Graduate Student Research Poster Competition

M.S. DIVISION

Pork Quality Variation is Not Explained by Activity of Rate-Limiting Glycolytic Enzymes

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Our objective was to determine if increased *in vitro* glycolytic enzyme activity is associated with rapid decline in postmortem pH that leads to inferior pork color and water holding capacity. Thirty-two Duroc (n = 16) or Hal 1843™ free Pietrain (n = 16) sired gilts were harvested over a two-week period. Temperature of the *longissimus* muscle (LM) was logged continuously from 45 min to 24 h postmortem at 5 min intervals and LM pH was measured at 20, 45, 180 min and 24 h postmortem. Temperature of LM at 45 min postmortem was negatively correlated with 45 min pH ($P < .05$). Minolta L values for LM chops at 24 h postmortem ranged from 49.6 to 60.2. Purge, determined as fluid loss from vacuum packaged loin sections, ranged from .79 to 9.91% in loin sections stored at 4°C from d1 to d6 postmortem. After purge determination, two 2.5 cm thick loin chops were cut and allowed to drip in a simulated retail case at 4°C overnight. Drip loss ranged from .7-1.8%. Minolta L values (d1, d2, d6 and d7) were correlated to all measures of fluid loss ($P < .002$). Phosphofructokinase and pyruvate kinase activities in LM sarcoplasmic fractions were quantified using coupled enzyme assays. Phosphofructokinase and pyruvate kinase activities were not correlated with LM pH, purge, drip loss, or color ($r < .2$ or $> -.2$; $P > .31$). These data indicate that variation in pork color and water holding capacity is not associated with LM glycolytic capacity.

Myofibrillar Protein Patterns: As Predictors of Post Mortem Tenderness?

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Tenderness is the primary sensory attribute influencing acceptability of beef. Myofibrillar protein degradation plays a predominant role in determining tenderness in skeletal muscle. The mechanisms controlling muscle tenderness are not well understood. The objective of this research was to determine the contributions of myofibrillar protein patterns and evaluate their influence on muscle tenderness in age matched beef carcasses. Beef carcasses (n = 1,062) were selected to match the breed type, sex class, marbling score, dark cutting discount, overall maturity, hot carcass weight and yield grade distribution as reported in the 1995 National Beef Audit. Of these carcasses 100 were selected on the same basis and analyzed for muscle color, pH, temperature, and electrical impedance of the *L. lumborum* (LL) muscle. Samples aged 7 days were evaluated for tenderness by a trained sensory panel and Warner Bratzler shear. Based on these results 10 carcasses, 5 tough and 5 tender, were selected for further analysis. Sodium dodecyl sulfate gel electrophoresis showed differences in myofibrillar protein patterns between tough and tender muscles. Visual comparisons indicated differences in Troponin T degradation and was confirmed using western blot analysis. Weakening of the myofibrillar structure was further demonstrated by ultrastructural comparisons using light and transmission electron microscopy. These measures of protein degradation may be important predictors of muscle tenderness and contribute to our understanding of the role of myofibrillar protein architecture in determining tenderness.

Characterization of the Quality Attributes of Fresh, Pumped Pork Loins

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Barrows (n = 347) from a commercial crossbred line were harvested on two separate occasions to evaluate the effects of pump level, raw material quality (pH), and pump solution ingredients on pork quality. Boneless, paired pork loins (n = 120) were selected based on 14 h pH and transported to the University of Illinois. Ultimate pH, drip loss, instrumental color (L*, a*, b*), and proximate analysis were evaluated prior to pumping. Paired loins were cut into four sections and randomly assigned to one of four pump levels (0, 6, 12, or 18%). Loin sections were pumped with 0.4% sodium tripolyphosphate (STP) for experiment one (Exp. 1) and 0.4% STP and

0.4% salt for experiment two (Exp. 2). Pump retention, vacuum package purge loss, sensory characteristics, Warner Bratzler shear (WBS), retail purge loss, and instrumental color (L*, a*, b*) were evaluated. In Exp. 1, increasing pump level increased ($P \leq 0.05$) retention and purge. Increased pH significantly increased pump retention and reduced purge loss. A pump level by pH interaction was observed for cook loss at 70°C. In Exp. 2, increasing pump level increased pump retention ($P \leq 0.05$). Purge loss from the 18% pump level was higher ($P \leq 0.05$) than controls. Increased muscle pH consistently reduced purge loss and resulted in juicier, more tender pork. Pumped pork had higher tenderness, juiciness, and saltiness scores than controls. Pump level and pH had limited effects on WBS and cook loss. The results suggest that pump level and pH impact retention and purge but have limited effects on WBS, cook loss, and palatability attributes.

Analysis of Adipocyte Gene Expression During Marbling in Angus X Hereford Steers

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Understanding the biology of adipose development and differentiation would substantially benefit the beef industry. The present study tested for differential gene expression in intramuscular adipocytes during fat deposition of feedlot steers. Angus × Hereford steers (n = 50) were fed a high-energy concentrate ration *ad libitum* for 20 (n = 5), 86 (n = 15), 121 (n = 15) and 146 (n = 15) d to obtain various developmental stages of marbling. U.S. Choice quality percentages were 0%, 6%, 67%, and 87%, respectively. Intramuscular adipose was excised from the *longissimus dorsi*, snap frozen in liquid nitrogen and stored at –80°C. Pooled intramuscular adipose samples (days on feed) of extracted RNA (2 µg) were analyzed by differential display-polymerase chain reaction (DD-PCR), using 200 primer combinations comprised of 20 arbitrary (5′) and 10 anchor (3′) oligonucleotides. Seventy excised bands were reamplified by PCR, sequenced and submitted to GenBank for homology identification. Twenty-one bands contained significant homology to known genes. Sequences encoding regions for the translational repressor of NAT1 (cytidine deaminase) and myopodin loci were evaluated by Northern hybridization to confirm differential gene expression among treatment groups. Findings suggest that numerous genes were identified during adipocyte differentiation in intramuscular adipose tissue.

Time of Electrical Stimulation on Muscle pH, Temperature, and Meat Quality in Pork Carcasses

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Carcasses from sixty-four gilts were subjected to one of seven treatments to determine effects of electrical stimulation (ES) at various times postmortem on pork quality. Treatments were ES (500 V, 26 pulses, 2 sec on / 2 sec off) at 3, 15, 25, 35, 45, and 55 min postmortem, or no stimulation (NS). Temperature and pH of longissimus muscles were recorded at 1, 7, 14, 20, 30, 40, 50, and 60 min, and 24 h postmortem. Compared with NS, ES at 3, 15, and 25 min resulted in lower ($P < 0.05$) muscle pH up to 60 min postmortem. Muscle pH of carcasses stimulated after 25 min postmortem did not differ ($P > 0.10$) from controls. Compared to NS, ES at 3 and 15 min resulted in greater ($P < 0.05$) muscle temperatures up to 30 min postmortem. ES at 25 min resulted in greater ($P < 0.05$) muscle temperatures from 30 through 60 min postmortem. However, ES after 25 min did not affect temperature. Carcasses stimulated at 3 and 15 min postmortem exhibited lower ($P < 0.05$) color and firmness scores. ES at 3 and 25 min postmortem resulted in lower ($P < 0.05$) water holding capacity. ES had no effect on CIE L*, a*, b*, marbling, or 24 h pH. In conclusion, ES early postmortem alters rates of pH and temperature declines and stimulates development of PSE-like characteristics as shown by differences in drip loss, color and firmness scores.

Consumer Acceptance and Value of Beef Differing in Marbling Level

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To study consumer visual preference, sensory acceptance and the value placed on beef steaks differing in marbling level (high = upper two-thirds Choice and low = Select) but similar in Warner-Bratzler shear force ($P > 0.05$), consumers in Chicago and San Francisco (n = 124 in each location) were selected. Consumers were paid $25-$35 for their participation. A silent, experimental auction was used to discover the value placed on steaks differing in marbling level. There was a significant difference in visual preference; 72.6% of consumers preferred the low marbled steak. Among consumers preferring low marbling, 61.6% used fat as a selection criteria, while among those preferring high marbling, 65.4% used marbling. When steaks were visually evaluated, consumers preferring high marbling were willing to pay $0.75/.45 kg more ($P < 0.05$) for their preferred steak, while consumers preferring low marbling were willing to pay $1.12/.45 kg more ($P < 0.05$) for their preferred steak. However, during sensory evaluation,

consumers found high marbled steaks to be significantly more juicy, tender and desirable in flavor and overall acceptability. In the experimental auction, they were willing to pay $0.16/.45 kg more (P = 0.056) for high marbled steaks than low marbled steaks. Although not significant, consumers in Chicago were generally willing to pay more ($0.23/.45 kg) for high marbled steaks than low marbled steaks when compared to consumers in San Francisco ($0.09/.45 kg more). While the majority of consumers found the visual appearance of low marbled steaks more appealing, they found high marbled steaks more acceptable in flavor and overall acceptability and were willing to pay more for the product they found more acceptable.

Influence of Conjugated Linoleic Acid (CLA) and High Oil Corn on Belly and Bacon Quality

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Forty-seven barrows at a weight of 55 kg were fed one of six diets. These diets consisted of: diet 1, normal corn; diet 2, diet 1 + 1.25% CLA-60 oil; diet 3, high oil corn; diet 4, diet 3 + 1.25% CLA-60 oil; diet 5, diet 1 + choice white grease; diet 6, diet 5 + 1.25% CLA-60 oil. Bellies were fabricated after a 24 hr chill, and belly firmness was measured by using the belly bar firmness test. Then bellies were cured and thermal processed. Other characteristics measured after processing were proximate composition, sliceability, yield and sensory attributes. Statistical analysis was performed using the GLM procedure of SAS. CLA improved belly firmness ($P < 0.05$) for all diets according to the belly bar firmness test; however, sliceability of CLA bacon was not improved. Also, bellies from normal corn diets were firmer compared with bellies from high oil corn and choice white grease diets ($P < 0.05$). Sensory panel scores showed that CLA increased flavor and decreased aroma in bacon from normal corn diets ($P < 0.05$). According to cooking method, the frying method increased lean color and flavor intensity ($P < 0.05$) compared with the microwave method. Improved belly firmness from CLA supplemented pig diets allows the feeding of diverse diets without deleterious consequences on belly and bacon quality.

Biomechanical Characterization of Meat Tenderness

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Current techniques for predicting meat tenderness lack accuracy, are time consuming, destructive and require sample cooking. Warner-Bratzler shear (WBS) is the most utilized instrumental method for predicting tenderness but correlations of WBS with trained sensory panel are variable. Development of a non-destructive objective method with superior accuracy, speed and repeatability is truly warranted. This study was performed to verify the technique and mathematical models developed by Spadaro (1996) to predict muscle tenderness of raw, bovine *longissimus dorsi* samples. Biomechanical properties of fresh and aged steaks were determined by applying a static force to muscle fibers arranged in parallel and perpendicular orientations. Total energy dissipated and initial and final stiffness of raw steak cubes with designated fiber orientations were calculated using the models and technique of Spadaro (1996) and correlated to overall sensory tenderness scores and WBS values. Linear regression models predicting cooked sensory tenderness were constructed from biomechanical measurements. Energy dissipated-parallel and initial stiffness-perpendicular ($R^2 = 0.73$ and $R^2 = 0.73$, respectively) were effective predictors of sensory tenderness while WBS was less effective ($R^2 = 0.62$). Regardless of aging, biomechanical measurements were more effective predictors of bovine tenderness than WBS. This study confirmed the work of Spadaro (1996) and offers a more accurate means of predicting cooked meat tenderness from a raw sample than WBS. The potential exists for application of an accurate instrumental method for assessing meat tenderness on a raw sample that is more rapid and less costly than sensory evaluation.

Improving the Consistency and Competitiveness of Market Cow and Bull Beef

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The 1999 National Market Cow and Bull Quality Audit was comprised of face-to-face interviews with industry representatives (n = 49), in-plant evaluations of cattle/carcasses in holding pens (n = 3,969), on harvest floors (n = 5,679) and in carcass coolers (n = 4,378), and a Strategy Workshop. Face-to-face interview concerns related to price discovery for carcasses following excessive trimming/testing due to bruises, arthritic joints, antibiotic residues, and pathogens; along with too frequent incidence of antibiotic residues and birdshot. In-plant audits revealed that 88.9%, 10.3% and 88.2% of cow carcasses and 18.9%, 21.2% and 52.9% of bull carcasses had inadequate muscling, arthritic joints and at least one bruise, respectively. Also, 14.5% and 30.8% of cow carcasses and 6.9% and 5.9% of bull carcasses had excess external fat and yellow-colored external fat, respectively. In aggregate, 24.1%, 19.2%, 7.2%, 6.7%, 9.5% and 1.1% of livers, tripe, hearts, heads, tongues and whole cattle/carcasses, respectively, were condemned and 60.6%, 2.4% and 46.5% of cattle had hide damage from latent defects, insect damage and brands, respectively. Producers should promote value in cows/bulls by managing to minimize quality defects, monitoring the health and condition and marketing in a timely manner. Using these

techniques, producers might have recaptured $13.82, $27.50 and $27.50, respectively, for each cow/bull harvested in 1999.

Physical and Chemical Properties of 39 Muscles from the Beef Chuck and Round

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With the increasing popularity of value-added products and the decline in value of the beef chuck and round, the need exists to characterize the muscles from these two primals. The objectives of this study were to determine the physical and chemical properties of 39 muscles from the beef chuck and round and the effects of quality grade, yield grade, and weight on these properties. Chucks and rounds (96 each) were selected from beef carcasses varying in carcass weight (250 to 295 kg and 386 to 431 kg), yield grade (1 to 5), and quality grade (Select - to Choice +). Chucks and rounds were fabricated into 27 and 12 muscles, respectively, for which color, expressible moisture, proximate composition, emulsion capacity, pH, total collagen content, and total heme-iron content were determined. The means and standard deviations across the entire population of muscles were 41.06 ± 4.55, 29.57 ± 4.05, and 22.78 ± 4.32, respectively, for L*, a* and b*, 37.50 ± 5.15% weight loss due to centrifugation (expressible moisture), 6.86 ± 3.45, 72.28 ± 2.83, and 1.26 ± 0.28 mg/g, respectively, for fat, moisture, and ash, 174.2 ± 18.8 mL oil emulsified/2.5 g of lean for emulsion capacity, 5.78 ± 0.32 for pH, 11.69 ± 6.54 mg/g for total collagen content and 20.78 ± 4.43 ppm for heme-iron. In 17 to 33 of the 39 muscles, increasing quality grade significantly ($P < 0.05$) increased fat, pH, and emulsion capacity and decreased moisture and ash. Yield grade effects were detected for 1 to 11 muscles and weight effects were found in 0 to 8 muscles, depending on trait. These data indicate considerable variation among muscles in physical and chemical characteristics. Although some two- and three-way interactions exist, quality grade appears to exert a greater influence on muscle traits than yield grade or carcass weight.

Development and Characterization of a Soy-Myosin-Collagen Textural Modifier

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Hydration, solubilization and/or gelatinization of meat and non-meat proteins prior to incorporation into an emulsion may improve sensory and textural product attributes. Soy protein concentrate (SPC), turkey skin (TS), and mechanically deboned turkey meat (MDTM) were used to develop an AW textural modifier for use in reduced fat turkey frankfurters. The SPC was hydrated (200-800% AW; wt/wt basis) for 2 min, while MDTM (10-40% AW; wt/wt basis) was solubilized (2% salt, chopped 2 min) and TS (25-100% AW; wt/wt basis) was gelatinized (80°C). Emulsion stability was significantly improved ($P < 0.05$) up to 600% AW for SPC and at 50% AW for TS. Although not significant, hydration and emulsion stability increased up to 40% AW in MDTM. Based on these results, prototype textural modifiers were manufactured by combining hydrated SPC (200-600% AW), MDTM (10-40% AW) and TS (25-50% AW) using a central composite response surface design. Hydration response surface curves indicate that holding SPC constant at 200% AW and increasing AW levels for MDTM from 10 to 40% increased hydration values. Increasing AW levels for TS from 25 to 50% did not increase hydration values. Holding SPC AW levels at 200%, and evaluating AW levels for TS (25-50%) and MDTM (10-40% AW) suggest improved emulsion stability as AW levels approached 40% for TS and 10% for MDTM. Textural modifiers at AW ranges of 35-38% (TS), 200-250% (SPC) and 35-40% (MDTM) may be optimal for improved emulsion stability. Further research will address the effects of textural modifiers in reduced fat turkey frankfurters.