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Trained sensory perception of pork eating quality as affected by fresh and cooked pork quality attributes and end-point cooked temperature

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ABSTRACT

The present study evaluated individual and interactive influences of pork loin ($n = 679$) ultimate ph (pH), intramuscular fat (IMF), Minolta L^* color (L^*), Warner-Bratzler shear force (WBSF), and internal cooked temperatures (62.8 °C, 68.3 °C, 73.9 °C, and 79.4 °C) on trained sensory perception of palatability. Logistical regression analyses were used, fitting sensory responses as dependent variables and quality and cooked temperature as independent variables, testing quadratic and interactive effects. Incremental increases in cooked temperature reduced sensory juiciness and tenderness scores by 3.8% and 0.9%, respectively, but did not influence sensory flavor or saltiness scores. An increase of 4.9 N in WBSF, from a base of 14.7 N (lowest) to 58.8 N (greatest) was associated with a 3.7% and 1.8% reduction in sensory tenderness and juiciness scores, respectively, with predicted sensory tenderness scores reduced by 3.55 units when comparing ends of the WBSF range. Modeled sensory responses for loins with pH of 5.40 and 5.60 had reduced tenderness, chewiness, and fat flavor ratings when compared with responses for loins with pH of 5.80 to 6.40, the range indicative of optimal sensory response. Loin IMF and L^* were significant model effects; however, their influence on sensory attributes was small, with predicted mean sensory responses measurably improved only when comparing 6% and 1% IMF and L^* values of 46.9 (dark) when compared with 65.0 (pale). Tenderness and juiciness scores, were related to a greater extent to loin WBSF and pH, and to a lesser extent to cooked temperature, IMF and L^*.

1. Introduction

Fresh meat quality is a term that encompasses several factors including wholesomeness, healthfulness, visual properties, and palatability. All of these factors can be influenced by various antemortem factors including transport (Leheska, Wulf, & Maddock, 2002), feeding, and exercise strategies (Rosenvold et al., 2001), as well as postmortem strategies including variation in carcass suspension (Moller, Kirkegaard, & Vestergaard, 1987; Moller & Vestergaard, 1986). However, at the commercial level, from the farm through the packing plant, there are no standard procedures utilized to assure consistency, resulting in extensive variation in muscle quality properties that influence pork eating satisfaction. Because variation in fresh pork quality continues to exist at the retail level, it is important to take a fundamental look at the combination of quality attributes observed in pork products and determine their influence on eating quality. Through the use of trained sensory methods, an assessment of the influence of individual and combinations of quality attributes can be assessed. Utilization of these findings will help define expectations with regard to the ability of consumers to differentiate among levels of a given attribute, identify individual or combinations of quality attributes to target for improvement, and potentially establish quality targets for the pork industry. Therefore, the objective of the present study was to evaluate the potential independent and interactive influences of commonly measured pork quality indicators (loin color, pH, intramuscular fat, and shear force) on trained sensory panel perception of pork eating quality across four cooked temperatures. To achieve this objective, commercially derived loins were selected to capture and test the variation in and combinations of pork quality present in the US pork industry.

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2. Materials and methods

2.1. Loin selection criteria

Loins utilized ($n = 679$) represented a subset of loins collected ($n = 1120$) within three U.S. commercial packing facilities ($n = 228$, 228, and 223 loins per plant). By design, loins used were selected to represent the normal range of industry observed values and selected with the statistical ability to test main and interactive effects of fresh pork quality measurements (Minolta L^* (L^*), ultimate pH (pH), and intramuscular fat percentage (IMF)) on sensory panel measures of palatability. Post-collection, loins were placed into three-dimensional subclasses based on L^* (3.9 unit increments), pH (0.10 unit increments) and IMF (1% increments). Loins chosen for sampling were selected, to the extent possible, to create a uniform distribution for each individual quality measurement.

2.2. Loin quality assessment

Whole, boneless loins were collected on the fabrication line at approximately 24 h postmortem. Using the size of the *spinalis dorsi* muscle as an anatomical indicator, the loin was cut at approximately the 7th rib, and the cut surface was allowed to "bloom" for 10 min. Loin pH was measured using a portable pH meter (HI98240, Hanna Instruments, Italy) equipped with a glass-tipped pH probe (FC201D, Hanna Instruments, Italy) placed in the center on the exposed 7th rib loin surface and inserted approximately 1 cm under the cut surface. After "bloom", loin color was measured on the 7th rib loin surface using a Minolta Colorimeter (CR-310, 50 mm diameter orifice, 10° standard observer, D^{65} light source, calibrated against a white tile; Minolta Company, Ramsey, New Jersey), recording L^*.

A 1.25 cm-thick section of loin was cut immediately posterior to the 7th rib location, subcutaneous fat and connective tissue removed, and the muscle used for subsequent assessment of moisture and fat amounts using the air-dry oven and Soxhlet ether extraction methods (AOAC, 2007), respectively. Approximately 2 g of powdered sample from each chop was added to dried, pre-weighed thimbles (filter paper #1, Whatman®, Maidstone, England), and weights were recorded. Analysis of the samples was performed in triplicate. The samples were dried in a convection oven at 100 °C for 18–24 h then removed and placed in a dessicator for cooling. Weights were taken and recorded to determine percent moisture. Samples were placed in a Soxhlet apparatus and refluxed with petroleum ether for approximately 18 h. Samples were removed and placed under a hood to allow ether to evaporate and then placed in a convection oven for approximately 12 h. Samples were removed and placed in a dessicator until cooled to room temperature. Weights were taken and recorded to determine percent fat (IMF) in each sample.

Following quality assessment, whole loins were weighed and individually vacuum-sealed for storage and transportation. Loins were transported under refrigeration to The Ohio State University Meat Science Laboratory, Columbus, OH, where the loins were stored and aged at 2 °C for a minimum of 7 and maximum of 10 d postmortem, with processing occurring on the Friday following the previous sampling week.

An additional factor included in the present study, but not reported in this manuscript, was a comparison between enhanced and non-enhanced pork loins with similar 24 h fresh pork quality parameters. Although the focus of the present manuscript is a study of trained sensory panel perceptions regarding non-enhanced pork, the procedures involved in loin selection and trained sensory panel evaluation portions of the study require provision of a brief description of collection procedures for the enhanced product. Briefly, within one packing plant, sampling numbers were doubled and loins were classified based on quality parameters and paired. Pairs of similar quality loins were then randomly assigned to enhancement or non-enhancement. Enhancement was completed using needle injection. Final loin target inclusion rates were: 10% pump rate, 2.5% potassium lactate, 0.35% sodium phosphate, and 0.35% salt.

2.3. Loin processing

After aging, loins were removed from their package and weighed to assess loin purge loss. Loins were then tempered in a freezer (−28.8 °C), creating a slightly frozen surface, and sliced, beginning at the anterior end, into 12, 2.54 cm-thick chops. Four chops per loin were then randomly assigned to three experimental groups (consumer sensory evaluation, trained sensory evaluation, or Warner-Bratzler Shear Force (WBS) assessment) and, within each experimental group, to one of four end-point cooked temperatures (62.8 °C, 68.3 °C, 73.9 °C, or 79.4 °C). While previous research (Hansen, Hansen, Aaslyng, & Byrne, 2004) described longitudinal variation in loin sensory tenderness measures, randomization of chops to experimental group and within experimental group to a cooked temperature end-point avoided confounding of chop location with L^*, pH, and IMF measurements obtained only at the 7th rib location. Following allocation, chops were individually packaged using a roll-stock machine and frozen at −28.8 °C until used within their respective experimental group.

2.4. Warner-Bratzler shear force

Warner-Bratzler shear force chops were weighed prior to and after thawing to assess thaw purge. Chops were cooked using a clam-style cooker (George Foreman grill) to the designated internal cooked temperature. Internal temperature (Digi-sense, Model # 277653 or equivalent) was monitored by copper constant thermocouples (Digi-sense, K-type probe, 30.48 cm × 1.016 cm diameter, Code 93631-11 or equivalent) inserted into the geometric center of each chop. Chops were removed from the grill at their designated temperature, recording cooking time, temperature, and cooked weight. Cook loss was measured using pre- and post-cooked weights. Chops were cooled for four hours to approximately 22.2 °C prior to tenderness assessment. Six, 1.27 cm diameters cores were removed from each chop parallel to the longitudinal orientation of the muscle fibers. Each core was sheared with a Warner-Bratzler shearing device (Model TA.XT2^{plus} Texture Technologies, Scarsdale, New York) with a probe travel distance of 40 mm from the base, a pre-test speed of 5 mm/s, a test speed of 3.33 mm/s and a post-test speed of 20 mm/s.

2.5. Trained sensory panel evaluation procedures

Trained sensory panel testing was conducted at Texas A&M University and Iowa State University to accommodate the large number of chops ($n = 3616$). Prior to initiation of the sensory testing, cross-training of panelists was conducted; in addition, panel location was included in statistical modeling to account for location differences in responses. Testing required approximately 83 d of testing within each sensory panel location. Loins were sorted within packing plant of origin based on quality classification and were alternately assigned to a trained sensory panel location in an attempt to establish a near uniform representation of quality variation within each panel location. The four chops within a loin, each representing a cooked temperature, were tested in the same panel location. Chops were sampled within cooking session to represent two or more plants, two or more temperatures, and both