initial weight – dry bag weight)].

[3]24 h drip loss percentage = [(Initial weight – 24 hr weight) / initial weight × 100].

[4]48 h drip loss percentage = [(Initial weight – 48 hr weight) / initial weight × 100].

[5]Cook loss percentage = [(raw weight – cooked weight)/raw weight]

[6]SEM (largest) of the least squares means in the same column.

Table 3.3 Instrumental and subjective color and marbling scores for pork loins (*N* = 200) of 4 weight groupings of pork hot carcasses

Carcass weight[1]	L*[2]	a*[3]	b*[4]	Color score[5]	Marbling score[6]
LT	59.1	16.6	14.4	4.2	2.3
MLT	59.5	16.4	14.3	4.3	2.4
MHVY	58.7	16.9	14.5	4.2	2.2
HVY	58.1	16.6	14.4	4.4	2.4
SEM[7]	0.33	0.18	0.16	0.10	0.08
P-value	0.38	0.27	0.82	0.29	0.26

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

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

[3]a* (redness; ; – 60 = green and 60 = red).

[4]b* (yellowness; – 60 blue and 60 = yellow).

[5]Color score: 1 to 6 according to the National Pork Board color standards.

[6]Marbling Score: 1 to 10 according to the National Pork Board marbling standards.

[7]SEM (largest) of the least squares means in the same column.

Table 3.4 Demographic characteristics of consumers (N = 197) who participated in consumer sensory panels

Characteristic	Response	Percentage of consumers
Gender	Male	45.2
	Female	54.8
Household size	1 person	17.8
	2 people	32.5
	3 people	14.7
	4 people	17.8
	5 people	7.6
	6 people	9.6
Marital status	Married	50.3
	Single	49.7
Age	Under 20	9.6
	20-29	35.5
	30-39	24.9
	40-49	12.7
	50-59	6.6
	Over 60	10.7
Ethnic origin	African-American	6.6
	Asian	4.6
	Caucasian/White	72.1
	Hispanic	7.6
	Mixed Race	6.1
	Native American	0.5
	Other	2.5
Income	Under $25,000	17.6
	$25,000-$34,999	7.8
	$35,000-$49,999	10.9
	$50,000-$74,999	18.7
	$75,000-$99,999	14.5
	$100,000-$149,999	18.7
	$150,000-$199,999	6.7
	> $199,999	5.2
Education level	High school graduate	11.2
	Some college/technical school	27.9
	College graduate	34.0
	Post college graduate	26.9
Most important palatability trait when consuming pork	Tenderness	18.3
	Juiciness	22.3
	Flavor	59.4
Most important visual trait when purchasing fresh pork	Chop color	20.1
	Chop firmness	3.6
	Chop size	19.1
	Marbling	10.3
	Price/kg	32.0
	Total price	13.9
	Other	1.0
Preferred degree of doneness when consuming pork	Rare	0.0
	Medium rare	10.2
	Medium	20.8
	Medium well	28.9
	Well done	35.5
	Very well done	4.6
Weekly pork consumption	1 to 5 times	71.2
	6 to 10 times	22.5
	11 or more times	6.3

Table 3.5 Least squares means for consumer (*N* = 197) palatability ratings[1] of pork top loin chops of varying hot carcass weight groups

Carcass weight[2]	Juiciness rating	Tenderness rating	Flavor rating	Overall like rating
LT	57.3	55.5[b]	58.5	58.7[b]
MLT	59.9	60.4[a]	59.6	60.3[b]
MHVY	59.8	60.8[a]	61.3	61.2[ab]
HVY	63.7	64.4[a]	62.5	64.7[a]
SEM[3]	1.75	1.75	1.51	1.55
P-value	0.05	< 0.01	0.10	0.02

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

[1]Sensory scores: 0 = extremely dry/tough/dislike flavor/dislike overall; 100 = extremely juicy/tender/like flavor/overall like.

[2]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

[3]SEM (largest) of the least squares means in the same column.

Table 3.6 Least squares means for the percentage of consumers (N = 197) who indicated the sample was acceptable for juiciness, tenderness, flavor, and overall for top loin chops from varying hot carcass weight groups

Carcass weight[1]	Juiciness acceptability	Tenderness acceptability	Flavor acceptability	Overall acceptability
LT	78.5^{b}	80.2^{b}	82.9	80.2
MLT	80.7^{b}	85.7^{a}	83.7	83.6
MHVY	80.1^{b}	86.8^{a}	82.9	83.5
HVY	86.1^{a}	89.7^{a}	85.1	87.4
SEM[2]	2.28	2.26	2.28	2.37
P-value	0.04	< 0.01	0.81	0.07

^{ab}Least squares means in the same column without a common superscript differ ($P < 0.05$).

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

[2]SEM (largest) of the least squares means in the same column.

Table 3.7 Least squares means for the percentage of samples rated as unsatisfactory, every day, better than every day, and premium quality by consumers (*N* = 197) of pork top loin chops from carcasses of varying hot carcass weights

Carcass weight[1]	Unsatisfactory	Everyday quality	Better than every day	Premium
LT	17.3[a]	48.7	25.6	7.6
MLT	14.1[ab]	48.3	26.6	10.1
MHVY	16.3[a]	47.1	24.3	11.2
HVY	10.6[b]	46.8	30.0	11.8
SEM[2]	2.11	2.56	2.38	1.77
P - value	0.04	0.94	0.34	0.20

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

[1]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 124.4 kg, and HVY = 124.4 kg and above.

[2]SEM (largest) of the least squares means in the same column.

Table 3.8 Least squares means for trained sensory panel ratings[1] for pork top loin chops of varying hot carcass weight groups

Carcass weight[2]	Initial juiciness	Sustained juiciness	Myofibrillar tenderness	Connective tissue	Overall tenderness	Pork flavor	Off flavor
LT	53.3[b]	45.3[b]	63.6[b]	4.3	62.7[b]	31.5	5.2
MLT	52.9[b]	45.1[b]	66.8[a]	4.2	65.3[ab]	31.7	7.3
MHVY	57.1[a]	49.9[a]	68.9[a]	4.0	67.5[a]	32.1	4.9
HVY	55.8[ab]	48.0[ab]	68.7[a]	3.9	67.3[a]	31.5	3.1
SEM[3]	1.24	1.32	1.11	0.38	1.14	0.52	1.93
P - value	0.03	0.02	< 0.01	0.81	< 0.01	0.62	0.38

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

[1]Sensory scores: 0 = extremely dry/tough/none/extremely bland/no off-flavor; 50 = neither dry nor juicy/neither tough nor tender; 100 = extremely juicy/tender/ abundant/extremely intense

[2]Carcass weight groups: LT = under 111.8 kg, MLT = 111.8 to 119.1 kg, MHVY = 119.1 to 124.4 kg, and HVY = 124.4 kg and above.

[3]SEM (largest) of the least squares means in the same column.

Appendix A - Consumer and Trained 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

Please sign and return one copy. The second copy is for your records.

Demographics questionnaire

KANSAS STATE UNIVERSITY

Big Panel #

Please tell us a little about yourself:

Panelist Number

Gender

- Male
- Female

Age

- Under 20
- 20 to 29 years old
- 30 to 39 years old
- 40 to 49 years old
- 50 to 59 years old
- Over 60

Ethnic Origin

- African-American
- Asian
- Caucasian/White
- Hispanic
- Native American
- Other
- Mixed Race

Marital Status

- Single
- Married

Household Size

- 1 Person
- 2 People
- 3 People
- 4 People
- 5 People
- 6 People
- > 6 People

Annual Household Income

- < $25,000
- $25,000 - $34,999
- $35,000 - $49,999
- $50,000 - $74,999
- $75,000 - $99,999
- $100,000 - 149,999
- $150,000 - $199,999
- > $199,999

Highest Level of Education Completed

- Non-High School Graduate
- High School Graduate
- Some College / Technical School
- College Graduate
- Post-College Graduate

What temperature do you cook your pork to?

- Very Rare
- Rare
- Medium-Rare
- Medium
- Medium-Well
- Well-Done
- Very Well-Done

When eating pork, what palatability trait is the most important to you?

- Flavor
- Juiciness
- Tenderness

When purchasing fresh pork, what is most important to you?

- Chop Color
- Chop Size
- Chop Firmness
- Marbling
- Price/lb
- Total Package Price
- Other

How many times a week do you consume pork?

0 3 6 9 12 15 18 21

None

>>

Consumer visual questionnaire for unlabeled chops

Sample Number

Sample Number

Overall Appearance Desirability

Extremely Undesirable 0	Neither Desirable nor Undesirable 50	Extremely Desirable 100

Desirability

Was the overall appearance of this sample desirable?

- Desireable
- Undesireable

Likelihood to purchase

Extremely Unlikely 0	Neither Likely nor Unlikely 50	Extremely Likely 100

Purchase

Would you purchase this sample?

- Yes
- **No**

If no, what made you choose not to purchase this sample?

- Chop Color
- Chop Firmness
- Chop Size
- Chop Thickness
- Marbling
- Other

>>

Consumer visual questionnaire for labeled chops

Sample Number

Sample Number

Overall Appearance Desirability

Extremely Undesirable 0 | Neither Desirable nor Undesirable 50 | Extremely Desirable 100

Desirability

Was the overall appearance of this sample desirable?

Desireable

Undesireable

Likelihood to purchase

Extremely Unlikely 0 | Neither Likely nor Unlikely 50 | Extremely Likely 100

Purchase

Would you purchase this sample?

Yes

No

If no, what made you choose not to purchase this sample?

Chop Color

Chop Firmness

Chop Size

Chop Thickness

Marbling

Price/lb.

Total Package Price

Total Package Weight

Other

>>

Consumer palatability questionnaire

Round 1

Sample Number

Sample #

Juiciness

Extremely Dry	Neither Juicy nor Dry	Extremely Juicy
0	50	100

Juiciness

Was the sample acceptable for juiciness?

Acceptable

Unacceptable

Tenderness

Extremely Tough	Neither Tough nor Tender	Extremely Tender
0	50	100

Tenderness

Was the sample acceptable for tenderness?

Acceptable

Unacceptable

Flavor

Dislike Extremely	Neither Like nor Dislike	Like Extremely
0	50	100

Flavor

Was the sample acceptable for flavor?

- Acceptable
- Unacceptable

Overall Liking

Dislike Extremely 0	Neither Like nor Dislike 50	Like Extremely 100

Overall

Was the sample acceptable overall?

- Acceptable
- Unacceptable

Please choose one of the following to rate the quality of the pork sample you have just eaten.

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

>>

Trained sensory panel questionnaire

KANSAS STATE UNIVERSITY

Panelist

Sample Number

Initial Juiciness

Extremely Dry	Neither Juicy nor Dry	Extremely Juicy
0	50	100

Initial Juiciness

Sustained Juiciness

Extremely Dry	Neither Juicy nor Dry	Extremely Juicy
0	50	100

Sustained Juiciness

Myofibrillar Tenderness

Extremely Tough	Neither Tough nor Tender	Extremely Tender
0	50	100

Myofibrillar Tenderness

Amount of Connective Tissue

None	Abundant
0	100

Amount of Connective Tissue

Overall Tenderness

Extremely Tough	Neither Tough nor Tender	Extremely Tender
0	50	100

Overall Tenderness

Pork Flavor Intensity

Extremely Bland 0

Extremely Intense 100

Pork Flavor Intensity

Off Flavor Intensity

Extremely Bland 0

Extremely Intense 100

Off Flavor Intensity

☐ Not Applicable

Off Flavor Description

>>

Appendix B - Data Sheets

Chop L* a* b*

Chop ID	L*	a*	b*

Date:______________ Time:____________ Page Number: ______________________________

Chop Size

Chop ID	Weight	LEA	Width	Length

Page Number:____________________

Pork Chop Color and Marbling

Chop ID	Color	Marbling

Page Number:______________________

Pork Loin Drip Loss

Chop ID	0 Hrs	24 Hrs	48 hours

Page Number: ____________________

Pork Loin pH

Loin ID	Anterior	Center	Posterior

Page Number: ______________________

Purgeloss

Plant ID	Loin ID	Packaged Wt.	Unpackaged Wt.	Dry Package Wt.

Pork Loin Ventral Color and Marbling

Loin ID	Color	Marbling

Page Number:____________________

Loin Ventral L* a* b*

Loin ID	L*	a*	b*

Page Number: ____________________

Pork Cookloss Percentage and Peak Temp

Chop ID	Raw Weight	Cooked Weight	Peak Temperature

Page Number: ______________________

Intramuscular Fat Analysis

Chop ID	Weight of Tube	Weight of Wet Sample	Dry Tube Weight

Page Number: ____________________

Moisture Analysis

Chop ID	Weight of Pan	Weight of Wet Sample	Dried Weight of Sample and Pan

Page Number: ______________________