RESEARCH ABSTRACT

ANIMAL SCIENCE

Title: Effects of Pork Quality and Cooked Temperature on Consumer and Trained Sensory Perception of Eating Quality in Non-enhanced and Enhanced Pork Loins – **NPB #06-139 and #07-005**

Investigator: Steve Moeller

Institution: The Ohio State University

Co- Investigators: Rhonda Miller, Henry Zerby - Texas A&M University

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Industry Summary

Project Design and Objectives

The present study was conducted to evaluate the influences of fresh pork color (Minolta L*), intramuscular fat (IMF), and ultimate pH (pH), and cooked pork Warner Bratzler shear force (WBS) on consumer and trained sensory perception of pork loin (chop) eating quality. Trained and sensory assessments of eating quality were assessed at four end-point cooked temperatures (62.8° C (145° F); 68.3° C (155° F); 73.9° C (165° F); and 79.4° C (175° F). The effects of variation in quality and cooked temperature were assessed for both non-enhanced and enhanced (10% pump rate, 2.5% potassium lactate, 0.35% sodium phosphate, and 0.35% salt) pork loin chops. Loins used in testing were collected from three cooperating U.S. packing plants, with selection designed to capture the variation in and combinations of Minolta L*, IMF, and pH observed in the U.S pork industry in an attempt to understand the individual influence each quality attribute as well as potential interactions among quality attributes as they relate to eating quality of pork. Consumer testing was conducted in Chicago, Philadelphia and Sacramento, targeting 760 consumers within each test market. Trained sensory testing was conducted at Texas A&M University and Iowa State University.

Non-enhanced Loin Findings

Consumer responses were assessed on an 8-point scale with a rating of 1 representing a very unfavorable response and a rating of 8 representing a very favorable response. For non-enhanced pork over all attributes assessed, predicted mean consumer responses were consistently near or slightly under five on the 1 to 8 point end-anchored scale, indicating a very neutral or slightly unfavorable perception of pork eating quality regardless of variation in fresh quality measures or cooked temperature. Increasing cooked temperature of the non-enhanced chops reduced ratings for consumer perceptions of juiciness, tenderness and overall-like, with the effect being most pronounced when comparing the lowest cooked temperature (145° F) with the greatest cooked temperature (175° F). Intramuscular fat level had a significant, but small impact on consumer perception of eating quality attributes; increasing juiciness, tenderness, and overall-like ratings, but only of a measurable and practical influence when comparing the least (1% IMF) with the greatest (6% IMF) levels. Consumer response ratings were greatly influenced by loin pH and WBS. Increasing loin pH from a base of 5.40 to 6.40 resulted in ~1.0 unit favorable improvements in mean responses for tenderness and juiciness ratings. As WBS increased, consumer ratings for tenderness, juiciness, and overall-like decreased, with the most favorable ratings (≥ 5 on the 8-point scale) occurring for WBS levels of < 2.5 kg shear force, a value representing the mean WBS of chops cooked to 145 F. Increasing WBS to 4.0 kg resulted in mean consumer ratings near 4.0 on the 8-point scale. Minolta L* had no statistical influence on consumer perception of eating quality in the present study when assessed with the effects of pH, IMF, WBS and cooked temperature in the model.

Trained sensory responses were evaluated using a 10-point end anchored intensity scale. Panelists assessed tenderness, chewiness, juiciness, fat flavor, lean flavor, and saltiness attributes. The negative influence of increasing cooked temperature on juiciness ratings was in a similar direction, but of a greater magnitude in the trained panel when compared with the consumer ratings. Increasing cooked temperature by 10° F reduced trained panel ratings by 0.38 units, resulting in an overall 11.5% reduction in juiciness ratings when comparing 145° F and 175° F end-point cooked

temperatures. Trained panelists ratings for pork tenderness were near 6.5, on the 10-point scale, a mean value indicative of a moderate level of tenderness for the non-enhanced pork. Increasing cooked temperature from 145° F to 175° F reduced mean ratings by a small, but significant 0.27 units in the present study. Cooked temperature had no statistical influence on either fat flavor or lean flavor as assessed by the trained panel. At the average WBS (~2.65 kg) the mean trained panel rating for tenderness was ~ 6.70 units on the 10-point scale. Increasing WBS in 0.50 kg increments reduced mean tenderness ratings by ~3.8%, resulting in mean ratings near 4.69 for chops with WBS of 5.0 kg and near 3.91 for chops with WBS of 6.0 kg, the toughest chops tested in the study. Incrementally increasing WBS by 0.50 kg led to reductions in trained panel juiciness (- 1.8%) and lean flavor (- 2.5%) ratings, an indication that tougher chops were perceived as less juicy and having less lean flavor. Loin pH influenced trained panel perceptions of tenderness, juiciness, and fat flavor in a curvilinear manner with chops from loins with a pH level of 5.60 or less receiving much lower (unfavorable) ratings when compared with chops from loin with a pH of 5.8 or greater. The curvilinear influence of pH on trained panel attributes suggests that loins with lower pH (≤ 5.60) were clearly less desirable and that, while the magnitude of the influence of loin pH on sensory attributes decreases at a slower rate beyond a pH of 5.80, trained panelists continued to rate chops more favorably up to a pH of 6.40 for nearly all attributes. Trained panels reported significant, but very small improvements in tenderness, chewiness, juiciness, and flavor ratings as IMF increased; however, similar to the observed influence of IMF on consumer responses, the effects observed were of practical value only when comparing the ends of the 1% to 6% range. Minolta L* color contributed to a significant, but very small effect on trained panel ratings for juiciness, tenderness, and lean flavor, with the palest chops (Minolta L* = 65.0, Color score 1) receiving measurably lower ratings when compared with the darkest (Minolta L* 46.9, Color score 5) chops evaluated and very limited differentiation in ratings when comparing and contrasting adjacent color scores (ie Color Score 1 vs. 2 or 3 vs. 4).

Based on the consumer and trained sensory response data collected, shear force and loin pH were the two primary pork quality attributes that influenced perceptions of pork eating quality for non-enhanced chops. However, both measures present logistical and technical challenges for use as either classification or sorting tools within the industry. For example, loin pH has been shown to be greatly influenced by the environment beginning with the pig at the farm and continuing through the chilling process within the packing plant. Coupled with challenges related to instrumentation and the inability to capture pH on every carcass at existing line speeds within U.S. packing plants, pH, while valuable, remains a challenging tool to implement. Shear force assessment, as measured in the present study, requires the pork to be cooked, resulting in a loss of product, difficulty in maintaining identity, and storage of remaining product until results are known and used as a sorting or marketing tool. Therefore, while results of the present study provide evidence for the value of shear force and pH as indicators of quality, implementation strategies that improve the logistical challenges present or development of new technologies to meet the challenges are necessary for the industry to make a concerted effort toward improvement of pork eating quality.

Results of the present study suggest that a reduction in the recommended cooked temperature from the existing 160° F to a lesser degree of doneness (either 145° F or 155° F) would have a positive influence on juiciness, tenderness and likelihood of purchase of non-enhanced chops, particularly for consumers that currently cook pork chops or loins to temperatures that exceed 160° F. Lowering the cooked temperature would have little influence on pork flavor attributes which were rated relatively low in both consumer and trained sensory panels. Loin intramuscular fat improved

eating quality as measured by the trained and consumers panels when comparing the upper end of the observed range (6% IMF) with the lower extreme (1% IMF) which is likely to have the greatest industry value when utilized as a trait in targeted- or niche-market scenarios where consumers are willing and able to pay for the extra cost that is often associated with producing pigs that have greater loin IMF. The influence of loin color, although significant only in the trained panel, on eating quality was very small or not present in the current study and is an indication that the contributions of pH and or shear force may have overridden or accounted for the individual contribution of color to eating quality variation. Color will likely remain a valuable indicator of eating quality in the fresh state because visual appeal plays a large role in point of purchase decisions, particularly for very pale or PSE-like pork.

Non-enhanced Loin Findings

Enhancement has been a tool used by the pork packing and processing industries to improve eating quality characteristics of pork. In the present study, a subset of loins were collected within a single packing facility and paired based on similarities in loin quality attributes. One loin from each paired loin set was enhanced and the other remained in the fresh state as a non-enhanced loin. The data were analyzed as a subset of the full consumer and trained sensory portions of the present study.

Increasing cooked temperature had little influence on WBS of enhanced chops, while WBS of non-enhanced chops increased and the difference between enhanced and non-enhanced chops increased as cooked temperature increased in the present study. The interactive influence on WBS for enhanced chops was observed in direct comparisons of consumer responses, whereby increasing cooked temperature of non-enhanced chops resulted in small but consistent reductions in consumer satisfaction, while for enhanced loins as cooked temperature increased consumer ratings were either not changed or were improved slightly. When comparing enhanced with non-enhanced chops at the cooked temperature extremes of 145° F and 175° F, the predicted mean ratings for enhanced chops increased by 0.73 and 1.15 units respectively for Juiciness Like, 0.81 and 1.08 units respectively for Tenderness Like, 1.1 and 1.31 units respectively for Flavor Like, and 0.88 and 1.13 units respectively for Overall Like. Enhancement improved consumer perceptions of eating quality even at a low cooked temperature, with the impact increasing as cooked temperature increased. Enhancement also improved trained sensory panel ratings for juiciness (5.4%), tenderness (6.8%), chewiness (2.6%), but had no influence on fat or lean flavor levels when assessed across the range of cooked temperatures assessed. In contrast with consumer responses, the enhancement effect was consistent at each cooked temperature.

Loin intramuscular fat had no influence on consumer ratings for tenderness like or level, and a significant, but very small (1.3% change over the range of 1% to 6% IMF) influence on trained sensory ratings for tenderness when assessed for both enhanced and non-enhanced chops. Increasing loin IMF improved consumer ratings for juiciness like and level by ~2.5% and trained sensory ratings for juiciness ~3.0%, favoring chops with 6% IMF over chops with 1% IMF for both enhanced and non-enhanced chops. At equal levels of IMF, enhanced chops were rated 11.3% more juicy by the consumer panelists and 5.6% more juicy by the trained panel.

Loin pH influenced consumer perceptions of eating quality in a non-linear fashion across the range of pH evaluated resulting in larger incremental changes in mean responses when increasing

loin pH from 5.40 to 5.60 for all descriptive attributes when compared with changes in loin pH from 5.80 to 6.00, 6.00 to 6.20, and 6.20 to 6.40. Consumer perceptions of loin juiciness attributes were optimized at a loin pH in the range of 5.80 – 6.00 and optimized for loin tenderness in the range of 6.00 to 6.40 across both enhanced and non-enhanced chops. Loin pH had no measurable influence on trained sensory juiciness, chewiness, lean flavor, or saltiness ratings; however, increasing loin pH from a low of 5.40 to the upper level of 6.40 improved tenderness ratings by 6.4% and fat flavor ratings by ~3.6% for both enhanced and non-enhanced chops. Consumers rated flavor attributes most favorably at a loin pH of 5.80, while trained panelist responses for fat flavor increased as pH increased from 5.40 up to 6.00, and changed only slightly as pH increased up to 6.40.

Enhancement improved consumer ratings for juiciness and tenderness attributes by approximately 12% across the range of WBS evaluated in the study, a finding somewhat larger than the 5.5% improvement in juiciness ratings and the 7.00% improvement in tenderness ratings observed in the trained panel evaluation. In addition, the influence of WBS on trained and consumer ratings for juiciness and tenderness were large and consistent across both enhanced and non-enhanced chops. Trained sensory ratings for tenderness were reduced by 3.3% for each 0.50 kg increase in WBS while consumer ratings were reduced ~3.5% for each 0.50 kg increase in WBS for both enhanced and non-enhanced chops, indicating that tougher pork was identified as being less desirable in both enhanced and non-enhanced chops; however, the additive influence of enhancement allowed enhanced chops to have greater mean ratings for tenderness at greater levels of WBS.

Results from the present study reinforce the significant positive influence that enhancement has on consumer and trained sensory perceptions of pork eating quality across the wide range of fresh pork quality attributes observed in the U.S. swine industry. Enhancement offered protection against overcooking and allowed pork with low pH and high WBS values to be rated as good as or better than non-enhanced pork measured at the optimal levels of pH and WBS. Based on the results of the present study, enhancement appears to offer significant improvements in eating quality when compared with non-enhanced loins with similar fresh pork quality attributes.