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Abstract

The objective of this study was to determine shear force, pH, marbling, color characteristics, percentage of intramuscular fat, and purge loss of pork loins from various premium brands in comparison to commodity products. Pork loins (n = 30/brand; Institutional Meat Purchasing Specifications #414) from five premium (PRE A, B, C, D, and E) and two commodity brands (COM A and B) were purchased from food service purveyors and commercial abattoirs. Loins were transported to the Kansas State University Meat Laboratory, Manhattan, KS, and allowed to age 14 to 15 days under refrigerated conditions (36 to 39°F) before fabrication. All PRE brands were similar ($P > 0.05$) with lesser ($P < 0.05$) slice shear force values than COM A, with the exception of PRE C, which had greater ($P < 0.05$) slice shear force values than all other brands evaluated. Similar results were found for Warner-Bratzler shear force, with PRE C having greater ($P < 0.05$) Warner-Bratzler shear force values than all other treatments, and no difference ($P > 0.05$) found among the other PRE products. Commodity A was also tougher ($P < 0.05$) than all PRE brands, except PRE C for Warner-Bratzler shear force. For subjective loin color evaluations, all PRE brands were similar ($P > 0.05$), with only PRE C having a greater ($P < 0.05$) color score than PRE B. Commodity B had a lesser ($P < 0.05$) loin subjective color than all PRE products except PRE B and D. Also, COM B had a greater ($P < 0.05$) L* value (lighter) and lesser ($P < 0.05$) a* value (less red) than all of the other brands. No difference ($P > 0.05$) in a* was found among the PRE brands and only PRE D and E differed ($P < 0.05$) for L*. The two COM products had a similar ($P > 0.05$) chop color score, however COM B was lighter ($P < 0.05$) than all PRE brands. Premium A and E had greater loin visual marbling than all other brands, with no difference ($P > 0.05$) found among the two COM brands and the other 3 PRE brands. However, for chop visual marbling, the two COM brands had less ($P < 0.05$) marbling than all PRE brands, except PRE B and C. For fat percentage, all brands had between 2 to 3% fat, with COM A having less ($P < 0.05$) fat than all PRE brands other than PRE B and D. Little variation was found among brands for pH, but COM B had a lower ($P < 0.05$) pH than all of the other brands. Premium A, C, and D had less ($P < 0.05$) weight lost as purge than any of the other brands. The differences observed within the quality traits evaluated show variation among different premium pork loin brands. This provides evidence that consumers and retailers will receive different levels of pork quality and eating satisfaction dependent upon the premium brand purchased.

Keywords

color, marbling, pork, quality, shear force, tenderness

Evaluation of the Quality Characteristics of Premium Pork Loins

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Summary

The objective of this study was to determine shear force, pH, marbling, color characteristics, percentage of intramuscular fat, and purge loss of pork loins from various premium brands in comparison to commodity products. Pork loins (*n* = 30/brand; Institutional Meat Purchasing Specifications #414) from five premium (PRE A, B, C, D, and E) and two commodity brands (COM A and B) were purchased from food service purveyors and commercial abattoirs. Loins were transported to the Kansas State University Meat Laboratory, Manhattan, KS, and allowed to age 14 to 15 days under refrigerated conditions (36 to 39°F) before fabrication. All PRE brands were similar ($P > 0.05$) with lesser ($P < 0.05$) slice shear force values than COM A, with the exception of PRE C, which had greater ($P < 0.05$) slice shear force values than all other brands evaluated. Similar results were found for Warner-Bratzler shear force, with PRE C having greater ($P < 0.05$) Warner-Bratzler shear force values than all other treatments, and no difference ($P > 0.05$) found among the other PRE products. Commodity A was also tougher ($P < 0.05$) than all PRE brands, except PRE C for Warner-Bratzler shear force. For subjective loin color evaluations, all PRE brands were similar ($P > 0.05$), with only PRE C having a greater ($P < 0.05$) color score than PRE B. Commodity B had a lesser ($P < 0.05$) loin subjective color than all PRE products except PRE B and D. Also, COM B had a greater ($P < 0.05$) L^* value (lighter) and lesser ($P < 0.05$) a^* value (less red) than all of the other brands. No difference ($P > 0.05$) in a^* was found among the PRE brands and only PRE D and E differed ($P < 0.05$) for L^*. The two COM products had a similar ($P > 0.05$) chop color score, however COM B was lighter ($P < 0.05$) than all PRE brands. Premium A and E had greater loin visual marbling than all other brands, with no difference ($P > 0.05$) found among the two COM brands and the other 3 PRE brands. However, for chop visual marbling, the two COM brands had less ($P < 0.05$) marbling than all PRE brands, except PRE B and C. For fat percentage, all brands had between 2 to 3% fat, with COM A having less ($P < 0.05$) fat than all PRE brands other than PRE B and D. Little variation was found among brands for pH, but COM B had a lower ($P < 0.05$) pH than all of the other brands. Premium A, C, and D had less ($P < 0.05$) weight lost as purge than any of the other brands. The differences observed within the quality traits evaluated show variation among different premium pork loin brands. This provides evidence that consumers and retailers will receive different levels of pork quality and eating satisfaction dependent upon the premium brand purchased.

Introduction

The last revision to the pork grading standards occurred in 1985. Ultimately, those standards no longer accurately reflect value differences in today's pork products. Modern pork production is characterized by products with improved color and higher marbling content, two factors that have been consistently identified by researchers as the main components affecting pork eating quality.[1,2] Because there is an absence of a meaningful United States Department of Agriculture pork grade standards, packers have taken the initiative to sort the darker colored, higher-marbled pork to market as premium products. With this, premium product price is 15 to 20% more than commodity products.[3] Because of a lack of consistent standards in the criteria used for product segregation for these premium programs, differences may exist in quality characteristics and ultimately lead to variation in pork eating quality. Therefore, the objective of this study was to determine shear force, pH, marbling, color characteristics, percentage of intramuscular fat, and purge loss of pork loins from various premium brands in comparison to commodity products.

Procedures

Pork loins (n = 30/brand; Institutional Meat Purchasing Specifications #414[4]) from five premium (PRE A, B, C, D, and E) and two commodity brands (COM A and B), were purchased from food service purveyors and commercial abattoirs. Brands used for this study represented a wide breadth of premium products available in the market and represented different programs offered from numerous packers. Loins were transported to the Kansas State University Meat Laboratory, Manhattan, KS, and allowed to age under refrigerated conditions (36 to 39°F). Loins were fabricated at 14 or 15 days postmortem.

The loin was weighed in the package before being opened to obtain an initial weight. After opening, the loin was removed from the package, dabbed dry with paper towels and reweighed. Packages were washed and hung dry 24 hours before being weighed. Percent purge loss was determined using the equation [1 – (loin weight/(initial weight – dry package weight))]. Loins were evaluated on the ventral side in the area where the back ribs were removed immediately following opening for L*, a*, and b* using a Hunter Lab Miniscan spectrophotometer (Illuminant A, 1-inch aperture, 10° observer; Hunter Associates Laboratory, Reston, VA) at three locations within the loin and averaged. Moreover, experienced Kansas State University personnel evaluated each loin for subjective color and marbling scores according to the National Pork Board Color and

[1]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(2):153-163. doi: 10.1016/S0309-1740(01)00065-1

[2]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(2):927-933. doi: https://doi.org/10.1016/S0309-1740(02)00310-8

[3]Wright, L. I., J. A. Scanga, K. E. Belk, T. E. Engle, J. D. Tatum, R. C. Person, D. R. McKenna, D. B. Griffin, F. K. McKeith, J. W. Savell, and G. C. Smith. 2005. Benchmarking value in the pork supply chain: Characterization of US pork in the retail marketplace. Meat Sci. 71(3):451-463. doi: https://doi.org/10.1016/j.meatsci.2005.04.024

[4]North American Meat Institute. 2014. The meat buyer's guide. 8th ed. North American Meat Institute, Washington D.C.

Marbling Standards.[5] Loins were fabricated into 1-inch thick chops using a commercial meat slicer (Trief Model PUMA 700F, Trief USA Inc., Shelton, CT). Chops were sliced immediately posterior to the spinalis dorsi and assigned to testing procedures.

Following a 30-minute bloom time, chops designated for color analysis were evaluated for L*, a*, and b* using a Hunter Lab Miniscan spectrophotometer at three locations within the chop and averaged. pH was measured using a pH meter (model HI 99163; Hannah Instruments, Smithfield, RI). Kansas State University personnel evaluated each color chop for subjective color and marbling scores according to the National Pork Board Color and Marbling Standards.

Following fabrication and color readings, the chop designated for chemical intramuscular fat analysis was refrigerated (36 to 39°F) overnight before being homogenized. Total fat analysis was determined for each sample using the chloroform:methanol extraction method described by Folch.[6] Analyses were performed in duplicate and percent fat was calculated using the formula: Percent fat = [(g residue after drying/g of wet sample) × 2 × 100].

Chops designated for shear force analyses were vacuum packaged and frozen at -4°F. Prior to shear evaluation, chops were thawed under refrigeration (36 to 39°F) for 24 hours. Chops were weighed prior to cooking and a thermometer (Super-Fast Thermopen, ThermoWorks, American Fork, UT) was inserted into the geometric center of each chop and remained in place during the cooking process. Chops were cooked on clam-style grills (Cuisinart Griddler; Cuisinart, Stamford, CT) set to a surface temperature of 350°F and removed from grills to achieve a peak temperature of 160°F. Following cooking, chops were reweighed and the cook loss was determined using the equation [((initial weight – cooked weight)/initial weight) × 100]. Slice shear force was conducted immediately after the post-cooking temperature rise was complete using the shear force protocol that Shackelford[7] developed. The slice was sheared once with a flat, blunt-end blade using an Instron model 5569 testing machine (Instron, Canton, MA), the crosshead speed was set at 500 mm/minute. For Warner-Bratzler shear force, chops were cooled for 12 hours at 36 to 39°F prior to Warner-Bratzler shear force analysis according to the American Meat Science Association Warner-Bratzler shear force protocols.[8] Six 0.5-inch diameter cores were removed parallel to muscle fiber orientation. The cores were sheared once, perpendicular to muscle fibers on an Instron Model 5569 testing machine (Instron, Canton, MA) with the use of a Warner-Bratzler shear blade. Values were reported as the peak pounds of force required to shear through the core. Values were averaged across all cores from a single chop.

[5]NPB. 2002. NPPC Official Color and Marbling Standards. Michigan State University.

[6]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.

[7]Shackelford, S. D., T. L. Wheeler, and M. Koohmaraie. 2004. Technical Note: Use of belt grill cookery and slice shear force for assessment of pork longissimus tenderness. J. Anim. Sci. 82(1):238-241. doi: 10.2527/2004.821238x

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

Statistical analysis was conducted in SAS (Version 9.4, SAS Inst. Inc., Cary, NC) using PROC GLIMMIX with $\alpha = 0.05$. Data were analyzed using a completely randomized design with the fixed effect of brand and loin as the experimental unit.

Results and Discussion

All PRE brands were similar ($P > 0.05$) with lesser ($P < 0.05$) slice shear force values than COM A, with the exception of PRE C, which had greater ($P < 0.05$) slice shear force values than all other brands evaluated. Similar results were found for Warner-Bratzler shear force, with PRE C having greater ($P < 0.05$) Warner-Bratzler shear force values than all other treatments, and no difference ($P > 0.05$) found among the other PRE products (Table 1). Commodity A was also tougher ($P < 0.05$) than all PRE brands, except PRE C for Warner-Bratzler shear force. Previous research has identified tenderness as the most important sensory characteristic when eating meat.[9,10] Shear force values correlate with tenderness sensory ratings,[11] indicating PRE C would be the toughest for consumers.

For subjective color evaluations, the two COM products had a similar ($P > 0.05$) chop color score; however COM B, was lighter ($P < 0.05$) than all PRE brands (Table 2). Loin subjective color was similar ($P > 0.05$) among all PRE brands, with only PRE C having a greater ($P < 0.05$) color score than PRE B. Commodity B had a lesser ($P < 0.05$) loin subjective color than all PRE products except PRE B and D. Instrumental color expresses color as three numerical values, L* for the lightness and a* and b* for the green–red and blue–yellow color components. Commodity B had a greater ($P < 0.05$) L* value (lighter) and lesser ($P < 0.05$) a* (less red) value than all of the other brands. No difference ($P > 0.05$) in a* was found among the PRE brands and only PRE D and E differed ($P < 0.05$) for L* (darker). Steenkamp[12] measured consumers' quality expectations based on visual appraisal and found color had a significant impact on quality expectations. Brewer[13] reported the longissimus lumborum L* and b* means to reflect those reported in this study; however, they reported a greater a* (more red). Additionally, in that study, similar results were reported as bloom time affected all instrumental measures except L* value, but to varying degrees. Moreover, Zhu[14] reported an a* change of 0.589 was required before consumers perceived a significant difference in meat redness. This indicates that consumers would likely be able to detect

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[9]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. 1995. Consumer acceptability of beef steak tenderness in the home and restaurant. J. Food Sci. 60(5):963-965.

[10]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(1):91-97.

[11]Davis, G., G. Smith, Z. Carpenter, and H. Cross. 1975. Relationships of quality indicators to palatability attributes of pork loins J. Anim. Sci. 41(5):1305-1313.

[12]Steenkamp, J.-B. E. M., and H. C. M. Van Trijp. 1996. Quality guidance: A consumer-based approach to food quality improvement using partial least squares. Eur. Rev. Agric. Econ. 23(2):195-215. doi: 10.1093/erae/23.2.195

[13]Brewer, M. S., L. G. Zhu, B. Bidner, D. J. Meisinger, and F. K. McKeith. 2001. Measuring pork color: effects of bloom time, muscle, pH and relationship to instrumental parameters. Meat Sci. 57(2):169-176. doi: https://doi.org/10.1016/S0309-1740(00)00089-9

[14]Zhu, L. G., and M. S. Brewer. 1999. Relationship between instrumental and visual color in a raw, fresh beef and chicken model system. J. Mus. Foods 10(2):131-146.

COM B as significantly paler, but see no differences among any of the other brands for redness.

Premium A and E had greater loin visual marbling scores than all other brands, with no difference ($P > 0.05$) found among the two COM brands and the other 3 PRE brands. However, for chop visual marbling, the two COM brands had less ($P < 0.05$) marbling than all PRE brands, except PRE B and C. For percentage fat, all brands had between 2 to 3% fat, with COM A having less ($P < 0.05$) fat than all PRE brands other than PRE B and D. Intramuscular lipid content effects on pork loin tenderness are conflicting.[15,16] For consumer preference, Steenkamp[17] reported intramuscular marbling had a negative impact on quality expectations; however, a positive impact on quality eating experience. Huff-Lonergan[18] reported marbling and intramuscular fat content were not significantly correlated to consumer sensory juiciness scores; however, were positively correlated with flavor scores. From this it can be inferred that consumers may not prefer the visual appearance of fat within PRE E, but this product may produce a more appealing flavor.

Although little variation was found among brands for pH, COM B had a lower ($P < 0.05$) pH than all of the other brands. pH measurements are commonly used to predict several meat quality traits. Brewer[19] showed as pH increased, visual pink color intensity concurrently increased. Because COM B had the lowest pH, the low observed a* value and the most pale pinkish gray to white color score could be attributed to that as well. Additionally, pH has also been shown to increase water holding capacity and therefore decrease purge loss. Previous literature reports significant positive correlations between pH and Hunter color values, drip loss, and sensory characteristics.[18] Premium A, C, and D had less ($P < 0.05$) weight lost as purge than any of the other brands, whereas COM A had the greatest amount of purge loss, being only similar to PRE B.

In conclusion, the differences observed within the quality traits evaluated in this study show variation among different premium pork loin brands. This provides evidence that consumers and retailers will receive different levels of pork quality and eating satisfaction dependent upon the premium brand purchased. Pork quality traits are complex and influenced by various factors, making the prediction of quality difficult, especially when developing a marketing program for premium pork.

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[15]Dikeman, M. E. 1987. Fat reduction in animals and the effects on palatability and consumer acceptance of meat products. In: Reciprocal Meat Conference. p 93-103.
[16]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(1):67-72. doi: https://doi.org/10.1016/S0309-1740(99)00038-8
[17]Steenkamp, J.-B. E. M., and H. C. M. Van Trijp. 1996. Quality guidance: A consumer-based approach to food quality improvement using partial least squares. Eur. Rev. Agric. Econ. 23(2):195-215. doi: 10.1093/erae/23.2.195
[18]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(3):617-627. doi: 10.2527/2002.803617x
[19]Brewer, M. S., L. G. Zhu, B. Bidner, D. J. Meisinger, and F. K. McKeith. 2001. Measuring pork color: effects of bloom time, muscle, pH and relationship to instrumental parameters. Meat Sci. 57(2):169-176. doi: https://doi.org/10.1016/S0309-1740(00)00089-9

Table 1. Loin tenderness, purge loss, and pH attributes of premium and commodity pork loin brands

Treatment[1]	WBSF[2]	SSF[3]	Purge loss	pH
PRE A	4.9[cd]	21.3[c]	1.1[d]	5.5[b]
PRE B	4.8[cd]	20.5[c]	2.3[ab]	5.6[a]
PRE C	6.5[a]	32.5[a]	1.2[d]	5.6[a]
PRE D	4.8[cd]	23.1[c]	1.2[d]	5.6[a]
PRE E	4.7[d]	22.5[c]	1.8[c]	5.6[a]
COM A	5.7[b]	27.1[b]	2.3[a]	5.6[a]
COM B	5.2[bc]	21.9[c]	1.8[bc]	5.4[c]
SEM	0.09	0.56	0.00	0.03
P – value	< 0.01	< 0.01	< 0.01	< 0.01

[abcd]Means within the same column without a common superscript differ ($P < 0.05$).
[1]Five premium (PRE A, B, C, D, and E) and two commodity brands (COM A and B) were evaluated.
[2]Warner-Bratzler shear force, lb.
[3]Slice shear force, lb.

Table 2. Loin color and marbling attributes of premium and commodity pork loin brands

Treatment[1]	L*[2]	a*[3]	b*[4]	Marbling[5]	Color[6]	IMF, %
PRE A	59.7[bc]	15.6[a]	14.2[ab]	2.8[a]	3.6[ab]	2.7[ab]
PRE B	59.7[bc]	14.8[a]	14.0[b]	2.1[b]	3.3[bc]	2.5[bc]
PRE C	59.7[bc]	15.2[a]	13.6[bc]	2.2[b]	3.6[a]	2.6[ab]
PRE D	59.9[b]	15.4[a]	14.7[a]	2.4[b]	3.4[abc]	2.4[bc]
PRE E	58.3[c]	14.8[a]	14.1[ab]	3.1[a]	3.5[ab]	2.9[a]
COM A	59.4[bc]	15.2[a]	14.3[ab]	2.0[b]	3.3[bc]	2.2[c]
COM B	61.7[a]	14.0[b]	13.2[c]	2.0[b]	3.1[c]	2.4[bc]
SEM	0.55	0.23	0.20	0.13	0.11	0.00
P – value	< 0.01	0.03	< 0.01	< 0.01	0.03	< 0.01

[abc]Means within the same column without a common superscript differ ($P < 0.05$).
[1]Five premium (PRE A, B, C, D, and E) and two commodity brands (COM A and B) were evaluated.
[2]L*: 0 = black, 100 = white.
[3]a*: -60 = green, 60 = red.
[4]b*: -60 = blue, 60 = yellow.
[5]Marbling scores determined by National Pork Board Standards (NPB, 2002).
[6]1 = pale pinkish gray to white; 6 = dark purplish to red.
[7]Percentage intramuscular fat content.