Fostering Student “Active-Based Learning” in a Senior Level Meat Science Course

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As part of the course requirement for Physiology and Biochemistry of Muscle as Food, students are required to organize, prepare, and present what will become their textbook which is centered on a specific aspect of meat science and (or) muscle biology. On the first day of class students are asked to write down a question pertaining to muscle (meat science, muscle biology, or growth and development). This initial assignment provides the instructor with information regarding the level and area of student interest in the broad field of meat science. From this information, the instructor can pick a broad focal point (such as “The role of meat in a healthy diet”) and assign a more specific topic to the individual students. The students are asked to prepare a literary review of the assigned topic and consider the paper as a textbook chapter. Students are required to research the topic, prepare an outline, write a five-six-page paper regarding this topic, and present one 20-minute lecture. All papers are compiled by the instructor, edited, arranged in a book format, and distributed to the class prior to initiation of the student lecture section of the course. The instructor and the students of the course evaluate each student lecture. Students are also responsible for preparing two exam questions and answers from their respective lectures. The final exam is then developed from these questions. This format of classroom instruction is built upon the idea that individuals learn more when they have to instruct another. Often the University system is criticized for failing to instill job related skills in its students. Preparation, organization, and oral presentation skills as well as the ability to work as a team member are traits that are strongly sought after by potential employers. This style of “active” learning provides students with valuable job related skills and a better understanding of meat science.

Does Creatine Monohydrate Supplemented to Swine Finishing Rations Effect Pork Quality

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Three experiments were run to evaluate the effect of supplementing creatine monohydrate (CMH) fed during the final stage of growth to determine its effect on fresh pork quality. In experiment 1, twenty-four Duroc-sired market hogs (107 kg) were individually penned and fed a traditional finishing diet. Treatments consisted of a control diet (C) tested against two durations of CMH supplemented diets (25 g CMH/pig/day) fed for 5 (T1) or 10 (T2) days prior to slaughter with 8 replicates per treatment. Pigs were slaughtered on day 11 of treatment (118 kg). Forty-five minute pH1 increased in linear fashion with treatment in the ham semimembranosus (SM) muscle (C = 6.11; T1 = 6.32; T2 = 6.46; P = 0.06) and 24 h (C = 5.57; T1 = 5.56; T2 = 5.78; P = 0.02). Numeric improvements were observed for SM L-value (C = 44.2; T1 = 42.9; T2 = 42.1; P = 0.26) and SM % drip loss (C = 3.80; T1 = 3.28; T2 = 2.47; P = 0.18). Loin muscle % drip loss revealed a numeric quadratic effect (C = 6.04; T1 = 4.30; T2 = 5.20%; quadratic trend, P = 0.06). Five days supplementing CMH improved % chemical IM loin fat (C = 2.77; T1 = 4.40; T2 = 3.55%; quadratic trend, P = 0.06). This initial trial provided positive incentive that CMH may improve pork quality. In experiment 2, CMH was mixed into a complete swine-finishing ration to simulate an actual production setting. Sixty pigs were allotted three pigs per pen and five pens per treatment. Treatment diets included 20 g of CMH/pig/day fed for 5, 10 and 15 days prior to slaughter were compared to controls receiving no CMH. Pigs (123 kgs) were delivered to a commercial packing plant (31 km) and slaughtered by industry practices. Carcasses were blast chilled and placed in the cooler for 24 h. Right loins were collected from the fabrication line, vacuum packaged, and stored for 7 d at 3°C then unpackaged and weighed to calculate purge and re-measure light reflectance. Warner/Bratzler (WB) shear force was determined on 7
d aged loin chops. A cubic trend was observed for ultimate loin pH (P = .102) with controls and 5 d higher than 10 d and 15 d. Under L*-values had a negative linear contrast after 7 d aging (C = 49.67; 5 d = 48.71; 10 d = 51.46; and 15 d = 52.96; P < .01); a cubic effect was shown for moisture lost as purge (C = 2.28; 5 d = 1.50; 10 d = 2.08; and 15 d = 1.90%; P = .05); and WB shear differed in a linear fashion (C = 2.97; 5 d = 2.95; 10 d = 3.50; and 15 d = 3.33 kg; P = .025); and a numeric cubic increase was shown for per cent moisture lost after 5 d (C = 2.11; 5 d = 2.48; 10 d = 1.82; and 15 d = 1.99%; cubic effect, P = .021). Supplementing CMH in Exp. 2 had no effect on ultimate pH, increased L*-values with increased duration of supplementation, improved IM lipid concentration, and numerically reduced purge loss. The additional cost of supplementing CMH to finishing rations may be cost prohibitive. Experiment 3 evaluated an additional supplement, α-lipoic acid (ALA), combined with CMH to test if ALA would improve the uptake of CMH by skeletal muscle. Forty-eight commercial hybrid barrows were blocked by BW prior to test and randomly allotted to supplementation of 24 g CMH/pig/day, 600 mg LA/pig/day, combined CMH and ALA, or no CMH or ALA for five days prior to slaughter (113 kg) administered orally in three divided doses. Twelve pigs per treatment were individually penned with ad libitum access to water and finishing ration. The intact SM and the posterior portion of the boneless loin was vacuum packaged and stored for 7 days to determine purge loss. A 2 x 2 factorial design was used to test the fixed effects of slaughter day, CMH, ALA, and interactions. Lipoic acid LM PH 1 (6.48 vs 6.04) and LM L*-value (52.9 vs 49.3) were significantly (P < .05) higher and lower than controls. Ham SM L*-values tended to be darker than controls after 7-d aging (45.9 vs 47.2; P = .073). Lipoic 24-h loin pH (5.35 vs 5.29; P = .09) tended to be higher than CMH*ALA, while GM L*-values (45.5 vs 47.7; P = .07) were lower. Cook loss was significantly (P < .05) lower for ALA (27.9%) vs CMH*ALA (32.1%). Although not statistically different, purge loss from ALA loin (33.2%) and SM (27.2%) was lower than CMH*ALA loin (43.3%) and SM (36.2%). The effects of supplementing CMH appear to be variable regarding pork quality. Supplementation of ALA to finishers appears to have positive effects on pork quality and deserves further study.

**Meat Judging as a Learning Tool: Gender Comparison by Contest**

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Discussion of differences between male and female students or workers range from completely arbitrary stereotypes to formal evaluations of performance. Meat judging tests a students’ visual acuity, technical knowledge, application of logic, critical thinking, decision making and ability to communicate. Meat judging scores allow the objective comparison of gender differences over time. Category point totals between male and female contestants were evaluated for beef quality grading (QG), beef yield grading (YG), NAMPs fabrication specifications (SP), placing of classes (PL), reasons (RS), and total contest score (CN). Point totals (pt) were from the National Western (NW), Southeastern (SE), Iowa State Invitational (IS), American Royal (AR), and International (IN) meat judging contests from 1993 through 1999. A total of 2112 (1302 male (M) and 810 female (F)) observations were evaluated. Gender assignment was by name recognition. Comparison of the overall mean by category revealed M advantage in YG (1.6 pt, P = .02); SP (1.3 pt, P = .11); PL (2.3 pt, P = .002), and CN (1.0 pt, P = .66). M advantage was shown in QG (2 pt, P = .71) and RS (4.2 pt, P = .0001). The contests reported herein are progressively more difficult by design; NW being the most straightforward, and IN requiring greatest application of knowledge. The chart which follows shows the progression of points (Least Square Means by gender) and P values for each of the contests.

<table>
<thead>
<tr>
<th>Contest</th>
<th>GEN D</th>
<th>QG</th>
<th>YG</th>
<th>SP</th>
<th>PL</th>
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<tr>
<td>NW F</td>
<td>126.9</td>
<td>93.9</td>
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<td>M</td>
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<td>P</td>
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<tr>
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<td>96.6</td>
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<td>AR F</td>
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<td>74.5</td>
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For all categories, the contests were significantly different (P > .0001). For QG, YG, RS, and CN a positive linear effect (P > .0001) was shown. Cubic effects were observed for SP and PL (P < .0001). These data indicate a consistent advantage in reason writing for F; but while the M averages are higher than F in most other categories, the differences are not consistently significant.

**Effect of the Rendement Napole Genotype on Sensory Characteristics of Non-Pumped, Water-Pumped, and Sodium Tripolyphosphate-Pumped Pork Longissimus Sections Cooked to Two Endpoint Temperatures**

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Sodium tripolyphosphate (STP) pumping was evaluated on fresh pork longissimus from pigs of different RN genotype to determine the effect on pork quality and sensory attributes. Sixty-four gilts from a commercial hybrid line which were of two RN genotypes (RN*rn+, rn+rn+) were fed finishing diets containing two dietary lysine contents (4.8, 6.4 g/kg), and were
fasted (12, 36 h) prior to harvest. The longissimus muscle from the right carcass was divided into three 12.7 cm sections and randomly allocated to the following pumping treatments: non-pumped, water pump, and 4.5% STP. Loin sections were pumped to 9.78% (water) and 9.47% (STP) over green weight, vacuum packaged, heat shrunk, and aged for 14 d. Following aging, 2.54 cm chops were cut, packaged, and frozen for subsequent analysis. Boneless loin chops were cooked internally to 70°C and 80°C. Non-pumped loin sections resulted in the least amount of purge loss, while STP treated loins had the highest salable yield. Pumping the loin sections with water and STP resulted in increased raw moisture and cooked moisture (calculated on both a raw and cooked weight basis). STP also increased juiciness and tenderness ratings in the sensory analysis. Increasing the cooking endpoint temperature decreased juiciness and cooked moisture percentage on both a raw and cooked weight basis. RN m+ pork had lower shear force and scored higher for tenderness and juiciness regardless of pumping treatment or end point temperature. These data indicate that increasing end point temperature reduced sensory attributes while STP and the RN gene improved sensory properties.

**Consumer Purchase Intent and Visual Acceptability of Pumped Pork Loins**

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Pork loins were fabricated into roasts (1.5 kg each), pumped to 0, 6, 12, or 18% over initial weight to contain 0.25% sodium triphosphate and 1% sodium chloride, and vacuum packaged. Consumer (n = 196) sensory evaluations were conducted in retail supermarket meat departments. Consumers evaluated appearance acceptability of pork loins on white paper over ice approximately 2 m beneath fluorescent overhead lighting. Parameters of interest included acceptability of color, purge in the package, texture appearance, overall appearance acceptability, and purchase intent. Seventy percent of respondents were between 26 and 55 years of age; 70% were female; 45% consumed pork 1-2 times/week and 25% consumed pork 2-3 times/month. Pork was most often consumed at home (>88%). Nearly 42% of respondents purchase prebasted turkey, 30% purchase marinated meat, and >36% would purchase “enhanced” pork. Consumers expressed concern about ingredients on the label: phosphate (60%), salt (74%), and water (26%). About 29% were concerned about pork because of safety (42%) and nutrition (42%). Fifty-seven percent “probably would buy” or “definitely would buy” the unpumped product. Consumers rating loins in the higher two purchase intent categories decreased with increasing pump level until, at 18% pump, only 46% “probably would buy” or “definitely would buy” the product. Fifty-eight percent of consumers that rated the amount of liquid in the package of the unpumped loins as “somewhat acceptable” (29%) or “very acceptable” (29%). Consumers rating loins in the higher two categories for acceptability of liquid in the package decreased to 42% for 6% pumped loins, <37% for 12% and 18% pumped loins. Fifty-five percent of consumers rated the color of unpumped loins as “somewhat acceptable” (28%) or “very acceptable” (27%). Twenty-four percent of consumers rated overall appearance of unpumped samples in the highest acceptability category while >24% rated the 6%, 12%, and 18% pumped loins in the “somewhat acceptable” category. Of consumers who “definitely would buy” these products, 50% placed them in the “very” acceptable category for overall appearance.

**The Impact of Nebraska BEEF 706 on Participant's Knowledge and Attitudes Concerning the Improvement of Beef Quality, Consistency and Value**

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Four Nebraska Beef 706 workshops were conducted to improve the quality, consistency, and value of Nebraska beef. The three-day workshops were a cooperative effort of the University of Nebraska, the Nebraska Cattlemen, and the Nebraska Beef Council. The objective of this study was to determine the change in knowledge and attitudes of participants in Nebraska Beef 706. Participants were presented a pre-workshop and post-workshop questionnaire that included seven true or false questions and twelve statements for rating issues of beef quality, consistency, and value (1 = very important; 5 = not very important). Participants answered an average of 4.92 correct answers on the true or false questions before the course and improved that score to an average of 5.92 correct after the course. This change demonstrated an increase in participant’s knowledge about quality and consistency issues. Beef quality issues were rated as important or very important on the pre-workshop evaluation (range 1.3 to 2.3 average score). This indicates that participants were already sensitive to beef quality and consistency issues, but the workshop increased the focus. Two quality issues with the greatest change from pre to past evaluation were “Reducing meat cost with added ingredients,” and “Decrease hide damage.” Participants also indicated that the emphasis placed on increasing quality and consistency of beef in their operations would be “a major emphasis.” Participants in Nebraska Beef 706 increased their knowledge about beef quality, consistency, and value, and also developed attitudes that place an increased importance on improving quality, consistency and value in beef. As a result, beef producers in Nebraska should be able to make more informed decisions on improving the quality and value of beef and beef products.
Effect of Lactic Acid Spraying on Survival of *Escherichia coli* 0157:H7 and *Escherichia coli* Biotype I on Beef Carcasses

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Survival of *Escherichia coli* 0157:H7 and *Escherichia coli* Biotype I on beef carcasses sprayed with 2% lactic acid and/or tempered at 21°C for 4 hours were evaluated during extended storage. In a split-plot design experiment, two cattle were slaughtered and split into quarters for each of four trials. Two quarters per treatment were inoculated with a beef-manure slurry containing a five-strain mixture of *E. coli* 0157:H7. Inoculated quarters were either not treated, sprayed with lactic acid, tempered, or tempered and sprayed with lactic acid prior to storage at 4°C for 14 days. Two combined sponge samples per carcass quarter were taken on days 0, 1, 3, 7, 14 for enumeration of *E. coli* 0157:H7 and *E. coli* Biotype I. Results indicated that tempering was not significantly effective on survival of either type of *E. coli* (total reductions after 14 days: Biotype I; 3.66 log<sub>10</sub> cfu/cm<sup>2</sup> from both tempered and non-tempered carcasses; serotype 0157:H7; 4.42 log<sub>10</sub> cfu/cm<sup>2</sup> from non-tempered carcasses and 4.2 log<sub>10</sub> cfu/cm<sup>2</sup> from tempered carcasses). However, on each sampling day, numbers of *E. coli* Biotype I on carcasses sprayed with lactic acid were significantly lower than on non-sprayed carcasses throughout storage (total reductions; 4.08 log<sub>10</sub> cfu/cm<sup>2</sup> from acid sprayed carcasses and 3.66 log<sub>10</sub> cfu/cm<sup>2</sup> from control carcasses) while numbers of *E. coli* 0157:H7 were significantly less than control counts only after 3 days of storage (total reductions; 5.04 log<sub>10</sub> cfu/cm<sup>2</sup> from lactic acid sprayed carcasses and 4.42 log<sub>10</sub> cfu/cm<sup>2</sup> from control carcasses). Survival patterns of both *E. coli* on control carcasses were statistically similar as both declined 3-4 log<sub>10</sub> cfu/cm<sup>2</sup> during 14 days of storage. Results from this study demonstrate that spraying beef carcasses with lactic acid reduces numbers of *E. coli* including serotype 0157:H7 strains, but the effect is dependent upon storage time, probably due to surface desiccation.

Proteolytic Activity by Bacterial Starter Cultures for Meat Fermentation Using Beef Protein Extract

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Starter cultures are widely used in sausage fermentation for flavor development and process control. Limited proteolysis of muscle proteins during sausage production may result in nitrogenous substances that contribute to the product’s final flavor profile. Whether proteolysis occurs due to endogenous enzymes of the meat itself or to proteolytic activity associated with starter culture metabolism is not well known. The objective of this study was to determine the extent of proteolytic activity of six starter cultures commercially utilized in fermented sausage manufacture. Proteolytic activity of *Pediococcus acidilactici*, *Lactobacillus sake*, *Lactobacillus curvatus*, *Streptomyces griseus*, *Staphylococcus xylosus* and *Staphylococcus carnosus* was examined using beef protein extracts. After activating each freeze-dried culture, sterile beef protein extract (pH 6.00) prepared with physiological saline was inoculated to approximately 10<sup>5</sup> CFU/ml. The extracts were incubated at 30°C and sampled at 0, 24, 48, 72, and 96 hr for pH, bacterial count and proteolytic activity. For proteolytic activity, primary amines (free amino acids and acyl-

Type of Bacterial Starter Culture, Aging and Fermentation Effects on Some Characteristics of Inoculated Beef Sausages

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Rapid sausage fermentation is practiced in the USA whereas most European processors utilize low temperature, longer time for combined aging and fermentation effects. This may result in a greater role for nitrogenous flavor components resulting from metabolism of the fermenting starter cultures. The objective of this study was to evaluate the effect of type of starter culture, pre-fermentation holding time and fermentation of beef sausage mixes on NPN, acidity, composition, and growth of starter cultures. Beef sausage mixes were inoculated with either *Pediococcus acidilactici* or *Staphylococcus xylosus* with *P. acidilactici* or *Staphylococcus carnosus* with *P. acidilactici*, the mixes subdivided and then held for 0, 24, 48, or 72 h at 8-10°C prior to fermentation. After holding (pre-fermentation), the mixes were fermented for 16 h ending at 41°C. Total nitrogen of all sausage mixes did not differ due to holding or fermentation effects over all starter cultures and there was not a significant change in moisture content (range of 66.8-70.1%) through the holding and fermentation periods. Holding time had no effect on NPN (ΔNPN) content among all cultures. After fermentation, however, sausage mixes held 72 h and inoculated with *S. carnosus* had higher NPN contents compared to *P. acidilactici* alone (*P* < 0.05) and *S. xylosus* (*P* < 0.10). The pH of mixes decreased during holding and followed the same pattern for all mixes. The initial pH declined (P < 0.05) from approximately 5.8 to pH 5.2-5.3 as the holding time increased to 72 h. After fermentation, the pH of all mixes, irrespective of previous holding times, was 4.4-4.5. Total acidity of the mixes followed an inverse pattern to pH, increasing as holding time increased. A significant increase in total acidity occurred with fermentation but there was no effect due to prior holding time or type of starter culture. Final acidities ranged from 1.78-1.83% (as lactic acid).

53rd Annual Reciprocal Meat Conference
peptides) generated from culture metabolism in the extracts, were determined from absorption at 340 nm after reaction of trichloroacetic acid filtrates with o-phthalaldehyde. L. sake had greater (P < 0.05) proteolytic activity than any other culture. From highest to lowest activity, the other cultures ranked as follows: L. curvatus > S. camosus > S. griseus > P. acidilactici > S. xylosus. Whereas the control extract maintained pH at 5.95, all inoculated extracts showed a pH decline by 96 h to 3.76-4.31. All cultures except S. xylosus had CFU increases within 24 h of incubation. Only L. sake and S. xylosus had counts less than their initial inoculation level which was likely related to their extensive pH reduction of the extracts. These results provide evidence that several commercially available starter cultures for meat fermentation do possess significant proteolytic activity when tested using beef protein extracts.

**Consumer Preference for Meat Color and Packaging Did Not Affect Eating Satisfaction**

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We investigated whether consumer preferences for meat colors (red, purple, and brown) or for meat packaging systems (modified atmosphere, MAP; vacuum skin pack, VSP; or conventional PVC over wrap) influenced sensory scores of beef top loin steaks (choice) and ground beef patties. To test effects of the meat colors, boneless beef top loin steaks (choice) and ground beef patties (20% beef steaks and patties) were packaged in different atmospheres of either 0.5% carbon dioxide (low O2); 100% nitrogen (N2); or 1% oxygen, 39% nitrogen, and 60% carbon monoxide, 39.5% nitrogen, and 60% carbon dioxide (CO); 100% nitrogen (N); or 1% oxygen, 39% nitrogen, and 60% carbon dioxide (low O2). This promoted red, purple, and brown color development, respectively. To test effects of package type, steaks and patties were pre-treated with CO to promote development of the red color, and then re-packaged using MAP, VSP, or PVC over wrap. The meats were displayed for members of four consumer panels who evaluated meat color and indicated their likelihood to purchase similar meat. Next, the panel members tasted meat samples from what they had been told were the packaging treatments just observed. However, the meat samples tasted by each panelist were actually from a single fresh (i.e., not treated) steak or patty so that any difference in taste scores would reflect expectations established during the visual evaluation. The same ballot and sample coding were used for both the visual and taste evaluations. Color and packaging influenced (P < .001) visual score and likelihood to purchase. The decreasing order of visual scores and likelihood to purchase were red > purple > brown and PVC over wrap > VSP > MAP. Visual score and likelihood to purchase were correlated with r² > .8. However, color and packaging did not affect (P > .5) taste scores. Thus, perceptions of quality established by the meat colors and packaging influenced consumers' likelihood to purchase, but did not bias eating satisfaction.

**Sensitivity of Economic Values for Beef Tenderness to Payment System**

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The aim of this study is to determine the effect of beef tenderness classification and pricing structure on expected income resulting from genetic selection for tenderness. We constructed a model of beef tenderness, assessed as Warner-Bratzler shear force (WBS) at a population mean from 2.0 to 7.0 kg. Tenderness classification comprised from two to six equally sized tenderness classes with premiums and penalties incurred within each class. Carcass value at each WBS was the product of fraction of carcasses within tenderness class together with premiums or discounts within each class. Payment systems included premiums (P) for tender beef, discounts (D) for tough beef or P+D in combination. Economic value (EV) was derived as the impact of a marginal (-.1 kg) change in sire breeding value for WBS on future farm income under each tenderness classification and payment structure. Derived economic values were sensitive to population mean WBS, tenderness classification and payment system. The highest EV for improving tenderness occurred when carcasses were assigned into two classes (tender or tough) under a P+D pricing system. A sire -.1 kg superior in genetic merit for WBS would improve herd income by up to $650 under such circumstances. As the number of tenderness classes increased, maximum EV declined but EVs at low or high WBS scores increased as a greater fraction of carcasses incurred either premiums or discounts, respectively. When carcasses were assigned in two tenderness classes, economic values for beef tenderness had equal value under P and D payment systems. When carcasses were assigned into three or more tenderness classes, economic value was higher for P and D payment systems at low and high population mean values of WBS, respectively. A payment system with only two tenderness classes inflated the economic value for tenderness. Expected benefits from genetic improvement of tenderness should be assessed relative to the population mean for WBS, tenderness classification and payment system.

**The Use of Pork Collagen as a Functional Ingredient in Frankfurters**

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The objective was to evaluate the quality and sensory characteristics of regular fat frankfurters utilizing pork collagen in the formulation. Fresh pork (20% and 50% fat, respectively) was obtained from the Iowa State University Meat Laboratory. Frozen mechanically deboned chicken (MDC), 15% fat, was obtained from International Dehydrated Foods, Inc., Monett,
Effects of Cattle Transport on Metabolism and Meat Quality

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In previous study, cattle caught in a snowstorm during transport to slaughter had calpastatin activities 2-3 fold higher than normal and their shear force values were among the highest. Hence the purpose of the present study was to determine if calpastatin activity could be upregulated by transport (TR = 0, 8, and 48 h; n = 32 per group). We also wanted to determine if metabolic indicators of stress/starvation could be correlated with muscle calpastatin activity. TR-48 cattle lost 11.9% of their body weight, compared to 6.6% and 2.9% in TR-8 and control cattle (TR-0). Average shear force values were significantly higher in meat from TR-48 animals compared to TR-8 and TR-0 animals 24 h postmortem (P < 0.01). This effect persisted after 6 d of aging and even after 4 mo of frozen storage. At 24 h, consumers would have rated 80% of all carcasses as unacceptable. After 6 d of aging, only the TR-0 and TR-8 carcasses had undergone appreciable tenderization, decreasing the proportion of unacceptable carcasses to 34% and 41% while 91% of the TR-48 would still have been unacceptable. Correlation coefficients of loin muscle shear force at 6 d with calpastatin activity and fat-free % moisture were -0.22 and -0.57, respectively (P = 0.03 and P = 0.0001). Across all animals, increases in plasma β-hydroxybutyrate and free fatty acids were correlated with 6 d shear force (r = -0.52 for both, P = 0.0001). Increases in plasma β-hydroxybutyrate for the TR-48 group were correlated with muscle calpastatin activity at slaughter (r = -0.40, P = 0.03), indicating that the decrease in protein degradation associated with upregulation of calpastatin activity may in part be related to elevated blood ketone bodies. Extremely high levels of calpastatin activity (2-3 fold above control values) were not obtained and may have been previously observed due to the combined stress of transport and low ambient temperature.

Profilng the Variability in Tenderness of Beef Strip Loins

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Strip loins from 58 steer and heifer carcasses from a commercial slaughter plant in Canada were shipped to the USDA-Meats Laboratory in Beltsville, MD by 4-days postmortem. Selection criteria for carcasses were marbling score of Traces to Slight minus, 4 mm or less fat over the ribeye, and hot carcass weight between 275 and 360 kg. Four steaks (2.5 cm thick) were cut from each strip loin, one just anterior to the gluteus muscle insertion (A), two in the middle (B and C) equally spaced approximately 6 cm apart, and a fourth steak (D) at the 12-13th rib. Steaks from paired sides were removed at identical locations. Steaks were grilled on electric grills to an internal temperature of 71°C then cooled to room temperature before cores were removed. Shear-force was determined using Food Technology Corporation Texture Analyzer with Warner-Bratzler meat shear cell in compression mode, cross-head speed of 250 mm/min and blade thickness of 3.18 mm. The maximum number of cores possible was removed from each steak in two parallel rows along the long axis of the steak (subcutaneous fat side or dorsal vs ventral) and sequence of cores from medial to lateral was also maintained. A total of 464 steaks were used to profile the tenderness variability between and within a strip loin and carcass side. Mean differences in shear-force between left and right paired steaks from
Freezing Rate Alone, Without Storage, Has No Effect on the Functional Properties of Beef

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This study determined the isolated effect of freezing rate alone (no frozen storage) on the functional properties of thawed muscle proteins. A Latin square design was used to allocate 24 semitendinosus muscles from 12 heifers to four freezing treatments: 1.8 mm/h (slow blast), 7.8 mm/h (fast blast) and 49.8 mm/h (liquid nitrogen - two treatments: samples at 10°C were immersed in liquid nitrogen or samples were slow chilled from 10°C to 0°C, then immersed in liquid nitrogen). The frozen samples were thawed in water at 10°C and then analyzed. The rate of freezing had no effect on any of the parameters measured (total, myofibrillar and sarcoplasmic protein solubilities; sulphydryl content; surface hydrophobicity; emulsion activity index; emulsion stability; tissue color). It is therefore concluded that freezing rate on its own does not affect muscle proteins; rather it is the interaction between freezing and storage temperature and time that affect protein functionality.

Comparison of Compression and Tension Shearing Methods of Beef Top Loin Steaks

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Beef top loin steaks of different USDA Quality grades were evaluated for Warner-Bratzler shear force (WBS) values using
three methods: tension (TEN) and compression (COMP) on the United Testing Machine and standard WBS (SWBS) on the Salter Warner-Bratzler Shearing device. Carcasses were selected from three USDA Quality grades (Choice, Select and Standard) and strip loins (n = 53) from these carcasses were captured. Loins were cut into 2.54 cm thick steaks and frozen until further analysis. One steak was allotted each for TEN, COMP, and SWBS and sensory panel. Shear and sensory steaks were cooked to 71°C. Six cores per steak were sheared by TEN, COMP, and SWBS. The crosshead speed was set at 200 mm/min for both machines. Shear force values (kg) for the TEN, COMP, and SWBS methods were 4.08, 3.85, and 3.39 ± 0.193, respectively. No differences were detected in shear force between the TEN and COMP methods (P > 0.05). SWBS shear force values were lower than TEN values (P < 0.05) but no differences were detected between the SWBS and COMP, shearing methods. Correlations between initial tenderness sensory scores and the shearing methods (TEN, COMP, and SWBS) were -0.73, -0.40, and -0.44, respectively (P < 0.01). Results from this experiment indicate that shear force values vary across machines. SWBS had the highest correlation with sensory panel tenderness scores. More studies need to be conducted to clarify these findings.

The Role of Muscle Glycogen Content and Dark Cutting Beef

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Dark cutting beef occurs when muscle glycogen levels are depleted prior to slaughter. This research was conducted to determine the threshold level of glycogen needed to avoid the dark cutting condition. Samples (n = 180) were taken from the 12th rib region of beef carcasses 2-4 d postmortem. A visual score was used to classify samples (n = 121) based on color. A score of one represented normal-appearing muscle and five represented extremely dark muscle. Samples were frozen on dry ice and stored at -30°C prior to analysis for glycolytic potential and pH. Initial muscle glycogen levels were calculated from postmortem glycolytic potential values. Regression revealed a significant quadratic relationship between estimated pre-slaughter glycogen levels and pH (R² = 0.92, root mean square error = 0.13), where ultimate muscle pH decreased with increasing glycogen level. An inflection point occurred at approximately 80 mmol/kg of glycogen and a pH of 5.7. Muscle L*, a*, and b* values had significant curvilinear relationships to pH (R² = 0.34, 0.61, and 0.55, respectively). Mean pH values for muscles scoring one through five were 5.47, 5.73, 6.05, 6.31, and 6.72, respectively. All pH values differed from each other (P < 0.05). Estimated glycogen levels were 96.4, 80.2, 67.0, 58.8, and 48.5 mmol/kg, respectively. All glycogen levels were significantly different from each other (P < 0.05) except those for scores four and five (P = 0.08). These data document the significant effect of glycogen level on ultimate pH and color of beef. Visual assessment of color may be more effective in classifying dark cutting beef than the L*, a*, and b* scale. It appears that 80 mmol/kg of glycogen is needed in muscle prior to harvest to prevent the dark cutting condition.

Effect of Different Cooking Instruments on Warner-Bratzler Shear Force Values

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This study was conducted to evaluate if cooking instrument affected Warner-Bratzler shear (WBS) values. Ribeye rolls were collected from USDA Choice and Select beef carcasses from a commercial beef processing facility (n = 130). Ribeye rolls were transported to Texas Tech University and aged for 14 days. Three 2.5 cm steaks were fabricated from the ribeye roll for each cooking instrument treatment. The three cooking instruments used were Farberware grill, Star Chargriller (gas grill) and Magi’grill (belt grill). Steaks were cooked to 71°C and chilled at 4°C for 24 hours. Steaks cooked on the belt grill had lower (P < .05) WBS values than steaks cooked on Farberware and gas grills. Mean WBS value of steaks cooked on the belt grill was 3.48 kg, while mean WBS value of steaks on the Farberware was 3.83 kg, and the gas grill was 3.95 kg. Also, steaks cooked on the gas grill resulted in a higher percentage of steaks with WBS values less than 3.0 kg (tender) and a lower percentage of steaks with WBS values greater than 4.5 kg (tough). Steaks cooked on Farberware had higher (P < .05) cooking loss percentages than steaks cooked on the gas or belt grills. This research provides valuable results when comparing WBS values of steaks cooked using different cooking instruments.

The Effect of Paylean™ on Lean Yields and Pork Quality Characteristics

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This study was conducted to determine the effects of feeding Paylean™ (ractopamine· HCl) to genetically lean pigs on growth performance, lean yields, and pork quality measures. One hundred eighty Dekalb barrows were assigned to 36 pens. The pens were blocked by weight (6 pens/block¹, starting block BW = 69 to 83 kg). Pens within a block were then randomly assigned one of three Paylean™ treatments so that each treatment within a block was represented by two pens. Treatments
included: Control diet (C), and Paylean™ at 9 g/ton (P9) or 18 g/ton (P18). Pigs were slaughtered by blocks when the block average BW was ~109 kg. Gain and feed efficiency were improved (P < .01) with Paylean™, but feed intake did not differ (P > .1). Dressing percent was higher (P < .01) for P9 and P18 than C, and P18 had less (P < .05) cooler shrink than C. P9 and P18 had higher (P < .005) yields (% of hot carcass wt) of trimmed, boneless ham, loin, sirloin, tenderloin, and butt than C. Belly thickness and belly yields (% of hot carcass wt) were not different. Carcass pH at 45 minutes postmortem and ultimate pH, and subjective color, firmness, and marbling scores were not different. L* Minolta reflectance measures of the longissimus dorsi at the 10th rib were not different while a* and b* values were higher (P < .01) for C than for P9 and P18. P18 tended (P < .1) to have less purge loss from unenhanced loins (NAMP #414, vacuum-packaged and aged for 14 d) than C (2.68% C, 1.89% P18), and Warner-Bratzler shear (WBS) on chops from these loins was approximately 16% higher (P < .05) for P9 and P18 than C. However, in enhanced loin sections (injected with a brine solution, vacuum-packaged and aged for 14 d) purge loss was higher (P < .05) for P18 (1.71%) compared to C (1.36%), and chop WBS was not different (P > .1). Feeding Paylean™ resulted in more efficient pork production, increased boneless subprimal yield, and had little effect on pork quality measures.

After 4 weeks at 2°C, 0.5% CO-MAP steaks had redness values >12, compared to redness values < 10 for VP steaks. Ground beef in 0.5% CO-MAP retained high redness values (a* > 12) after 3 weeks storage with uniform red color throughout and aerobic plate count of < 106 cfu/g. In conclusion, red color was retained for 3 weeks storage of CO-VP steaks. For extended storage (4 weeks), however, CO-MAP treatment was preferred for red color.

### Chemical and Physical Changes in Smoked Rainbow Trout (Oncorhynchus mykiss) Associated with Frozen Storage

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Frozen storage is an important preservation method for maintaining microbiological and chemical stability and extending shelf life of food products. However, this method can induce biochemical changes such as protein denaturation, particularly in fish muscle. Freeze-induced protein denaturation in raw material affects protein-protein and protein-water interactions that, in turn, affect product texture. The objective of this study was to determine the effect of frozen storage (-20°C) on quality of smoked rainbow trout fillets prepared from fresh fillets and fillets following 78 d of frozen storage. The experimental design was a 2 x 2 x 4 factorial, balanced incomplete block design with fillet storage as the main plot. Eight treatment combinations of two brine concentrations (8.7 and 17.4% NaCl) and four brining times (30, 60, 90, and 120 min) were the sub-plots. Treatments were replicated on three separate days. Brined fillets were smoked in microprocessor-controlled smokeoven. Brine uptake, raw and cooked pH, cook yield, shear force, water activity, water-phase salt content, and cooked proximate composition were measured on fillets. A fish mince was also prepared from each treatment. Hardness, cohesiveness, protein solubility (total protein solubility and myofibrillar proteins), and raw proximate composition were determined on the mince. Frozen storage at -20°C for 78 d increased (P < 0.05) total soluble protein and decreased (P < 0.05) myosin and actin solubility. The increase in protein solubility after frozen storage might be caused by modifications of chemical groups especially sulfhydryls. Decreased myosin and actin solubility may be due to the increased protein-protein interactions. Use of frozen fillets reduced hardness of cooked mince and shear force of smoked fillets by 86% and 55%, respectively, and it tended to decrease cohesiveness. Fat content of smoked products prepared from frozen fillets decreased (P < 0.05) because of decreased structural integrity and reduced ability to retain fat. In conclusion, frozen storage resulted in lower myosin solubility that, in turn, negatively affected product texture.

### Evaluation of Carbon Monoxide (CO) Treatment in Modified Atmosphere (MAP) or Vacuum Packaging (VP) to Increase Color Stability of Fresh Beef

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Our objective was to evaluate carbon monoxide (CO) pretreatment to obtain desirable red color in vacuum packaged (VP) beef steaks.

In experiment 1, select beef top loin steaks were pressure treated at 15 psig with 5% CO, 60% CO2, 35% N2 for 30, 60, 90, or 120 minutes, then vacuum packaged (VP). All steaks developed a bright red color after pressurized CO pretreatment, with Hunter color a* (redness) values > 12 and CO penetration depth of 1-2 mm. However, after 24 h VP storage, only steaks pressure treated for 120 min retained a red color, with Hunter redness values 11-13 and penetration depth of 2 mm. In comparison, steaks treated with 0.5% CO in a modified atmosphere package (MAP) for 24 h had similar bright red color, and greater CO penetration depth (4 mm). The 24 hr CO-MAP pretreatment was also much less labor intensive for large quantities of steaks. Thus, CO-MAP pretreatment was used for VP steaks in experiment 2.

In experiment 2, color stability and microbial load was monitored during storage of steaks treated as follows: 100% CO-MAP for 1 hr, then VP; 5% CO-MAP for 24 h, then VP; 0.5% CO-MAP (steaks); 0.5% CO-MAP (bulk ground beef).
Development of the Porcine Myology Manual on CD-Rom

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Understanding of the skeletal and muscular of the pig is important in the pork industry as well as for research and teaching. The Institutional Meat Purchasers Specifications identifies cuts based on musculature. Today, more boneless meat cuts are being marketed and muscle separation is becoming a routine operation in the cutting process. With the use of computers and the internet, it is possible to present organized information that is easily accessible to a single student or a large number of people. The objective of this project was to develop a porcine myology manual which could be produced in a digitized form stored on a CD-ROM for computers or distributed across the internet.

To observe consumer acceptance and the value placed on the basis of similar Warner-Bratzler shear force (P < 0.05) and marbling level (P > 0.05). Telephone screening was used to select consumers. Prior to sensory evaluation, consumers were instructed on the auction procedures and three practice auctions were conducted. Taste panel samples (cooked to 70°C endpoint temperature) were rated using an 8-point hedonic scale for flavor, juiciness, tenderness and overall acceptability (5 = slightly desirable, slightly juicy, etc.; 4 = slightly undesirable, slightly dry, etc.). Consumers could then participate in a silent, experimental auction to purchase steaks from the same strip loins as the samples they tasted. Domestic beef was rated higher (P < 0.05) in overall acceptability, juiciness and tenderness. For flavor, the interaction between location and type of steak approached significance (P = 0.06); in Chicago, consumers rated domestic beef higher in flavor acceptability than Argentine beef (5.9 vs 4.5), and consumers in San Francisco also rated domestic beef higher in flavor acceptability than Argentine beef (5.7 vs 4.7). Consumers were willing to pay $0.69/45 kg more (P < 0.05) for domestic beef than Argentine beef; consumers in Chicago were willing to pay $0.88/45 kg more while consumers in San Francisco were willing to pay $0.48/45 kg more (P = 0.07). Domestic beef was more acceptable in palatability characteristics and, consumers were willing to pay more for the product that they found more acceptable.

Consumer Acceptance and Value of Argentine and Domestic Beef

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To observe consumer acceptance and the value placed on Argentine and domestic beef, consumers in Chicago and San Francisco (124 in each location) participated in taste panels and a silent, experimental auction. Strip loins from Argentina (animals were grass-fed) and the United States were paired on the basis of similar Warner-Bratzler shear force (P < 0.05) and marbling level (P > 0.05). Telephone screening was used to select consumers. Prior to sensory evaluation, consumers were instructed on the auction procedures and three practice auctions were conducted. Taste panel samples (cooked to 70°C endpoint temperature) were rated using an 8-point hedonic scale for flavor, juiciness, tenderness and overall acceptability (5 = slightly desirable, slightly juicy, etc.; 4 = slightly undesirable, slightly dry, etc.). Consumers could then participate in a silent, experimental auction to purchase steaks from the same strip loins as the samples they tasted. Domestic beef was rated higher (P < 0.05) in overall acceptability, juiciness and tenderness. For flavor, the interaction between location and type of steak approached significance (P = 0.06); in Chicago, consumers rated domestic beef higher in flavor acceptability than Argentine beef (5.9 vs 4.5), and consumers in San Francisco also rated domestic beef higher in flavor acceptability than Argentine beef (5.7 vs 4.7). Consumers were willing to pay $0.69/45 kg more (P < 0.05) for domestic beef than Argentine beef; consumers in Chicago were willing to pay $0.88/45 kg more while consumers in San Francisco were willing to pay $0.48/45 kg more (P = 0.07). Domestic beef was more acceptable in palatability characteristics and, consumers were willing to pay more for the product that they found more acceptable.

Perception of Degrees of Doneness of Beef by Professional Chefs

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This study was undertaken to ascertain how chefs determine doneness, chefs’ appraisal of cooked color compared to endpoint temperature, and differences in chefs perceived degrees of doneness and those described by AMSA (NLSMB). Data were collected from 22 professional chefs who averaged 24 years of experience, received a variety of training experiences, and resided in diverse locations. Most (95%) chefs determine doneness of steaks and ground beef by touch, and nearly all use thermometers for roasts. When asked for a “safe” endpoint temperature for roasts, 63% of chefs were 3-5°C lower than those given by USDA or FDA, whereas only 14% were low for ground beef. Beef eye rounds (semitendinosus) were roasted to 43, 49, 54, 60, 71, and 77°C, then cross-sections were evaluated visually under standardized lighting. Based on color, chefs assigned a degree of doneness and estimated the endpoint temperature. Over 85% of the chefs correctly identified doneness of pieces cooked
well, medium well, medium rare, and very rare. However, samples cooked medium were rated mostly as medium rare, and rare samples were correctly identified by only 5 chefs. Even when allowing a 5–6°C variance, chefs generally were unable to correctly determine actual endpoint temperatures based on visual color. Internal temperatures used by chefs tend to be lower than those published by AMSA, USDA or FDA. Chefs trained 15-20 years ago learned rare to ranged from 47-52°C (117-125°F) and most consider 49°C (120°F) to be rare today. USDA/FDA recommends 60–63°C for rare roasts. Chefs describe degrees of doneness as: rare = mostly red, cool; medium rare = red center surrounded by pink, warm; medium = pink all the way to the center, hot; medium well = pink surrounded by grey, quite hot; and well = no pink, quite hot. Differences exist in the perceptions of doneness between culinary professionals and meat researchers and some of these may have process/product development and food safety implications for whole muscle, non-intact, and ground products.

Improvement of the Physicochemical Properties of Pale Soft and Exudative (PSE) Meat Products with an Extract from Mechanically Deboned Turkey Meat (MDTM)

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The physicochemical states of the myofibrillar proteins confer functionality to meat systems and thereby have a direct role in determining the quality and value of processed meat. Inferior quality and loss of protein functionality of pale soft and exudative (PSE) meat and a surplus of underutilized mechanically deboned turkey meat (MDTM) are negative economical concerns in the processed meat industry. The objective of this research was to add the functional proteins present in a salt extract of MDTM to PSE meat during processing to create a value-added cooked pork sausage product. Myofibrillar and sarcoplasmic proteins were extracted from fresh MDTM with brine (1.4 M NaCl, 0.1 M Na₂HPO₄, and 0.05 M sucrose) and the extracted proteins recovered in the supernatant following centrifugation. Fresh pork sausages were made from either PSE or normal pork trimmings by preblending with either brine alone or MDTM extract. The water holding capacity (WHC) of precooked sausages was evaluated by the Carver Press filter paper method. Cooking loss and rheological analysis were performed on cooked sausages. Statistical analyses were determined by SAS. Sausages manufactured from PSE using the MDTM extract exhibited a 30% increase in rigidity (P < 0.05) compared to sausages made from PSE and brine alone. Sausages made from PSE and normal pork in which the MDTM extract was part of the preblend demonstrated an increase of 3.6 and 3.0% in WHC, and a reduction of 4.1 and 3.1% in cooking loss (P < 0.05), respectively, compared to sausages made employing brine alone. Results indicate that proteins present in a salt extract of MDTM have the potential to “lend” functionality to processed meat systems, and improve the physicochemical properties of fresh pork sausages. Thus, inclusion of a salt extract of MDTM could have a great economic contribution to the meat industry.

Comparison of Functional Properties of Sm Muscles with Normal and High pH Values During Postmortem Aging

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This work was to examine the influence of aging up to 96 h on the functional properties of bulls semimembranosus (Sm) muscles with normal pH (pH < 5.8) cut 24 and 48 h pm and abnormally high pH (pH > 6.2) cut 24 h pm. Lightness was measured by reflectance at 540 nm with a spectrophotometer. Protein, fat, pH and water holding capacity (WHC) was determined. Meat homogenate viscosity (MHV) was measured with a rotatory viscometer, cooking losses by weight loss and tenderness by Warner-Bratzler. Sm muscles cut 24 h pm had the highest WHC and MHV after 48 h and the lowest SF after 48 and 72 h. The Sm muscles cut 48 h pm had the best WHC at 72 and 96 h, the highest MHV after 48 h and similar SF values during aging. These parameters for the Sm muscles cut 24 h were better than those for Sm muscles cut 48 h pm, except WHC. No significant difference in cooking losses were found for the Sm muscles cut 24 and 48 h pm in spite of significant changes in WHC for these muscles. Lightness of the Sm muscles cut 24 h pm and after 48 h aging was higher than those of muscles cut 48 h pm. The Sm muscles of pH > 6.2 cut 24 h pm had lighter color after 48 h and the highest MHV after 72 h. Compared with normal pH Sm muscles excised after 24 h pm the DFD meat was characterized by higher WHC, lower values for lightness, cooking losses and SF. Considering higher lightness after 48 h pm and lower SF after 48 and 72 h pm for the Sm muscles of pH < 5.8, than that cut 48 h pm it appears that muscles cut 24 h pm should be directed toward the retail trade. In further processing, it is necessary to take into account that the highest WHC was obtained from Sm 48 h pm and 96 h pm, when cut 24 h pm, and after 72 and 96 h pm, when cut 48 h pm. Because most of the properties of the Sm muscles of pH > 6.2 was not aging time dependent and they were better than for normal pH muscles it is preferable to process DFD meat separately and rapidly.
Effect of Pump Level, Cooking Method and End Temperature on Sensory and Color Characteristics of Pork Loin Chops

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The longissimus was removed 24 h postmortem from 30 paired pork sides to assess sensory attributes of chops from fresh and cooked pumped pork loins. Loins were pumped to 110% of original weight to contain 0.25% phosphate, and 1% salt plus added water for comparison with unpumped samples. Chops (2.5 cm thick) were fried or grilled to 70° or 80°C. Two sets of replication (15 paired sides/replication) were conducted using 10 trained sensory panelists for the first set and 8 panelists for the second set. Sensory characteristics evaluated included pork flavor and off-flavor intensities, tenderness and juiciness. Shear values and color (L*, a*, b*) of the loins were also evaluated. A 2 (pump levels) x 2 (cooking methods) x 2 (endpoint temperatures) factorial design was used for statistical analyses. There was a trend for pork flavor, tenderness and juiciness to be enhanced by pumping while off-flavors were inhibited. Interactions between pump level and endpoint temperature occurred for pork flavor and juiciness. As endpoint temperature increased, pork flavor was enhanced for pumped loins while it remained constant in unpumped samples. Juiciness was reduced in unpumped loins cooked to 80°C while no change due to endpoint temperature occurred for pumped loins. Therefore, overcooking did not have adverse effects on flavor or juiciness of chops from pumped pork loins. Pork flavor intensity was higher in fried samples and off-flavors were higher in grilled samples. Pumping decreased yellowness and increased redness but had no significant effect on lightness. Shear value was lower in pumped samples. Results of this study suggest that pumping pork loins enhances sensory attributes with few detrimental effects on physical and quality characteristics.

Flavor Masking Agent Effects on Sensory Characteristics of Lactate-Containing Chicken Model Systems

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When added to meat products, sodium lactate (SL) and potassium lactate (PL) often create a salty flavor, as well as increased bitterness and soapiness as the concentrations increase. The objective of this study was to determine the effects of potential masking agents on sensory characteristics of 3% or 4% SL or PL, in a ground chicken model system. Ground chicken was mixed with 0.25% phosphate, 1% salt, and 10% water, and either 3% or 4% of SL or PL. Five potential masking agents, sucrose, dextrose, lactitol, sorbitol, and lysine, were added individually to each of the treatment combinations. Controls contained lactate without added masking agents. The samples were thermocoupled then cooked to 72°C in a circulating water bath. Samples and controls were evaluated at 45°C, in triplicate by eight trained sensory panelists for saltiness, bitterness, soapiness, and sweetness. Saltiness decreased in chicken containing 3% SL when 1% sucrose was added. Bitterness decreased in samples containing 4%...
SL when 1% sucrose, 1% dextrose or 1% lactitol was added. Sucrose, dextrose and lactitol also decreased soapiness in chicken containing 3% PL. Sweetness did not increase for samples with decreased bitterness and soapiness. Although saltiness decreased in 3% SL containing samples when sucrose was added, this effect was not observed in the 4% SL or in the PL treatments. Bitterness did not decrease in the 3% SL sample or in the PL samples and soapiness did not decrease in the SL samples or in the 4% PL sample. None of the masking agents had any positive effect on any sensory characteristic in samples containing 4% PL. Sorbitol and lysine had no positive effect on any of the lactate combinations. Results of this study demonstrate that bitterness, soapiness and saltiness may be reduced by masking agents.

Effects of -0.5 vs 3.3°C Refrigeration Temperature on Storage Properties of Retail Meat Products

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Eight meat products (ground beef, beef top round steak, boneless and skinless chicken breast, fully-cooked and sliced turkey breast, boneless pork chop, pork blade steak, ground pork, and fresh bratwurst) were aerobically packaged, stored in a retail case for 24 h, then held at room temperature for 90 min, and randomly assigned to either a -0.5°C or 3.3°C storage chamber to determine the effects of temperature on product quality, microbial growth, and rancidity development. A sensory panel evaluated products daily for percent discoloration, overall desirability, and visual acceptability. Colorimeter readings (Minolta CR-310 Chroma-Meter) were taken daily and microbial counts and thiobarbituric reactive substances (TBARS) were obtained at 0, 7, and 14 d. Panel results indicated that all products discolored at a faster rate at 3.3°C than at -0.5°C (P < .05). The effect of storage temperature on product discoloration was largest for ground beef and beef top round steak. Panel assessment found that overall desirability declined at a faster rate at 3.3°C than at -0.5°C for all products (P < .05). Products lasted up to 154% longer at -0.5°C than at 3.3°C before 50% of panelists said that they would not eat it based on visual appearance. Instrument measures of color coincided closely with panel evaluations. The effect of storage temperature on bacterial counts was large for boneless and skinless chicken breast and pork blade steak, intermediate for ground beef, fully-cooked and sliced turkey breast, and ground pork, slight for beef top round steak and boneless pork chop and not significant for fresh bratwurst (K = .05).

Characterization of Sow Longissimus Dorsi Quality Attributes

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Sow meat utilization has been restricted primarily to sausage production due to less desirable quality attributes. The quality attributes of hot-boned pork sow longissimus dorsi muscles were characterized and subjected to various processing technologies to enhance less desirable attributes. Boneless, pre-rigor pork sow longissimus dorsi muscle sections (n = 20, 2°C) were obtained from the anterior portion of sow loins separated at the 10th rib. Two one-inch thick chops were taken from the posterior end of each loin section. The raw chops were analyzed for pH, and subjective color, firmness and marbling scores. The remaining loin sections were segregated into two pH categories. Loins (n = 12) with a pH: higher than 5.8 were marinated (10% solution; 24 h at 2°C). Loins (n = 8) with a pH lower than 5.8 were injected with a brine cure solution (10%; 72 h at 2°C). Both treated loin sections were thermally processed to 71°C. After chilling, one-inch chops were taken from each loin section and analyzed for color yields, shear force values, and sensory attributes. An experienced panel (n = 5) evaluated each treated pork chop using an 8-point hedonic scale for juiciness, tenderness, connective tissue levels, pork fat flavor intensity, off-flavor intensity, and off-flavor characteristics. Shear force values were significantly lower (P < 0.001) for marinated and cured chops compared to untreated chops. Subjective sensory panel scores indicated juiciness and tenderness were improved (P < 0.05, P < 0.005, respectively) while detectable connective tissue level was reduced (P < 0.005) for marinated and cured chops compared to untreated chops. However, marination and curing/smoking did not eliminate livery, metallic, or rancid off flavors in a majority of the treated loin sections. Further research will address the specific undesirable flavor compounds found in sow meat and develop processing strategies to minimize their impact.
Pork Quality Attributes Associated with Carcass Side to Side Variation

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The objective of this study was to evaluate side-to-side variation in pork carcass quality. Barrows (n = 56; 45 kg) were fed a high-energy corn/soybean based diet ad libitum to a market weight of 118 kg. Animals were slaughtered at the University of Missouri abattoir. Immediately following electrical stunning, animals were shackled and hoisted by the right hind leg just prior to exsanguination. At 45 min postmortem, intramuscular pH was taken (10th-11th rib) in both left and right side loins (L: 6.10 vs R: 6.26 ± .05, P < 0.05). 24-h postmortem pH measurements showed no significant loin variation (L: 5.48 vs R: 5.51 ± .02, P > 0.05). Whole loins were halved at the 10th rib and light reflectance measurements (Hunter L*, a*, b*) were taken on the cut lean surface of the sirloin, center, and blade sections at 24-36 h postmortem. Differences in light reflectance were noted in the sirloin L* (L: 53.08 vs R: 57.61 ± .65, P < 0.05), center b* (L: 13.81 vs R: 13.01 ± .18, P < 0.05), and blade L* (L: 57.09 ± .44, P < 0.05), a* (L: 7.37 vs R: 6.26 ± .15, P < 0.05), b* (L: 14.72 vs R: 13.68 ± .21, P < 0.05) values. Loins were then vacuum packaged and stored at 1°C for a duration of either 21 or 41 days to represent storage time required for delivery in domestic and export markets, respectively. Immediately following their allotment to storage, left/right loin sensory characteristics were evaluated by a descriptive attribute sensory panel (n = 9) using a line scale of 1-10 (10 being the highest) for toughness and juiciness. Domestic loins (21 d) had a significant difference in toughness (L: 3.95 vs R: 2.74, P < 0.05) and juiciness (L: 3.19 vs R: 4.24, P < 0.05) while export loins (41 d) had a significant difference in toughness (L: 3.06 vs R: 2.82, P < 0.05) yet no significance in juiciness. From this trial it can be concluded that significant differences in left/right variation exist within a given pork carcass. This variation may be attributed to single leg shackling prior to exsanguination.

Effects of Tumbling and Nisin on the Microbial, Physical, and Sensory Characteristics of Marinated Chicken Drumsticks

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Currently, meat marination is practiced to improve product’s sensory attributes but the process is usually not intended to improve the microbial quality of the product. Tumbling, which helps the distribution of marinade solution during processing, should enhance the action of antimicrobial agents. Lim-
models for prediction of microbial counts, pH, purge and storage day. Microbial numbers and purge increased and pH values decreased with storage time (all P < 0.01). Using contemporary VIS/NIRS scans and chemometric measurements, calibration models were developed for TPC, R^2 = 0.33; Psy, R^2 = 0.32; Lab, R^2 = 0.26; internal pH, R^2 = 0.39; surface pH, R^2 = 0.45; purge, R^2 = 0.06; and storage day, R^2 = 0.50. These results indicate that a VIS/NIRS scan of vacuum packaged beef may be useful in measuring pH and microbial condition of product in the package. Calibrations developed to predict chemometric measures at 56 days using VIS/NIRS scans taken at day 0 gave acceptable predictions for internal pH, R^2 = 0.42 and surface pH, R^2 = 0.32, but were ineffective for predicting microbial counts or purge with R^2 < 0.10. The best calibrations were found using the visible wavelength range of 550 to 650 nm. The spectrophotometer proved to be effective in measuring microbial counts, pH and storage day for vacuum packaged beef steaks.

**Postmortem Glycolysis in Red Soft Exudative (RSE) Pork**


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RSE (Red, Soft, Exudative) pork poses a major problem: it is difficult to identify, and its causes are unknown. At an estimated incidence of 30%, costs associated with extra weight loss (due to increased purge) of RSE pork are more than $40 million per yr. Thus, elimination of RSE would result in significant economic savings. In this study, the hypothesis that RSE is a mild form of PSE (Pale, Soft, Exudative) was tested.

A total of 61 samples, 25 RFN (Red, Firm, Non-exudative), 22 RSE and 14 PSE samples, were included. Color and water holding capacity at 24 h postmortem were used to determine the quality (RFN, RSE or PSE) of the pork loin. Measures of postmortem metabolism, R-value (a measure of ATP breakdown, higher R-values indicate lower ATP levels) and pH decline, were assessed at various times postmortem. R- and pH-values indicate that, compared to RFN muscle, the postmortem glycolysis in RSE muscle is accelerated but glycolysis is not as fast as in PSE muscle. Thus, RSE is a mild form of PSE.

The increased rate of glycolysis in RSE muscle may be a result of a more ‘white’ fiber type. When selecting pigs for faster growth and increased leanness a selection for the faster glycolyzing white fiber type occurs. As it is not known at what critical postmortem time changes in muscle result in reduction of the water holding capacity, it is not clear if increased chilling rates could reduce or prevent the occurrence of RSE. Further research is necessary to determine the cause of the accelerated glycolysis in RSE muscle and to determine the process of water expulsion from RSE muscle.

**The Effects of Hydrolyzed Defatted Soy Flour on the Ripening Process of Sucuk a Turkish Dry Fermented Meat Product**

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Some research has reported the beneficial effects of soy proteins on the quality characteristics of a variety of meat products including some fermented or dry sausages. However, no study has been conducted on the effects of hydrolyzed defatted soy flour (HDSF) for sucuk, a dry fermented meat product. Hence the objective of this research was to determine the influence of HDSF on the drying characteristics of sucuk. The sucuk was manufactured by replacing 0, 10, 20, and 30% of the meat with hydrolyzed defatted soy flour (HDSF/WATER = 1/1.5), and ripened for 15 days at 15-23°C and 75-90% RH. Water activity (aw), moisture content and pH values of the sucuks were determined every 3 days during the ripening and drying process. Although the soy containing products had higher pH value at the beginning, they decreased more rapidly than those containing less or no HDSF sucuks. The final pH was 4.92 at 15 days of ripening for the control (no added HDSF) and this value was attained at the 12th, 9th and 6th days for the 10, 20, and 30% HDSF containing sucuks, respectively. Also, a rapid drying and lower aw values were determined with the hydrolyzed defatted soy flour containing products which would also be related to faster pH decline. This result indicated that HDSF addition could shorten the ripening time and drying process of the sucuks which normally takes for 12-15 days for processing. This practice would provide a faster turnover of capital. In conclusion, the use of HDSF in sucuk formulation is recommended for the meat industry, since not only would it reduce the time of ripening but also permits the production of a cheaper, high quality and a larger variety of meat products in terms of chemical and physical properties.

**The Possibility of Using Fluid Whey in a Frankfurter Type Meat Product**

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World wide, about 10 million tons of excess fluid whey is produced per year but there is a limited use for this product. Also, there has been a tremendous concern to utilize whey in food processing in order not to waste this invaluable protein.
and mineral source. The meat industry uses whey protein concentrates or dried milk proteins but not fluid whey in comminuted products. However, concentration or drying of this product requires an additional expense and energy consumption whereas adding fluid whey directly to the meat products would require almost no expense other than cooling, and this is already being utilized for the production of ice. The objective of this research was to study the possibility of using fluid whey to replace ordinary ice used in frankfurter formulation, and to determine the technological, chemical and sensory quality properties of these sausages. Fresh fluid whey was cooled to 0-1°C, and substituted for 0, 25, 50, 75, and 100% of the ice used for sausage emulsion formation. The results showed that there was no statistically significant difference in most of the technological, chemical sensory parameters determined in this research. However, emulsion stability rates were significantly (P < 0.05) increased with the liquid whey addition of the formulation. Also, a slight increase in % total protein, fat, ash content and pH value were determined with the substitution of liquid whey. The fluid whey did not cause any deterioration in sensory parameters of the cooked sausages. These results suggest that natural liquid whey could be incorporated into frankfurter type sausage formulations by replacing ordinary ice present in the formulation with liquid whey without any technological concern or additional cost. Hence, meat processors could assist in saving the environment and convert a dairy waste into a valuable food product.

Muscle, Postmortem pH, and Refrigerated Storage Effects on Ability of Vacuum-Packaged Pork to Re-bloom

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Effects of pH (Low: 5.2-5.5; Medium: 5.6-6.0; High: 6.1-6.8), muscle (Longissimus lumborum et thoracis (LT), Gluteus medius (GM), and Semimembranosus (SM)), and storage time (0, 7, 14, 21, and 28 days) on the ability of vacuum-packaged pork to re-bloom were investigated. Samples were vacuum packaged and stored at 4°C. Samples were removed from packages to bloom for up to 30 min at 4°C. Instrumental color (L*, a*, and b* values), hue angle (57.3° (arc tan b*/a*)) and Chroma (a*² + b*²)½ were calculated. L* value did not change significantly over the blooming period. Incremental changes in a* and b* values and Chroma and decrements in hue angle were significant after 30 min. The rate and degree of changes during the blooming period were influenced by pH, muscle and storage time. At low pH, a* value incremental change (as a percent of original) increased (P < 0.05) from 37% at day 0 to 60% at day 7. Significant a* value increments occurred at days 14 and 21 for medium and high pH samples, respectively. At low pH, hue angle decrement (as a percent of original) doubled from 4% at day 0 to 9% at day 7. Hue angle decrement increases were delayed and diminished with pH increase. Both percentage increments of b* value and Chroma increased after 14 days and continued until day 21. Among the three muscles, LT had the greatest a* value increment (47%) and hue angle decrement (8%). SM had the smallest a* value increment (40%) and hue angle decrement (5%). In contrast, LT muscle had the smallest b* value (18%) and Chroma (24%) increments. SM muscle had the greatest b* value (24%) and Chroma (28%) increments. In conclusion, pork stored for more than 7 days blooms more efficiently than does the fresh sample when the pH is low. The increase in blooming ability is delayed with pH increase. LT muscle blooms faster than GM and SM muscles in terms of a* value and hue angle changes. SM muscle blooms slowest.