Graduate Student Research Poster Competition

M.S. DIVISION

Effect of Ultimate pH on the Quality Characteristics of Pork

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A study was conducted to characterize the relationship between *Longissimus thoracis* ultimate pH (LTpH) and pork quality. Animals (N=47) from a variety of genotypes were selected for this study based on LTpH. Subjective measurements (color, firmness, marbling), objective color (L*, a*, b*), drip loss and purge loss were evaluated on the *Longissimus thoracis* (LT). Cooking loss, Warner-Bratzler shear (WBS), tenderness, juiciness and off flavor were measured on the *Longissimus lumborum*. Salt soluble protein (SSP) was evaluated on the LT, Semimembranosus (SM), and Biceps femoris (BF). Processing quality was evaluated using the boneless ham manufactured from the ground BF and SM. Data was analyzed as a regression with ultimate pH as the independent variable, and relationships were determined to be linear (L), quadratic (Q) or cubic (C). LTpH ranged from 4.86 to 7.15. LTpH explained 79% (C) of the variation in subjective color, which increased as pH increased. Drip loss, purge loss and L* decreased as LTpH increased (R^2= .57 C, .77 Q, and .28 Q). SSP of LT, SM and BF increased as LTpH increased (R^2= .36 Q, .30 L, and .22 L). WBS decreased and sensory juiciness increased as LTpH increased (R^2= .26 Q, .46 C). However, off flavor intensity increased as LTpH fell below pH 5.2 or exceeded 6.1(R^2= .52 C). Ham processing yield increased and L* decreased with increasing LTpH (R^2= .56 C, .55 Q). These data suggest that increasing LTpH will improve fresh pork quality and processed meat properties.

High Pressure Hydrodynamic Shock Wave Effects on Tenderness of Early Deboned Broiler Breasts Treated Immediately and After Storage

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The first objective of this study was to determine a relationship between Warner-Bratzler shear values (WBS) and consumer tenderness acceptability of broiler breasts. Eighty broiler breasts were deboned in a commercial plant at different times postmortem (0.75, 2, 4, 6, 24 hr) to provide significant variation in tenderness. WBS values were obtained on sous-vide cooked (78°C internal) breasts which were then divided into five groups based on their shear values. Consumers (n=62) evaluated tenderness on a nine-point hedonic scale. The second objective was to determine the effects of high pressure hydrodynamic shockwave on tenderness (48 hr postmortem) of early-deboned (52 min postmortem) breasts treated immediately (65 min postmortem; EDI; 6 replications) or treated after storage (24 hr postmortem; EDS; 15 replications) and compared to the corresponding non-treated companion breasts (EDC and EDSC, respectively). Broiler breast lobes were sealed in vinyl tubes. Packaged lobes were placed in a water-filled hydrodyne tank and a shockwave was produced by detonating 40 grams of molecular explosive in the water. EDI breasts (5.0 kg) were not different ($P>0.05$) in WBS than EDC (4.6 kg). EDS breasts (2.5 kg) were 42% more tender ($P<0.05$) than EDSC breasts (4.3 kg). Based on the consumer tests, the Hydrodyne treated EDS breasts would be acceptable to 94 % of consumers. Early-deboned breasts treated immediately may require higher pressure shockwaves or delayed treatment. The Hydrodyne process can overcome the problem with tenderness associated with early deboning if the breasts are processed after storage thereby providing processors with the option to debone earlier.

The Effects of Irradiation, High Hydrostatic Pressure, and Temperature During Pressurization on the Quality and Palatability of Cooked-Reheated Salmon and Catfish Filets

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Fully cooked salmon and catfish filets were treated with 0, 3, or 6 kGy ionizing radiation (irradiation), 0, 414, or 690 MPa of high hydrostatic pressure (HHP), and two different temperatures during pressurization (Ambient-HHP »21°C, or Heated-HHP =70°C), and combinations of the treatments. Kramer shear values increased for both salmon and catfish filets treated by HHP, Heated-HHP (70°C), and a combination treatment of HHP and 70°C. Irradiation decreased a* and b* values for salmon filets. Sensory panel tenderness and juiciness scores were lower for salmon treated with HHP, Heated-HHP, and a combination treatment of HHP and 70°C. Catfish tenderness and juiciness scores were lower for the

690 MPa HHP treatment. Irradiation increased tenderness and juiciness scores for salmon filets. Irradiation did not affect salmon flavor intensity scores and increased catfish flavor intensity scores. HHP and Heated-HHP decreased flavor intensity scores for salmon filets but had no effect on catfish flavor intensity scores. Thiobarbituric acid reactive substances (TBARS) were not affected by any of the main effects or combinations for salmon or catfish filets.

Near-Infrared Spectroscopy for Predicting Meat Quality Parameters

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Effective calibration of Near Infrared Spectroscopy (NIRS) for prediction of meat tenderness requires a profound effort to minimize tenderness variation induced by cooking. Visible and NIRS reflectance spectra (400-1700nm) were collected on USDA select beef longissimus dorsi steaks heated in 70°C water, in cook-in-bags, and cooked for 30, 40, 50, 60, 90, 120, 180, and 240 minutes. Warner-Bratzler shear force, cook loss, internal color, and collagen solubility were measured at each end cooking time. Warner-Bratzler shear force increased linearly (R^2=0.41) with increasing hold time reaching 3.60 kg at 240minutes. Cook loss also increased (R^2 =0.51) with increasing hold time reaching 35.31% at 240 minutes. Steak internal color (L*a*b*) was measured using a Minolta CR300 Colorimeter. The a* value and was found to decrease(R^2=0.63) with increasing hold time indicating a decrease in redness. Partial Least Squares(PLS) analyses were used to predict Warner-Bratzler shear force values from NIRS scans at each end point cook time. The PLS regression model combined the log of 1/R and the second derivative to give predictions at 40 min (R^2=0.43), 50 min(R^2=0.63), 60 min (R^2=0.20) and 90 min (R^2=0.43). Based on the coefficient of variation and the correlation value of the regression model the optimal hold time is 50 minutes, which has also been concluded by several other studies using NIR for predicting shear force values. Results from the study indicate that cooking in 70°C water for 50 minutes will allow uniform and consistent shear force values to be used in a calibration for prediction of tenderness.

National Beef Color and pH Survey

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The objectives of this study were to define the U.S. beef carcass population in terms of muscle color, ultimate pH, and electrical impedance; to determine the relationships among color, pH and impedance and with other carcasses characteristics; and to determine the effect of packing plant, breed type and sex class on these variables. 1000 beef carcasses were selected at three packing plants in Illinois, Ohio and Texas, to match the breed type, sex class, marbling score, dark cutting discount, overall maturity, carcass weight and yield grade distributions reported for the U.S. beef carcass population by the 1995 National Beef Quality Audit. Data collected on these carcasses included USDA grade data and measurements of muscle color (L*, a*, b*), muscle pH, muscle temperature and electrical impedance of the longissimus muscle. L* value was normally distributed. The distributions for a* and b* value both exhibited a long tail toward the lower numerical end, the tail corresponding to dark cutting carcasses. Color measurements were correlated with lean maturity and muscle pH. In addition, fat thickness was correlated with muscle color; fatter carcasses possessed higher colorimeter values. Although there was no significant packing plant effect on muscle pH, muscle colorimeter readings were different among plants. Steer carcasses had higher colorimeter readings than heifer carcasses, even though muscle pH was not different between steer and heifer carcasses. Bullock carcasses had higher muscle pH values and lower colorimeter readings than either steer or heifer carcasses. Dairy-type carcasses had lower muscle color values, along with higher muscle pH values as compared to both native-type and Brahman-type carcasses.

Development of a Model System to Study the Interaction of *E. coli* with Beef Muscle

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The enhanced green fluorescent protein (EGFP) gene on plasmid vector pEGFP was successfully introduced into a laboratory strain *E. coli* JM109 ATCC53323 and a pathogenic strain *E. coli* O157:H7 ATCC 43895. It was established that the presence of pEGFP to these organisms had no influence on the growth kinetics and the surface properties (hydrophobicity and electrophoretic mobility). At 37°C the recombinant strains maintained the vector and expressed the green fluorescent protein when grown with antibiotic selection. Colonies carrying EGFP plasmid emitted bright green fluorescence when excited with UV light without addition of any proteins, substrates, or cofactors. The EGFP expressing *E. coli* strains were used as a model to study the adhesion to meat surfaces using Laser Scanning Confocal Microscopy (LSCM). These constructed bacteria were added to beef muscle and could be visualized by LSCM. Images of bacteria and beef muscle were obtained after staining with Cy3 or Nile-Red dye. It was observed that the majority of the bacteria were attached to the outer surfaces of the myofibril fibers. They were mostly attached to the stained portion, which is believed to be the myofibril membrane. Some bacteria also appeared to be within crevices of the meat and these bacteria moved around freely.

Precooked Bacon Manufacture: Two Cooking Methods

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Precooked bacon is primarily produced by microwave cooking. Recent technology, double belt cooking, uses conduction through teflon coated belts to quickly cook uniformly thick products. Food service bacon, more thinly sliced, differs by addition of liquid smoke and more sugar to the curing brine than retail bacon. This study was designed to investigate the effects of bacon type, raw fat content and cooking method on cook loss and dimensional changes. Proximate analysis, cook yield and dimensional change data were collected. Bacon that was microwave cooked retained less moisture regardless of raw fat content when compared to the same bacon cooked on the belt grill (P<.03). Lean bacon had the highest yields. Retail bacon yielded more (P<.05) within each cooking method compared to food service type bacon. Belt grill cookery yielded more than microwave cookery for each location (P<.007). Food service bacon yielded less than retail. Food service type bacon shrunk more across all locations regardless of cooking method than retail type bacon (P<.05). As raw fat content increased, more length and width shrink occurred. Within bacon type, belt grilled bacon resulted in more distortion across the bacon slab than microwave cooked bacon (P<.008). Microwave bacon had a less distorted shape. Belt bacon shrunk more length wise and less widthwise. Dimensional changes and distortion of the slice during cooking may in part be due to the pressing of the bacon slab prior to slicing and differing collagen content across locations of the bacon slab.

Hydrodynamic Shock Wave Effects on Protein Functionality

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USDA Select beef *biceps femoris* (BF) was divided into four sections and randomly assigned to three Hydrodyne treatments and a control. Different amounts of explosive were suspended 30 cm above the vacuum packaged beef in the bottom of a water-filled tank and detonated, representing three Hydrodyne treatments (105 g, H1; 200 g, H2; 305 g, H3). In addition, BF steaks (2.54 cm) from a common source were packaged with each BF section. These served as internal transfer standards for the six replications to determine if the Hydrodyne process physically altered the structural integrity of the meat. H1 and H3 decreased (P < 0.05) Warner-Bratzler shear values from 3.86 and 3.99 kg to 3.01 and 3.02 kg, respectively. H2 shear values, 3.86 to 3.46 kg were not different (P > .05). Treated BF sections were analyzed for protein solubility and then used to manufacture frankfurters (2.0% NaCl, 0.5 % sodium tripolyphosphate, 156 ppm sodium nitrite, 0.42 % sodium erythorbate, 2.0 % sucrose, and 25 % water) cooked to 71°C. Frankfurters were evaluated for cooking yield, CIE L*a*b*, nitrosylhemochrome, Texture Profile Analysis (hardness, cohesiveness), and stress and strain (gelometer). The Hydrodyne process did not affect myofibrillar and sarcoplasmic protein solubility, cooking yield, or color (P > .05). Textural properties and gel strength of the frankfurters were not affected (P > .05) by the Hydrodyne Process. Beef trim from Hydrodyne processed meat could be used interchangeably with normal meat trim in the production of sausage and restructured meats since the functionality of meat protein is not affected significantly by the Hydrodyne process.

Influence of Chop Location on Boneless Pork Loin Quality

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Eighty-two boneless pork loins were used to examine the effects of chop location on longissimus muscle (LM) quality. At 7 d postmortem, loins were cut into 2.54-cm chops and location numbered 1 to 19, from posterior to anterior end. Chops were evaluated for visual and instrumental color (chops 1, 3, 5, 7, 9, 11, 13, 15, 17, 19), Warner-Bratzler shear (WBS) force (chops 2, 7, 12, 17), pH (chops 4, 9, 14, 19), and extractable lipid and moisture (chops 3, 8, 13, 18). The LM chops located from 3 to 11 were visually more reddish-pink ($P < .05$) than chops located at 1, 13, and 15. Location 19 was visually the darkest reddish-pink ($P < .05$). Chops located 1 to 9 were visually firmer and less watery ($P < .05$) than chops located between 13 and 19. Also, chop locations 17 and 19 were the softest and most watery ($P < .05$). Visual marbling was higher ($P < .05$) for chops 1 and 3 than chops located 5 through 19. The L* values were darker ($P < .05$) from chops 3 to 11 than chops 1, 13, and 15. The most anterior chops (location 17 and 19) had the highest ($P < .05$) a* values. Chop locations 13 and 15 had higher (P < .05) b* values than chops at 9 and 19 locations. The posterior chop (location 2) had the lowest ($P < .05$) WBS value. Chop 12 had a lower ($P < .05$) WBS value than chop 7. The anterior end (location 19) had the highest ($P < .05$) pH and location 4 had a higher (P < .05) pH than location 14. Chops from locations 3 and 18 had more ($P < .05$) extractable lipid than location 8. The highest quality chops appear to come from the posterior end. The anterior section was variable in quality-related traits. This study suggests that locations within the same loin may vary in color, tenderness, pH, and lipid (marbling). Therefore, chops within pork loins may need to be sorted to increase consistency of quality characteristics.