Use of electroencephalogram (EEG) technology to determine the state of market hog consciousness

B. T. Klinkner*1, R. L. Miller1, R. B. A. Dahlen2, L. Bergamasco2, D. J. Newman1, 2North Dakota State University, Fargo, ND, United States, 1Kansas State University, Manhattan, KS, United States

Animal welfare continues to impact many practices that pork producers and processors utilize today. One major issue that is being subjected to animal welfare scrutiny is animal euthanasia. Some principle areas of important research within this field include state of unconsciousness and ability to feel pain. Electroencephalogram (EEG) is a common tool used to measure brain activity in both humans and animals (Gerritzen et al., 2008). While many subjective measurements, such as loss of muscular tone, and loss of corneal reflex are factors used to determine the consciousness of animals, EEG recordings are known to more objectively assess this state (Kim et al. 2002). The objective of this study was to measure EEG values during the conscious and unconscious states of market hogs. Crossbred market hogs (n = 12, 121.9 kg ± 1.41 kg) were used to establish baseline EEG recordings from four different channel leads (L1, L2, R1, and R2) located on the head. In addition, heart rate was recorded. Hogs were placed in a chute and EEG was recorded continuously for 5 min through the conscious state. Next, hogs were anesthetized and another 5 min of EEG recordings was taken during the unconscious state. Raw EEG data were analyzed by an expert and artifact free data was gathered in both conscious and anesthetized stages. EEG data was processed with Magic Marker (Persyst II software) in order to obtain quantitative EEG (qEEG) parameters. The qEEG parameters used were Fast Fourier Transform Power (FFT-Power) spectrum and amplitude-integrated EEG (aEEG). EEG FFT-Power measurement averages for all four channels significantly decreased (P < 0.03) from the conscious to unconscious state (35.20 μV² vs. 5.69 μV² respectively). Likewise, aEEG measurement averages also decreased significantly (P < 0.01) from the conscious to unconscious state (13.06 μV vs. 5.73 μV respectively). Conscious heart rate was significantly higher (P < 0.01) in conscious (127.67 bpm) vs. unconscious (105.50 bpm) hogs. In conclusion, this preliminary research will help in establishing an objective research tool for use in determining unconsciousness and pain in hogs.

Evaluation of a novel means to euthanize piglets

R. L. Miller1, 2, B. T. Klinkner2, R. B. A. Dahlen2, E. P. Berg2, D. J. Newman2, 2North Dakota State University, Fargo, ND, United States

On-farm euthanasia is an inevitable and necessary means to alleviate animal suffering. Currently, the swine industry commonly utilizes blunt force trauma or carbon dioxide asphyxiation as approved methods to euthanize piglets (AASV, 2008). However, these current methods present negative concerns regarding animal welfare. Previous research conducted by our group has demonstrated that electromagnetic energy can be utilized in order to rapidly increase the brain temperature of a piglet. Research has shown that temperatures above 41 °C will cause proteolysis which would lead to nervous cell denaturation and loss of function (Fagain, 1997; Sharma, 2007; Gao et al., 2010). The objective of this experiment was to assess the effectiveness of euthanizing piglets through rapid heating of the brain by novel means using electromagnetic energy. Prior to the beginning of the experiment, a euthanasia containment box equipped with an electromagnetic power device and wave guide was designed to apply 1.4 kW of energy directly to each of the left and right side of the brain of piglets. To achieve the objective of this experiment, six crossbred piglets (BW = 4.3 ± 0.66 kg) were used. Prior to anesthesia, respiration rate, heart rate, and internal body temperature were taken. Furthermore, surface temperatures of the head were taken using a thermal imaging camera. After piglets were anesthetized (Telazol + Xylazine; 0.05 ml/kg BW), they were exposed for 40 s to the electromagnetic energy treatment (EET). Following the EET, respiration rate, heart rate, brain temperature, and surface temperature of the head were taken. Data were analyzed using generalized least squares (PROC MIXED, SAS Institute, Cary, NC). Piglet was the experimental unit. The model included EET as fixed effect and piglet ID as random effect. Differences were considered significant if P < 0.05. Prior to EET, average internal body temperature was 37.6 °C. Following EET, brain temperature was 62.8 °C. Likewise, average head surface temperature measurements were much higher after EET (P < 0.01; 70.7 vs. 34.2 °C, respectively). Severe thermal damage to the skin and skull was visually observed on the piglet’s head subsequent the EET. However, EET had no significant effect (P = 0.86) on heart temperature measurements.
rate of piglets (129 after vs. 133 bpm prior). Furthermore, respiration rate was reduced to zero in all piglets immediately following EET. Unassisted death occurred as heart rate ceased in five of the six piglets at an average time of 4.8 min (ranging from 3 to 7 min) post EET. Efforts were made to record electroencephalogram readings; but, due to thermal damage readings were not able to be obtained. In conclusion, electromagnetic energy has promise as being an effective way of euthanizing piglets.

Keywords: Euthanasia, Piglet, Welfare

Consumer Topics: General Abstract

Sensory rating of meat traits by consumers with preferences for beef from bulls or cows
Ales Dufek\textsuperscript{a}, Miroslav Homola\textsuperscript{b}, Agriresearch Rapotin Ltd., Víkyrovice, Czech Republic, \textsuperscript{b}Cattle Market Ltd., Prague, Czech Republic

Grilling is not a traditional method of preparation of beef in the cuisine of the Czech Republic, but nowadays it becomes more popular. Results from our initial evaluation of the questionnaire (analysis with classification and regression trees) focusing on grilled beef indicated that consumers are divided into two groups: 1) consumers who prefer beef from bulls (PrfB) or 2) from cows (PrfC). The purpose of this study was to determine whether the sensory rating of selected meat traits in beef from bulls or cows differs between the two groups (PrfB and PrfC). 125 consumers rated 4 samples of grilled longissimus muscle – 2 samples from bull and 2 from cow. The consumers had no information about the origin of the samples and rated on a 1–8 points scale with the score increasing with satisfaction with color, overall appearance, odor, odor intensity, tenderness, flavor, flavor intensity, initial juiciness, sustained juiciness, and texture. At the end, consumers judged the overall satisfaction and determined the most palatable sample. Differences in the rating of beef from bulls and cows between PrfB- and PrfC-groups were tested by a two-way ANOVA, followed by Tukey’s post hoc test. Initial correlation analysis showed that the score for overall satisfaction was highly correlated with flavor (r = 0.793, p < 0.01), as well as with overall texture (r = 0.765, p < 0.01) and flavor intensity (r = 0.736, p < 0.01); lower correlation was determined for overall satisfaction with sustained juiciness (r = 0.616, p < 0.01), tenderness (r = 0.592, p < 0.01), initial juiciness (r = 0.568, p < 0.01), color (r = 0.467, p < 0.01), overall appearance (r = 0.446, p < 0.01), odor (r = 0.442, p < 0.01) and odor intensity (r = 0.426, p < 0.01). The lowest correlation coefficient was determined for correlation between flavor and sustained juiciness (r = 0.280, p > 0.01), the highest between flavor and flavor intensity (r = 0.812, p < 0.01). The group of PrfB consumers rated the overall satisfaction at 6.54 and 5.83 (p = 0.047) for beef from bulls and cows, respectively. The rating of beef from bulls (5.43) and cows (6.33) in the PrfC group was opposite and the difference was significant at the higher level (p < 0.001). The difference in rating between the overall satisfaction of beef from bulls in the group PrfB (6.54) and beef from cows in the group PrfC (6.33) was non-significant (p = 0.806). The flavor of beef from bulls was rated by consumers from PrfB group at 6.7 and from PrfC group at 5.45 (p < 0.001). The flavor of beef from cows was rated by consumers from PrfB group at 6.01 and from PrfC group at 6.45, (p = 0.412). Rating of tenderness of beef from bulls was at 6.65 in PrfB group and 5.26 in PrfC group (p < 0.001). Rating of tenderness of beef from cows was at 5.78 in PrfB group and 6.09 in PrfC group (p = 0.688). Higher rating for beef from bulls in PrfB group or cows in PrfC group was significant at the level of p < 0.048 to p < 0.001 in other beef traits except color (p = 0.103), aroma (p = 0.142) and aroma intensity (p = 0.11). On the base of our results we can conclude, that rating of the selected meat traits in beef samples depends on whether the consumers prefer bulls or cows. However, rating of some traits is not affected by the belonging to the group of consumers.

Keywords: Consumer, Beef, Sensory rating

Consumer assessment of palatability of enhanced and non-enhanced Australian grain fed, Australian grass fed, and US grain fed beef from two beef muscles
A. J. Garmyn\textsuperscript{a}, K. S. Spivey\textsuperscript{a}, L. G. Garcia\textsuperscript{a}, R. Pollkinghorne\textsuperscript{b}, M. F. Miller\textsuperscript{a}, Texas Tech University, Lubbock, TX, United States, Marrinya Pty Ltd., Wuk Wuk, Australia

The objective of this study involved consumer assessment of palatability and satisfaction of enhanced and non-enhanced Australian grain fed, Australian grass fed, and US grain fed beef from two beef muscles. Strip loin and top sirloin butt primal cuts were collected from 12 grain fed and 12 grain fed carcasses in Australia and shipped to Texas Tech University (TTU). Tenderloin, strip loin, top sirloin butt, and eye of round subprimals from 12 USDA low choice carcasses were collected during fabrication from a single abattoir in West Texas and transported to TTU. Product from the USA was aged for 29 d postmortem, and Australian (AUS) sourced beef was aged 29–32 d postmortem. Subprimals were enhanced (if specified) and fabricated on 1 of 2 consecutive d at the TTU Gordon W. Davis Meat Science Laboratory. Subprimals allocated to enhancement were weighed then enhanced with a phosphate and beef protein based solution to achieve a 7% pump (gluteus medius 6.9 ± 1.4%; longissimus dorsi 6.9 ± 1.6%) using a multi-needle pickle injector (Wolf-Tec, Kingston, NY, USA). Product was frozen, sorted, and stored until consumer testing. Consumers (n = 360) were recruited from Lubbock, TX and surrounding communities to score tenderness, juiciness, flavor, and overall liking for each sample by vertically marking a 100-mm line scale for each trait. A combined weighted score (MQ4) was calculated using weightings of tenderness (30%), juiciness (10%), flavor (30%), and overall liking (30%) for each sample. Initially, data were analyzed as a completely randomized design with a 3 × 2 × 2 factorial arrangement of treatments. The main effects of country of origin/diet (AUS grain fed, AUS grass fed, and USA grain fed), muscle (longissimus dorsi (LD) and gluteus medius (GM)), and enhancement (0 or 7%) were included as fixed effects. Abattoir served as the random effect. Data were subsequently analyzed including consumer ratings for the psoas major (PM) and semitendinosus, which were fed to every consumer to serve as a reference point for tender and tough, respectively. Enhancement improved palatability in both LD and GM steaks as evidenced by greater (P < 0.05) consumer ratings for tenderness, juiciness, flavor liking, overall liking, satisfaction, and MQ4 compared to non-enhanced. Enhancing GM steaks resulted in consumer responses that were comparable or superior to non-enhanced LD samples. Similarly, scores for enhanced LD samples were comparable or superior to average consumer responses for PM samples. Consumers could not detect differences (P > 0.05) in tenderness, juiciness, flavor, MQ4, or satisfaction between grain fed beef from Australia and the USA. Consumers reacted least favorably to AUS grass fed beef as they marked smaller (P < 0.05) scores for all palatability traits and satisfaction compared to grain fed beef for both LD and GM samples. Consumers preferred grain fed beef over grass fed beef; however, enhancement improved palatability and satisfaction in grass fed and grain fed beef.

Keywords: Beef consumers, Country of origin, Finishing diet
Evaluation of eye lens nitrogen in relation to dentition, bone ossification, and chronological age of beef animals
K. S. Spivey, L. G. Garcia, B. J. Johnson, S. P. Jackson, J. D. Starkey, T. E. Lawrence, M. F. Miller, Texas Tech University, Lubbock, TX, United States, West Texas A&M University, Canyon, TX, United States

The beef industry uses age as a determinant in the economic value in beef cattle and carcasses. As beef animals advance in chronological age, certain physiological changes occur including increased skeletal maturity, myoglobin accumulation, eruption of permanent incisors, and greater collagen cross linking resulting in tougher meat. Ultimately, the changes reduce the dollar value associated with these carcasses. Accurately determining the age of beef animals is paramount in the pricing of beef carcasses. The present research evaluated the relationship of the age predictor variables wet lens weight, g (WWT), dry lens weight, g (DWT), nitrogen content, mg (ENW), percentage lens nitrogen (NPER), dentition (DENT), skeletal maturity (OSS), and chronological age in cattle (n = 190). Cattle of known age were sampled from 5 to 110 mo of age. Correlation of age predictor variables to age (mo) resulted in the following correlation coefficients: WWT (r = 0.61), DWT (r = 0.76), ENW (r = 0.76), NPER (r = 0.29), DENT (r = 0.84), and OSS (r = 0.79). Stepwise regression was used to develop an age prediction equation that utilized DENT and OSS: age (mo) = 11.86285 + 3.31019(DENT) + 0.03859(OSS). A separate equation was developed to determine the probability of an animal being >30 mo of age using stepwise logistic regression. The equation used DENT in the following equation: Probability of 30 mo = 5.2775 + 1.6229(DENT). Data also revealed that dental eruption occurs rapidly between 21 to 24 mo and equation: Probability of 30 mo = 5.2775 + 1.6229(DENT). A separate equation was developed to determine the probability of an animal being >30 mo of age using stepwise logistic regression. The equation used DENT in the following equation: Probability of 30 mo = 5.2775 + 1.6229(DENT). Data also revealed that dental eruption occurs rapidly between 21 to 24 mo and equation: Probability of 30 mo = 5.2775 + 1.6229(DENT). A separate equation was developed to determine the probability of an animal being >30 mo of age using stepwise logistic regression. The equation used DENT in the following equation: Probability of 30 mo = 5.2775 + 1.6229(DENT).

Keywords: Beef, Chronological age

Environment, Production Systems and Meat Quality: General Abstract

Evaluation of sources of variation for the weight of five pork primal and subprimal cut weights
A. P. Schinckel, M. E. Einstein, N. Olynk, C. Booher, B. Fields, E. Wilson, T. Dreadin, A. Sosnicki, Purdue University, West Lafayette, IN, United States, PIC North America, Hendersonville, KY, United States

Pork processors have the objective to market lean pork products, which are uniform in weight and composition. The objective of this study was to evaluate the sources of variation in the primal and subprimal weights including the variation between the carcass sides of pigs marketed over a range of BWs. The weights of five primal and subprimal cuts were evaluated from 1688 barrows and gilts of three sire and two dam lines at target market BWs of 113, 127 or 141 kg. The cut weight data were fitted to allometric functions of carcass weight (cut weight, kg = A CW^B). The equation was linearized as Log10 (cut weight, kg) = Log10 A + B Log10 (CW, carcass weight, kg) and included the fixed effects of sire line, dam line, and sex and their interactions with Log10 CW. Sire line, dam line and sex specific A and B values were obtained based on the significance (P < 0.05) of the fixed effects and interactions of the B values with the fixed effects. The predicted values of the cut weights were included in a model including the random effects of replicate, room within replicate, and pig, and fixed effect of side. Left side weights were greater (P < 0.01) than right side weights for bone-in loin, rough-cut belly and trimmed belly weight. The differences between the two sides were greatest for the rough-cut (7.22 versus 6.63 kg, P < 0.001) and trimmed belly weights (5.94 versus 5.60 kg, P = 0.001). The allometric functions of CW accounted for 47 (rough-cut belly) to 68% (bone-in loin) of the total variance in the cut weights. The random effect of pig accounted for 7.9, 2.4, 22.3, 11.6, and 14.9% of the variance with coefficients of variation (CV) of 2.92, 1.94, 6.21, 5.71 and 6.60% for bone-in ham, bone-in loin, boneless loin, rough cut belly and trimmed belly weight, respectively. The variance accounted for by pig is a measure of the variation in the mean weights of both sides of the pigs of the same genetic population at the same CW. For bone-in loin weight and to a lesser extent bone-in ham weight, there is a relatively small amount of within population pig to pig variation. The within-pig side to side variation accounted for 239, 27.1, 26.7, 15.2, and 17.2% of the total variance and had CVs of 4.67, 5.93, 6.57, 6.12 and 6.52% for the five cut weights. Three sources of variation accounted for the vast majority of the variation in cut weights of pigs of the same genetic population: CW, pig to pig variation, and side-to-side variation. The variation in cut weights can be reduced by decreasing the variation in hot carcass weight and reducing the variation in the fabrication of the cuts.

Keywords: Pig, Primal cut, Variation

Investigating the fresh meat retail case in the United States — 2010
L. G. Garcia, K. S. Spivey, M. J. Kelley, J. A. Henger, M. F. Miller, Department of Animal and Food Sciences, Texas Tech University, Box 42141, Lubbock, TX 79409, United States, Cryovac, Inc. Sealed Air Corporation, 10 Rogers Bridge Rd., Duncan, SC 29334, United States, National Pork Board, P.O. Box 9114, Des Moines, IA 50306, United States, The Beef Checkoff, 9000 E. Nichols Avenue Suite 215, Centennial, United States

The objective of this study was to further investigate trends of the retail fresh meat case focusing on fresh meat products and retail space in 124 stores nationwide across five regions of the United States in 2010. The United States was divided into Mountain/Southwest (MT), Midwest (MW), Northeast (NE), Southeast (SE), and West Coast (WC). Categories recorded for the self-service case were whole muscle beef cuts, ground beef, pork, veal, lamb, chicken, turkey, fresh sausage, value-added, heat and serve, ham bone-in, ham boneless, ham steak, processed meat, seafood, nonmeat, and offal. Categories recorded for the full-service were seafood, beef, pork, chicken, ground beef, lamb, fresh sausage, turkey, veal, and nonmeat. Additionally, packaging type, tray type, percent branded products, and consumer information (cooking instructions, nutritional and recipe information) were investigated. PROC FREQ was performed using the SAS application version 9.2. All 124 stores surveyed carried whole muscle beef, ground beef, and fresh chicken products in their retail meat case. Fresh pork, sausage, and value-added products were the second to be found (in over 91%) in fresh retail cases. Fresh seafood products were predominately found in stores carrying full-service cases. Stock keeping units (SKU) was greatest for the NE region (4291) while the WC had the least (3212). In contrast, SKU per meters ranged from 1.8 to 2.1 across regions. Polyvinyl chloride overwrap packaging (45.8%) was the most common packaging type recorded followed by laminate (13.4%) and modified atmospheric packaging (8.1%), nationally. White (30.6%), black (28.2%), and yellow (10.9%) were the most commonly seen tray colors on a national level. Forty two percent of packages carried a national brand; whereas, 32.7% carried a store brand, and the remainder 24.8% had no brand. Consumer cooking instructions (46.9%), nutritional (56.8%) and recipe (17.4%) information were recorded. In conclusion, this information gives an update of the content of fresh meat cases in the United States.

Keywords: Market survey, Retail case, Brand
Effects of castration on carcass composition, meat quality, and sensory properties of beef produced in a tropical climate

J. Rodriguez*a, J. Unruha, M. Villarealb, O. Muriellob, S. Rojasb, J. Camacho, J. Jaegerb, C. Reinhardtb, aKansas State University, Manhattan, KS, United States, bInstituto Tecnológico de Costa Rica, San Carlos, Costa Rica

Forty-eight (3/4 Brahman × 1/4 Charolais) male calves were used to determine carcass cutability and quality characteristics of steaks from four muscles aged for 2, 7, 14, or 28 d from intact bulls and steers castrated at 3, 7, or 12 mo of age grown under tropical pasture conditions. The experiment was conducted as a randomized complete block design with animal as the experimental unit and harvest group as a blocking factor with aging period as a repeated measure for Warner–Bratzler shear force (WBSF). Male calves were randomly assigned at birth to castration treatments, weaned at 7 mo, and raised together their entire life on pasture in Costa Rica. At 26 mo of age, cattle were harvested in 4 groups at a commercial harvest facility. Strip loin (longissimus lumborum, LL), tenderloin (psosas major, PM), top sirloin butt (gluteus medius, GM), and eye of round (semitendinosus, ST) steaks were aged for 2, 7, 14, or 28 d for WBSF. A sensory panel was conducted for all 4 muscles from intact bulls and steers castrated at 3 mo of age. Live BW, carcass traits, and total subprimal yields were not affected (P > 0.10) by male sex condition. For PM, GM, and ST steaks, WBSF values were similar (P > 0.41) for steaks from intact bulls and steers castrated at all ages. For both PM and GM, steaks aged for 28 d had the most tender (P < 0.05) WBSF values and steaks aged for 2 d had the toughest (P < 0.05) WBSF values. For the ST, WBSF values were toughest (P < 0.05) for steaks aged 2 d. A treatment × aging interaction (P < 0.05) was detected for LL WBSF values. At 14 d of aging, LL steaks from steers castrated at 3 mo tended (P = 0.07) to have more tender WBSF values than LL steaks from intact bulls. At 28 d of aging, steaks from steers castrated at 3 and 7 mo had more tender (P < 0.05) WBSF values than steaks from intact bulls and steers castrated at all ages. For both PM and GM, steaks aged for 28 d had the most tender (P < 0.05) WBSF values and steaks aged for 2 d had the toughest (P < 0.05) WBSF values. For the ST, WBSF values were toughest (P < 0.05) for steaks aged 2 d. A treatment × aging interaction (P < 0.05) was detected for LL WBSF values. At 14 d of aging, LL steaks from steers castrated at 3 mo tended (P = 0.07) to have more tender WBSF values than LL steaks from intact bulls. At 28 d of aging, steaks from steers castrated at 3 and 7 mo had more tender (P < 0.05) WBSF values than steaks from intact bulls and steers castrated at 12 mo. For LL steaks from steers castrated at 3 mo, steaks aged for 28 d had more tender (P < 0.05) WBSF values than steaks aged 2, 7, or 14 d and steaks aged 14 d had more tender (P < 0.05) WBSF values than those aged 2 d. For LL steaks from steers castrated at 7 mo, steaks aged 28 d had more tender (P < 0.05) WBSF values than steaks aged 2, 7, or 14 d. For LL steaks from steers castrated at 12 mo and intact bulls, steaks aged 28 d had more tender (P < 0.05) WBSF values than steaks aged 2 or 14 d. Although all sensory panel data collected were not statistically different (P > 0.05), LL steaks from steers castrated at 3 mo had more tender scores for overall tenderness (P = 0.17) than steaks from intact bulls. Following a similar trend, GM steaks from steers castrated at 3 mo had more tender scores for myofibrillar tenderness (P = 0.14) than GM steaks from intact bulls. This study indicates that castration at 3 mo would be the recommended production practice as it provided the greatest improvement of LL tenderness over intact bulls with no differences in carcass traits or subprimal yields. The degree of improvement in tenderness due to aging is muscle dependent.

Keywords: Beef, Castration, Tenderness

Effects of distillers dried grains with solubles supplementation on yearling heifers grazing northern Great Plains rangeland on carcass characteristics and meat quality

Q. P. Larson, R. J. Maddock, K. K. Karges, B. W. Neville, North Dakota State University, Fargo, ND, United States, Dakota Gold Research Association, Sioux Falls, SD, United States

The objective of this study was to evaluate the impact of distillers dried grains with solubles (DDGS) supplementation while grazing northern Great Plains rangeland on subsequent carcass characteristics and meat quality. A total of eighty-two heifers (initial BW: 319 ± 4.0 kg) were allotted to 1 of 2 supplementation treatments during the grazing season. Heifers were randomly assigned to 1 of 6 pastures with each pasture randomly assigned to 1 of 2 treatments (0% supplementation or 0.6% of BW supplementation of DDGS). After a 70 d summer grazing season, heifers were placed into feedlot pens for a 109 d finishing study. All heifers received the same corn-based finishing diet containing no DDGS. Heifers were harvested at a commercial abattoir and hot carcass weight, 12th rib back fat, percent kidney pelvic heart fat, ribeye area, marbling score, USDA yield grade and quality grade were evaluated. Strip loins (IMPS #180) were removed 24–48 h postmortem and transported back to North Dakota State University for further analysis. After the 7 d of dry storage, two 2.5-cm steaks were cut off from each loin sample for analysis. One steak from each animal was individually vacuumed packaged, and aged for an additional 7 d. Steaks were then cooked to an internal temperature of 71 °C, cooled to room temperature, six 1.27-cm cores were removed and evaluated by Warner–Bratzler shear force. The other strip steaks were prepared immediately for simulated retail shelf life display. Strip steaks were overwrapped with PVC and were displayed at 2 °C under cool white fluorescent lighting and evaluated objectively (L*, a*, b*) and subjectively (surface discoloration) every 24 h for the duration of the study starting at d 0. Hot carcass weight, and 12th rib back fat were similar between treatments (P = 0.47, and 0.57 respectively). Percent kidney, pelvic, and heart fat did not differ between treatments (P = 1.00). Ribeye area was similar (P = 0.50) and averaged 81.29 cm² for both treatments. Average USDA yield grades were similar (P = 0.30) for supplemented and unsupplemented (2.97, and 2.80 respectively). Marbling scores (where 500 = small⁰⁰, 600 = modest⁰⁰) were not different (P = 0.24) between treatments. There was a trend (P = 0.06) for decreased mean shear force for supplemented versus unsupplemented treatments (3.32, and 3.74 kg respectively). For strip steak retail evaluation, treatment did not affect mean b* value (P > 0.11 and 0.47, respectively), however treatment did affect L* values (P = 0.01). increased L* values were found for supplemented as compared with unsupplemented treatments. Treatment did not affect subjective surface discoloration (P = 0.12). Results indicate that supplementation of DDGS during grazing does not negatively impact carcass characteristics or retail shelf life display and could possibly improve the tenderness of strip loins.

Keywords: Distillers dried grains with solubles, Beef quality, Grazing

Leptin genotype and growing phase diet effects on carcass traits and meat quality

L. M. Hoffman, R. H. Pritchard, A. D. Weaver, S. M. Scramlin, M. G. Gonda, A. E. Wertz-Lutz, K. R. Underwood, South Dakota State University, Brookings, SD, United States

Leptin is a hormone involved in regulating feed intake, energy metabolism, and body composition, and affects beef cattle performance, carcass characteristics, and meat quality. The objective of this study was to test if a single nucleotide polymorphism (SNP) in the leptin gene (C.73 C>T) will interact with plane of nutrition to influence beef carcass quality. Angus cross steer calves (n = 153) were acquired from two sources and TT and CC calves were sorted by genotype into pens (7–8 head per pen) and randomly assigned to higher energy density (HE) or lower energy density (LE) diets. The leptin C.73 C>T polymorphism was genotyped by PCR-RFLP. The LE and HE diets were fed until steers reached a predetermined bodyweight of 430 kg. Cattle required 112 days on the LE treatment and 100 days on the HE treatment to achieve this bodyweight. A
common finishing diet was fed until steers reached a preset endpoint of 1.1 cm of 12th rib fat. The finishing phase was 80 days for the HE treatment and 89 days for the LE treatment. Hot carcass weight (HCW), percent KPH, and video image analyses of longissimus muscle area (LMA), 12th rib fat thickness, and marbling data were acquired. Whole rib and strip loin samples were removed from a subset of carcasses (n = 43, cattle closest to the mean of population body-weight at beginning of dietary treatment) to determine carcass composition and tenderness. Three 2.54 cm steaks were fabricated from the anterior end of each strip loin, aged for 7, 14, or 21 days at 2–4 °C and analyzed for Warner–Bratzler shear force (WBSF) analysis. One 2.54 cm steak was fabricated from each strip loin, retail overlapped, and placed in a cooler (4 °C) under fluorescent lighting for evaluation of L* (lightness), a* (redness), and b* (yellowness) values using a Minolta Colorimeter for 0 to 7 days. During the growing phase average daily gain (ADG), dry matter intake (DMI), and feed efficiency were greater for the HE than the LE group (P = 0.0001). In contrast, during the finishing phase, ADG, DMI, and feed efficiency were greater in the LE than the HE group (P = 0.0024). No diet by genotype interactions was observed for initial weight, midweight, KPH, marbling, or yield grade. No differences were observed for initial weight, end weight, HCW, KPH, marbling, or yield grade for diet or genotype. Twelfth rib fat was thicker in the HE than the LE group (P = 0.0086). The HE group had a larger LMA compared to the LE group (P = 0.002). Marbling score to carcass percent fat was greater in CC than the TT steers (P = 0.0086). From the subset steers, significant differences were not observed for treatment, genotype, day by treatment, genotype by treatment, day by genotype, or three way interactions for WBSF; however, day was significant (P = 0.0001). Interactions of treatment and day were not significant for L*. Increased growth rate during the growing phase caused lower a* and b* values (P = 0.0001) in the treatment by day interaction. This study indicated that the CC steers had a greater degree of marbling in proportion to rib fat, but other measures of growth performance and carcass characteristics did not differ as a result of leptin genotype or the interaction of genotype and plane of nutrition.

Keywords: Beef, Leptin genotype, Zilpaterol hydrochloride

Effect of metabolizable protein supplementation to ewes during late gestation on wether offspring feedlot performance and carcass characteristics

M. L. Van Emona, b, K. A. Vonnahmeb, P. T. Bergb, K. R. Maddock Carlinb, C. S. Schauera, a T. J. McEvers*a, P. J. Defoorb, R. S. Swingleb, S. E. Ivesb, J. P. Hutchesonc, T. E. Lawrenceb, West Texas A&M University, Beef Carcass Research Center, Canyon, TX 79016, United States, bCactus Research, Amarillo, TX 79116, United States, cHettinger Research Extension Center, North Dakota State University, Hettinger, ND, United States, dDepartment of Animal Sciences, North Dakota State University, Fargo, ND, United States

The objective was to determine the effect of supplementing metabolizable protein (MP) to ewes during the last 50 d of gestation on their offspring feedlot performance and carcass characteristics. Maternal dietary treatments in was isocaloric and contained 100% (100MP1), 80% (80MP1), and 60% (60MP1) of MP requirements in year 1 and 60% (60MP2), 100% (100MP2), and 140% (140MP2) of MP requirements in year 2 for ewes bearing twins during the last 50 d of gestation. Wether offspring were placed in the feedlot post-weaning. In year 1, feedlot wethers (29 ± 2 kg) were fed a common feedlot ration (84.4% whole corn, 15.6% commercial market lamb pellet). Initial and final feedlot BW, ADG, and G:F were not affected (P > 0.17) by maternal dietary treatment. Wethers born to ewes fed the 60MP1 diet had increased (P = 0.01) DMI compared with the wethers born to ewes fed the 80MP1 diet during the feedlot phase. Additionally, wethers born to 100MP1 ewes had reduced (P = 0.10) days on feed compared with wethers born to 80MP1 ewes and wethers born to 100MP1 ewes had increased (P = 0.04) percent boneless, closely trimmed, retail cuts compared with wethers born to the 60MP1 and 80MP1 ewes, with all other carcass characteristics not affected (P > 0.13). Loin Warner Bratzler shear force was also not different (P = 0.40) due to maternal dietary treatment. In year 2, feedlot wethers (28 ± 7 kg) were fed a common feedlot ration (84.7% whole corn, 13.5% commercial market lamb pellet). Maternal dietary treatment did not affect (P > 0.36) initial and final BW, ADG or G:F of wether offspring. Additionally, HCW, dressing percentage, longissimus muscle area, 12th rib fat depth, body wall thickness, leg score,
conformation score, flank streaking. USDA quality grade, yield grade, and percent boneless, closely trimmed retail cuts were not different \((P \geq 0.40)\) due to maternal dietary treatment. These data suggest that maternal MP supplementation at or above requirements during the last 50 d of gestation may enhance feedlot performance, but have no effects on carcass characteristics.

**Keywords:** Carcass characteristics, Metabolizable protein, Wethers

---

**The effects of routine exercise of feedlot cattle on beef striploin quality and composition**


Feedlot cattle are normally limited in the amount of physical activity in which they regularly participate. This research was aimed at discovering the effects of routine exercise of feedlot cattle in regard to fatty acid concentration, type I collagen crosslink state, Warner–Bratzler shear force values (WBFS), as well as instrumental CIE \(L^*, a^*,\) and \(b^*\) values for lean color of longissimus muscle. Steers \((n = 419)\) were stratified by weight and randomly assigned within strata to one of 4 treatments: 1) exercised 3 times/wk for the entire finishing period \((ALL); 2) exercised 3 times/wk for the first 10 wk \((E); 3) exercised 3 times/wk for the last 7 wk \((L);\) and 4) no exercise during the 116-d finishing period \((CON).\) Cattle were exercised by animal handlers for a minimum of 20 min at a trotting pace. At the conclusion of the finishing period the steers were harvested at a commercial beef facility where 3 striploins \((IMPS 180)\) were randomly selected from each treatment within each of the 7 strata for a total of 84 striploins. Striploins were then transported to the Kansas State University Meat Laboratory and at 2 d postmortem the anterior end of each striploin was removed with this portion being stored at \(-20^\circ C\) for fatty acid and collagen analysis. A 2.54 cm thick steak was taken from the anterior portion of the remaining striploin, vacuum-packaged, and aged to 14 d postmortem at \(4^\circ C\) to assess WBFS. The remaining portion of the striploin was vacuum-packaged and aged to 14 d postmortem at \(4^\circ C\). Once ageing time was achieved, a 2.54 cm thick steak was taken from the anterior portion of the striploin section and allowed to bloom for 30 min to attain CIE \(L^*, a^*,\) and \(b^*\) color values for lean color. Data were analyzed as a mixed model, with fixed effect of treatment and random effect of pen. Exercise regime did not impact concentration of saturated \((P = 0.67),\) monounsaturated \((P = 0.41),\) and polyunsaturated fatty acids \((P = 0.72).\) Beta 12 type I crosslinks \((P = 0.90),\) beta 11 type I crosslinks \((P = 0.92),\) and gamma type I crosslinks \((P = 0.72)\) were unaffected by treatment. WBFS values were 4.55, 4.71, 4.62, and 4.45 kg \((P = 0.87; S.E. = 0.2319)\) for ALL, E, L, and CON respectively. Furthermore, no differences were observed when evaluating tristimulus CIE \(L^*(P = 0.98), a^*(P = 0.56),\) and \(b^*(P = 0.42)\) lean color values. In summary, the implementation of routine exercise on feedlot steers did not alter tenderness, lean color, or composition of beef striploins.

This project was funded by the Darden Environmental Trust.

**Keywords:** Beef, Composition, Exercise

---

**Effects of zilpaterol hydrochloride and ractopamine hydrochloride on live performance and carcass characteristics of calf-fed Holstein steers**

T. R. Brown*, T. E. Lawrence, M. F. Miller, A. K. Sexten, K. D. Pfeiffer, J. M. Hodgson, C. L. Thomas, D. A. Yates, J. P. Hutcheson, J. C. Brooks*, Department of Animal and Food Science, Texas Tech University, Lubbock, TX, United States, 2Beef Carcass Research Center, Department of Agricultural Sciences, West Texas A&M University, Canyon, TX, United States, 3Department of Animal Sciences and Industry, Kansas State University, Manhattan, KS, United States, 4Mercik Animal Health, DeSoto, KS, United States

The objective of this study was to quantify the effects of zilpaterol hydrochloride \((ZH)\) and ractopamine hydrochloride \((RH)\) on live performance and carcass characteristics of calf-fed Holstein steers. Holstein steers \((n = 2275)\) were assigned to 1 of 3 treatments: 1) a control diet containing no ZH or RH; 2) a diet that contained ZH \([8.3 \text{ mg/kg (100% DM basis)};\) Merck Animal Health, DeSoto, KS\] for 20 d with a 3-d withdrawal period before slaughter; 3) a diet that contained RH \([300 \text{ mg/hd/d};\) Elanco Animal Health, Greenfield, IN\] for 28 d before slaughter. No differences were detected for dry matter intake \((P = 0.60)\) among treatment groups. Average daily gain was increased \((P < 0.05)\) for RH \((1.40 \text{ kg/d})\) and ZH \((1.39 \text{ kg/d})\) steers, as compared to control \((1.35 \text{ kg/d}).\) Additionally, feed:gain \((\text{kg/kg})\) was decreased \((P < 0.05)\) for RH \((3.02)\) and ZH \((3.08),\) as compared to control \((3.15).\) Steers fed ZH had a greater \((P < 0.05)\) hot carcass weight \((414.6 \text{ kg})\) and dressed yield \((63.9\%)\) when compared to RH \((406.9 \text{ kg}, 62.6\%)\) and control \((398.7 \text{ kg}, 62.3\%)\), respectively. No differences were detected for percentage of carcasses grading USDA Prime \((P = 0.49)\) and USDA Standard \((P = 0.59)\) among treatment groups. However, ZH steers had a decreased \((P < 0.05)\) percentage of USDA Choice \((65\%)\) and an increased \((P < 0.05)\) percentage of USDA Select \((31.0\%)\) grading carcasses as compared to RH \((70.2\%, 25.8\%)\) and control \((72.0\%, 24.8\%)\), respectively. Steers fed ZH had a greater \((P < 0.05)\) percentage of USDA yield grade 1 \((15.1\%)\) and USDA yield grade 2 \((55.0\%)\) carcasses, with a decreased \((P < 0.05)\) percentage of USDA yield grade 3 \((27.1\%)\) and USDA yield grade 4–5 \((2.8\%)\) grading carcasses as compared to RH \((10.5\%, 49.1\%, 36.1\%, 4.4\%)\) and control \((9.0\%, 47.7\%, 36.4\%, 6.9\%)\), respectively. These results suggest that feeding beta-agonist to calf-fed Holstein steers increases live performance. Furthermore, these results suggest that supplementing calf-fed Holstein steers with ZH enhances cutability, with slight decreases in quality when compared to calf-fed Holstein steers supplemented with RH or no beta-agonist.

**Keywords:** Beef, Zilpaterol hydrochloride, Ractopamine hydrochloride

---

**Measurement and Prediction of Meat Quality and Composition: General Abstract**

**Comparative effects of zilpaterol hydrochloride, ractopamine hydrochloride, and no beta-agonist on strip loin subprimal and steak yield in calf-fed Holsteins**


Steak cutting tests were performed on boneless strip loins from calf-fed Holsteins fed zilpaterol hydrochloride \((ZH)\), ractopamine hydrochloride \((RH)\), or no beta agonist to determine if increased subprimal red meat yield would translate to increased steak yield. Steers \((n = 565)\) were assigned to one of three treatments: ZH \((8.3 \text{ mg/kg of DM for 28 d};\) Merck Animal Health, Greenfield, IN\), RH \((300 \text{ mg/kg/d for 28 d};\) Elanco Animal Health, Greenfield, IN\), or no beta agonist \((CON).\) Only carcasses grading USDA Choice were selected for partitioning \((n = 315).\) Strip loins \((IMPS \# 180)\) were obtained and transported to Texas Tech University. Subprimals were weighed before and after trimming. Each strip loin was faced,
five 2.5-cm steaks were cut using a Marel Portioning Machine (IPM-3, Marel Townsend, Des Moines, IA), and the remaining subprimal was portioned into steaks weighing 11 oz (0.31 kg). Pre-trim and trimmed (<0.6 cm) subprimal weights differed (P<0.01) between treatments. In both instances, cattle treated with ZH produced the heaviest subprimals (5.57 and 4.38 kg), RH was intermediate (5.32 and 4.13 kg), and CON subprimals were lightest (5.16 and 4.01 kg). Subprimal trim was not different between treatments (P=0.63). Total average steak number and consequently total steak weight differed (P<0.01) between treatments; however, steak yield (70.4 to 71.7%) was not affected by beta agonist supplementation (P=0.20). The average number of total steaks from cattle supplemented with ZH (12.2) was greater compared to control (11.6) and RH (11.8), which did not differ. Strip loins from cattle supplemented with ZH had the heaviest average steak weight (4.00 kg), RH was intermediate (3.78 kg), and CON subprimals had the lightest average steak weight (3.63 kg). The average number and total weight of center steaks differed (P<0.01) due to treatment, but yield was not affected once again (P=0.71). Cattle supplemented with ZH had a greater number of center steaks (9.11) compared to CON (8.83) and RH (8.86), which did not differ. This resulted in heavier center steak weights for ZH cattle (2.93 kg) compared to CON (2.69 kg) and RH (2.77 kg). Vein steak average number differed (P<0.01) between treatments. CON cattle produced fewer vein steaks (2.8) when compared to cattle supplemented with either beta agonist (ZH = 3.1; RH = 3.0). Vein steaks from steers supplemented with ZH (0.96 kg) weighed more (P<0.01) than CON vein steaks; however, RH (0.80 kg) did not differ (P>0.05) from CON (0.84 kg) or ZH. Vein steak yield was similar between treatments (P=0.22). Steak trim did not differ between treatments (P=0.40). Purge loss was affected (P<0.01) by treatment. Strip loins from cattle supplemented with ZH had the greatest loss (1.86%), RH was intermediate (1.65%), and CON subprimals had the lowest purge loss (1.44%). Beta agonist supplementation resulted in heavier strip loins, which translated to greater total steak weight. When accounting for initial subprimal weight, steak yield did not differ between treatments; however, ZH had an advantage over RH for subprimal and steak weight.

Keywords: Beef, Tenderness, Multispectral image texture

Predicting beef tenderness using multispectral image texture features
Xin Sun*, James Magolski, Kasey Maddock-Carlin, Vern Anderson, Ashley Lepper, Christina Schwartz, Breanne Ilse, and Eric Berg, North Dakota State University, FARGO, ND, United States

The objective was to investigate the usefulness of raw meat surface texture using different wavelengths to predict cooked beef tenderness. Texture features (88 gray level co-occurrence, 81 fast fourier transform, and 48 Gabor wavelet filter texture features) were extracted from multispectral images (440, 550, 710, and 810 nm) of beef steaks obtained using a CCD camera (Model CoolSNAPES; Roper Scientific, Inc.) attached to a multispectral image system (MultiSpec Imager; Optical Insights). Images were obtained from 2.54-cm thick cross-sectioned steaks cut from longissimus thoracis (tender n=109, tough n=31) muscles. Steaks were classified as tough or tender based on Warner–Bratzler shear force values whereby ≤4.0 kg was considered tender. Texture features were submitted to STEPWISE multiple regression and support vector machine (SVM) analysis to establish prediction models for tenderness. Subsamples (80%) of tender and tough classified steaks were used to train the SVM or establish the STEPWISE models which were then validated on the remaining 20% of the steaks. Both models using multispectral image features at each of the 4 wavelengths classified tenderness of biceps femoris steaks with 77% accuracy. STEPWISE models (440 and 810 nm) were 80% correct in predicting tenderness of longissimus thoracis. Tenderness of semimembranosus steaks was predicted with an accuracy of 85% (440 nm), 80% (810 nm), and 70% (550 nm) using STEPWISE models and 75% (440 nm) and 65% (810 nm) using SVM models. STEPWISE and SVM models were ≤65% accurate in predicting tenderness of supraspinatus steaks. In conclusion, STEPWISE models (440 nm and 810 nm) predicted tenderness of 3 beef cuts with an accuracy of approximately 80%, while SVM models were less predictive of tenderness. Both models were considerably less accurate in classification of designated tough steaks. Multispectral texture features isolated through the development of SVM and STEPWISE models show potential as a means to predict tenderness of beef steaks, however, must be validated on a larger sample size.

Keywords: Beef, Tender, Tenderness, Multispectral image texture

Effect of crossbreeding and gender on Δ9 desaturase activity index in pigs
V. Alonso, P. Roncalés, J. A. Beltrán*, Department of Animal Production and Food Science, University of Zaragoza, Zaragoza, Spain

One of the key factors regulating fat deposition is the expression of lipogenic enzymes. Stearoyl-CoA desaturase (SCD), or Δ9 desaturase, is a key lipogenic enzyme, catalysing the conversion of palmitic (C16:0) and stearic (C18:0) acids to palmitoleic (C16:1n−9) and oleic (C18:1n−9) acids, the two major monounsaturated fatty acids (MUFA) of pork lipoa. The aim of this study was to investigate the effect of crossbreeding and gender (barrows; gilts) on Δ9 desaturase activity indices (C16:1n−9/C16:0; C18:1n−9/C18:0) and C16:2n−6/C18:1n−9 ratio in intramuscular (IMF) and subcutaneous fat (SCF) of pigs. This study was undertaken with carcasses of 29 gilts and 28 barrows from three different crossbreeding schemes which included Large White (LW), Duroc (D) and Pietrain (P) as sire lines and Landrace (LR)×LW as dam line. Animals were fed the same commercial feed, raised under similar conditions and transported from the farm to the slaughter-house at the same live weight (106–116 kg). The samples were removed from m. semimembranosus and subcutaneous fat at the level of thoracic ribs 24 h after slaughter. The samples were extracted in chloroform–methanol to determine composition in fatty acids from intramuscular fat and SCF and the methyl esters from fatty acids were analyzed in a gas chromatograph. Index for the activity of Δ9 desaturase was estimated from ratios of product to precursor fatty acids. All data were statistically analyzed by the GLM procedure of SPSS, version 15.0. Duncan’s post hoc test was used to assess differences between mean values when P≤0.05. The proportion of total saturated fatty acids (SFA) was (P≤0.001) greater in D×(LD×LW) and LW×(LD×LW) than in P×(LD×LW) in IMF. However, there were no significant differences in the total MUFA among crossbreeds. The Δ9 desaturase activity indices (C16:1n−9/C16:0; C18:1n−9/C18:0) were (P≤0.05) greater in P×(LD×LW) than in D×(LD×LW) and LW×(LD×LW) in IMF. This could be due to a greater potential for desaturation in the intramuscular MUFA metabolism of P×(LD×LW). Also, the absence of differences in the percentage of MUFA among crossbreeds may be explained by the inhibitory effect that linoleic acid (C18:2n−6) has on the enzyme SCD, as there was a slight tendency for C18:2n−6/C18:1n−9 to ratio to be greater in P×(LD×LW). In SCF, the concentration of SFA was (P≤0.01) less and Δ9 desaturase activity indices were (P≤0.001) greater in D×(LD×LW) and P×(LD×LW). Furthermore, the concentration of MUFA was (P≤0.001) greater in P×(LD×LW). However, P×(LD×LW) had less (P≤0.10) C18:2n−6/C18:1n−9 ratio than D×(LD×LW). These results could indicate that the highest incorporation of linolenic
acid in the SCF of D × (LD × LW) inhibited the synthesis of MUFA more than in P × (LD × LW), which held a high rate of desaturation of the SCF and, therefore, resulted in a greater percentage of MUFA. No differences between genders were detected for Δ9 desaturase activity indices in both IMF and SCF. However, the C18:2n−6/C18:1n−9 ratio was (P≤0.01) greater in gilts than barrows in SCF. In conclusion, gender and crossbreeding had no and moderate effects, respectively, on Δ9 desaturase activity indices involved in MUFA metabolism in the present study.

Keywords: Crossbreeding, Gender, Δ9 desaturase

Development of nutrient labels for four retail cuts from the beef rib
J. N. Martin*a, A. M. Lunt,a, L. L. Mayb, A. N. Haneklausb, K. B. Harrisb, J. L. Schutzc, K. E. Belk, D. R. Woerner,a, L. W. Douglassa, J. L. Leheska,a, J. M. Holdena, K. Y. Pattersonb, M. Duvallb, J. Howef, L. D. Thompsonc, Texas A&M University, College Station, TX, United States, Colorado State University, Fort Collins, CO, United States, Private Consultant, Longmont, CO, United States, U.S. Department of Agriculture, Washington, DC, United States

Beginning in March of 2012, the USDA Food Safety Inspection Service (FSIS) began implementation of a final rule requiring on-package nutrient labeling for many beef cuts; however, previously available nutrient data may not best represent beef available for purchase at retail. The objective of this research was to update the USDA National Nutrient Database for Standard Reference for four major beef cuts in order to provide accurate nutrient data for the development of retail nutrition labels. Seventy-two carcasses were selected across six regions of the U.S. to represent a national composite of yield grade, quality grade, gender, and genetic type. Beef ribs (IMPS #109) were obtained from one side of each carcass and randomly assigned to either fabrication of boneless (n = 36 ribs) or bone-in (n = 36 ribs) retail cuts. Ribs designated as boneless were fabricated into boneless lip-on ribeye steaks (IMPS #112A) or roasts (IMPS #112A). Ribs designated as bone-in were fabricated into bone-in lip-on ribeye steaks (IMPS #1103) or roasts (IMPS #109E). External fat for all cuts was trimmed to 0.64-cm. All retail cuts were vacuum packaged and individually frozen at 21 d post-mortem for subsequent dissection, homogenization, and compositing of the separable lean and separable fat. Raw separable lean from each cut was composited to form samples that represented USDA Select and Choice quality grades. Nutrient analysis was conducted on composited samples using AOAC methodology for all FSIS required nutrients available. The nutrient composition (per 4 oz or 115 g serving; lean and fat) of raw USDA Select or Choice boneless lip-on ribeye steaks trimmed to 1/8-inch (0.64-cm) external fat is shown in Table 1. Ribs designated as boneless were fabricated into boneless lip-on ribeye steaks, roasts and bone-in ribeye roasts. An inverse relationship was noted for protein values, which were larger in USDA Select (P<0.05) retail cuts when compared to USDA Choice cuts. The generation of updated nutritional information will foster the development of nutrition labels that adequately represent beef currently available at retail.

Keywords: Beef, Nutrition, Retail

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Select % daily value</th>
<th>Choice % daily value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories, g</td>
<td>265</td>
<td>291</td>
</tr>
<tr>
<td>Fat calories</td>
<td>175</td>
<td>206</td>
</tr>
<tr>
<td>Total fat, g</td>
<td>19.4</td>
<td>29.8</td>
</tr>
<tr>
<td>Saturated fat, g</td>
<td>8.6</td>
<td>43.0</td>
</tr>
<tr>
<td>Cholesterol, mg</td>
<td>85.1</td>
<td>28.4</td>
</tr>
<tr>
<td>Protein, g</td>
<td>22.5</td>
<td>45.0</td>
</tr>
<tr>
<td>Calcium, mg</td>
<td>8.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>1.89</td>
<td>10.5</td>
</tr>
<tr>
<td>Sodium, mg</td>
<td>57.5</td>
<td>2.4</td>
</tr>
</tbody>
</table>

*Percent daily values based on 2000-calorie diet.

The use of bioelectrical impedance analysis to estimate red meat yield in calf-fed dairy-type steers
A. Voyles*, T. Lawrence, West Texas A&M University, Canyon, TX, United States

An exploratory observational study was conducted to evaluate the ability of bioelectrical impedance analysis as an objective method to predict salable red meat yield (%RMY) of calf-fed dairy-type steers. Forty-six calf-fed dairy-type steers composed of 38 Holsteins and 8 Jerseys were humanely harvested at the West Texas A&M University Meat Laboratory (Establishment # 7124) and utilized to quantify the ability of bioelectrical impedance analysis (%RMY) of the variation in percentage RMY. Twenty-three of the carcasses investigated were fed the β-adrenergic-agonist Zilpaterol Hydrochloride (ZH) and 23 received a control ration. The mean, minimum and maximum carcass weights were 380.5 kg, 265.9 kg, and 536.8 kg, respectively, while the mean USDA numerical yield grade was 2.86, resulting in an average %RMY of 61.92. The BIA source terminals were placed at the posterior end of the hitch bone and between the second and third ribs, respectively. The detector terminals were placed 10 cm inferiorly of the source terminals. Measurements included reactance (Xc, ohms) and resistance (Rs, ohms) using the Quantum X body composition analyzer (RJL Systems, Clinton Township, MI). Moreover, the distance between the two innermost detector electrodes (L, cm), post-harvest carcass weight (HCW, kg) and four derived carcass values that included electrical volume (Evol), reactive (XcD), resistive (RsD), and impedance (IMP) were included in the final regression analysis. The carcasses were subsequently fabricated into wholesale cuts common in the US beef industry for the calculation of %RMY. The equation of %RMY = 73.26605 + (0.58728 × Xc) − (0.20636 × Rs) + (0.04225 × XcD) was derived using step-wise regression, which accounts for 46.7% (P<0.001, RMSE = 2.857) of the variation in percentage RMY. These data suggest that BIA has the potential to improve the current methods of predicting percentage RMY in calf-fed dairy type steers.

Keywords: Bioelectrical impedance analysis, Dairy type steers, Saleable red meat yield

Meat Processing, Ingredient Technology and Packaging: General Abstract
An evaluation of the effectiveness of FreshCase® technology to extend the storage life of beef and pork
X. Yang*, D. R. Woerner, J. D. Tatum, J. N. Sofos, I. Geornaras, K. E. Belk, Colorado State University, Fort Collins, CO, United States

An evaluation of the effectiveness of FreshCase® technology to extend the storage life of beef and pork...
This research evaluated the effect of FreshCase®, a novel packaging technology that has been shown to extend the shelf life of whole muscle beef and ground beef, whole muscle pork and ground pork sausages by stabilizing fresh meat color. FreshCase® utilizes a high-barrier nitrite containing film in conjunction with vacuum packaging technology. Storage life was defined by the number of days required to reach an aerobic psychrotrophic bacteria plate count of $10^7$ log CFU/g, and all samples were stored and evaluated until storage life expired. The storage life for beef steaks stored in FreshCase® and control (vacuum sealed without nitrite in the package film) packages at 4 °C was 36 days; and the storage life for ground beef stored in FreshCase® and control packages at 4 °C was 12 days. The storage life for pork chops stored in FreshCase® and control packages at 1 °C was 48 days; and the storage life for ground pork sausages stored in FreshCase® and control packages at 4 °C was 19 days. Values for CIE $a^*$ (redness) were greater ($p<0.05$) for FreshCase®-packaged samples for both beef steaks and ground beef with the increase of storage time. Both pork chops and sausages stored in FreshCase® packages retained more acceptable redder color ($p<0.05$) than those stored in the control packages throughout storage. By the point at which spoilage was detected, off-odors of putrid, acid, sour and rancidity for FreshCase®-packaged beef samples were detected, but were present at very low concentrations. Likewise, by the point of spoilage, no differences ($p>0.05$) existed between samples in control and FreshCase® packages in all off-odors detection for both pork chops and sausages, and the intensities of off-odors were very weak. Also, beef and pork samples resulted in very low (1.19 malonaldehyde mg/kg and 0.55 malonaldehyde mg/kg, respectively) TBA values throughout storage. Therefore, utilization of FreshCase® technology in whole muscle beef and ground beef, whole muscle pork and ground pork sausages resulted in a more stable fresh red meat color with a low level of off-odors, and lipid oxidation. In addition, FreshCase® did not influence microbial growth in vacuum packaged samples.

Keywords: FreshCase®, Storage life, Beef and pork

---

**Effects of post-mortem fat injection and addition of oleo-resin garlic on palatability and willingness to pay for beef semitendinosus steaks**

L. Holmes*, K. Brooks, T. Lawrence, West Texas A&M University, Canyon, TX, United States

The objectives of this study were to determine if post-mortem mechanical addition of fat and oleo-resin garlic into beef semitendinosus would improve overall palatability and consumers' willingness to pay for steaks. Forty pairs of muscles (USDA Select; IMPS 171C) were collected from a commercial beef processor, trimmed, split into four equal halves and randomly assigned to either control, fat-injection (12.5%), fat-injection with 0.008% oleo-resin garlic, or fat-injection with 0.008% oleo-resin garlic after 14 days of post-mortem aging to determine if fat enhancement and flavor addition would improve overall palatability and consumer acceptance. Proximate analysis revealed fat-injected steaks with and without garlic averaged 4.1% less ($p<0.05$) moisture and 5.9% more ($p<0.05$) fat than non-injected control steaks. In-home consumer panelists rated (9-point hedonic scale; 1 = like extremely; 9 = dislike extremely) fat-injected steaks without garlic more ($P<0.05$) than non-injected controls and fat-injected steaks with garlic. Moreover, fat-injected steaks had Warner–Bratzler shear force values that were 2.61 N less ($P<0.05$) than control steaks. Cooking losses for fat-injected steaks were 4.79% greater ($P<0.05$) than non-enhanced control steaks. Consumers were willing to pay more ($P=0.01$) for fat-injected steaks without garlic ($\$12.11/\text{kg}$) than non-enhanced control steaks ($\$10.93/\text{kg}$); garlic flavor enhancement decreased ($P<0.01$) willingness to pay $\$8.92/\text{kg}$ and $\$7.68/\text{kg}$ for the fat-injected steaks with 0.004% and 0.008% garlic, respectively. This study suggests that postmortem injection of fat into semitendinosus improved palatability and increased consumer willingness to pay for eye of round steaks; however additive of garlic flavor did not improve palatability or add value.

Keywords: Semitendinosus, Palatability, WBSF

---

**Effects of various tenderization strategies on non-fed beef palatability and tenderness**

J. Canon*, B. Coty, R. Cope, L. Branhm, K. Braden, Angelo State University, United States

As non-fed beef tends to lack general palatability, new technologies aimed at increasing tenderness of underutilized cuts from these animals would benefit the current beef industry. The objective of this project was to evaluate the effects of exogenous enzyme combinations and with and without mechanical/blade tenderization on the deep pectoral (PEC: NAMP # 115D) and biceps femoris (FLAT: NAMP #171BLO6) from non-fed cow carcasses (n = 120/muscle) having a skeletal maturity ranging from C50 to D50. Muscles (n = 120) were randomly assigned to one of six enzyme treatments (n = 20/enzyme treatment). Enzymatic treatments included: BBA = bromelain and bacillus, BF = bromelain and ficin, BP = bromelain and papain, PBA = papain and bacillus, FP = ficin and papain, and C = control. All enzymatic treatments were conveyed in a standard base brine. Base brine formulation consisted of water, sodium phosphate, sodium chloride and calcium chloride, and muscles were pumped to 7.5% of green weight. Within enzyme treatment, samples were evenly assigned to mechanical tenderization or a non-mechanically tenderized control. Analyses included myofibrillar fragmentation (MFI), trained sensory analysis and oxidative stability (TBA). Deep pectoral (PEC) MFI values increased with enzymatic treatment ($P<0.001$) and tenderization method ($P=0.02$). The enzymatic treatment containing bromelain and papain had the greatest MFI value. Neither enzymatic treatment, nor tenderization method affected FLAT MFI values ($P=0.08$, $P=0.39$, respectively). In the PEC, enzymatic treatment affected trained sensory attributes including tenderness, juiciness, and flavor ($P<0.05$). Overall acceptability in the PEC was affected by enzymatic treatment ($P<0.001$), with the control sample markedly more acceptable over all of the enzymatic treatments. Initial juiciness ($P=0.004$), sustained juiciness ($P=0.002$), as well as initial and sustained tenderness ($P<0.001$) of the PEC were all affected by mechanical tenderization method. In the FLAT, mechanical tenderization method had no effect on initial tenderness, sustained tenderness, or overall acceptability ($P>0.05$). Enzymatic treatment had no effect on cook loss ($P>0.05$) but did have an effect on all other sensory attributes ($P<0.05$); the control enzymatic treatment was the juiciest and the least tender, with the least off flavor and the greatest overall acceptability. Enzymatic treatment affected FLAT TBA values ($P=0.04$), as bromelain and ficin treatment (BF) showed the greatest oxidation. However, PEC TBA was not affected by treatment, tenderization method, or treatment by tenderization method combinations ($P>0.05$). All cutlets that were applied with combinations of non-injected controls and fat-injected steaks without garlic, whereas tenderness (4±1.25) and flavor (6±2.0) were different for fat-injected steaks when compared to non-injected controls and fat-injected steaks without garlic. Moreover, fat-injected steaks had Warner–Bratzler shear force values that were 2.61 N less ($P<0.05$) than control steaks. Cooking losses for fat-injected steaks were 4.79% greater ($P<0.05$) than non-enhanced control steaks. Consumers were willing to pay more ($P<0.01$) for fat-injected steaks without garlic ($\$12.11/\text{kg}$) than non-enhanced control steaks ($\$10.93/\text{kg}$); garlic flavor enhancement decreased ($P<0.01$) willingness to pay $\$8.92/\text{kg}$ and $\$7.68/\text{kg}$ for the fat-injected steaks with 0.004% and 0.008% garlic, respectively. This study suggests that postmortem injection of fat into semitendinosus improved palatability and increased consumer willingness to pay for eye of round steaks; however addition of garlic flavor did not improve palatability or add value.

Keywords: Semitendinosus, Palatability, WBSF
D. A. Yates², M. F. Miller³, ³Texas Tech University, Lubbock, TX, United States, State University of Campinas, Campinas, Brazil, ⁴Merck Animal Health, DeSoto, KS, United States

USDA Select carcasses (n = 20) were chosen from beef steers fed ZH (0 or 8.3 mg/kg; DM basis) for 20 d to determine the effects of calcium chloride and zilpaterol hydrochloride (ZH) on color stability of semimembranosus. Inside rounds (IMPS #:168) from alternating sides were injected (INJ) with CaCl₂ (5%; 200 mM) at 72 h post-mortem, immediately vacuum packaged and stored at 2 °C. At 7, 14 and 21 d postmortem, a steak (1.3 cm) was obtained for color evaluation. The remaining portion was re-vacuum packaged and stored until the next interval. Steaks were overwrapped with polyvinyl chloride film and placed in retail cases for 3 d at 3 °C. The deep (DSM) and superficial semimembranosus (SSM) portions of steaks were evaluated initially (0 h) for color and L*, a* and b* values. Samples were evaluated every 24 h for display color, discoloration, and L*, a* and b* values. Metmyoglobin reducing activity (MRA) was assessed at 0 h retail display, and lipid oxidation (TBARS) was evaluated after 72 h of retail display. Initial color scores indicated 7 d aged DSM were more cherry red (P < 0.01) compared to 14 or 21 d. Similarly, SSM aged for 14 or 21 d was darker (P < 0.01) initially compared to 7 d. In addition, ZH and no INJ resulted in initial scores reflecting lighter cherry red DSM (P < 0.01), but ZH and INJ did not affect SSM (P > 0.10). Increasing aging period and feeding ZH resulted in greater (P < 0.01) initial L* values for DSM and SSM. Injection reduced (P = 0.02) initial L* values in DSM, but no effect (P = 0.10) was noted for SSM. For initial a* values in DSM, interactions between aging and ZH, as well as aging and INJ were detected (P < 0.03). Interactions between ZH and aging, as well as INJ and aging, were detected (P < 0.01) for trained color and discoloration scores of DSM and SSM throughout display. Score increases as postmortem aging increased, as a reflection of darker lean and greater discoloration. For steaks aged 7 d, color and discoloration scores were similar throughout display regardless of ZH or INJ; however, the effects of ZH and INJ were noted in steaks aged 14 and 21 d. ZH resulted in lower color and discoloration scores compared to no ZH, indicative of less darkening and discoloration. L* values of 21 d aged DSM and SSM were lower than 14 d aged steaks throughout display (P < 0.01). L* values increased due to ZH (P < 0.01), but were not affected by INJ (P > 0.10). MRA was not affected by ZH or INJ (P > 0.05). ZH supplementation had no effect (P > 0.05) on TBARS values; however, INJ resulted in greater (P < 0.05) TBARS values, indicating greater lipid oxidation. Overall, ZH supplementation offered a color advantage to semimembranosus steaks throughout display; however, CaCl₂ injection reduced color stability if samples were aged 14 d or more.

Keywords: Calcium chloride, Semimembranosus color, Zilpaterol hydrochloride

Reducing sodium usage in brine enhanced meat products through the application of high pressure processing
A. C. Lowder⁴, C. A. Mireles DeWitt, Seafood Research and Education Center and the Department of Food Science & Technology, Oregon State University, Astoria, OR, United States

The use of (HPP) for modifying functional properties of meat proteins is only recently being investigated. Studies have shown favorable gel characteristics and batter stability of comminuted products with reduced salt (NaCl) and/or sodium phosphate (SP) content when HPP is applied. To date, HPP application in whole muscle product has only been investigated in fresh, non-injected roasts. This goal of this project was to determine if color, fluid retention, and protein biochemical properties of brine injected whole muscle beef

Effects of postmortem calcium chloride injection on color stability and lipid oxidation of semimembranosus steaks from beef cattle supplemented with or without zilpaterol hydrochloride
M. R. Hunt², S. B. Pflanzer³, A. Rodas-Gonzalez³, J. N. Martin³, S. M. Knobel³, A. J. Garmyn³, J. C. Brooks³, B. J. Johnson³, J. D. Starkey³, R. J. Rathmann³, P. E. de Felicio³, J. M. Hodgson³, J. P. Hutcheson³, D. A.
could be maintained using reduced salt and/or SP brines in combination with mild HPP treatment. To carry out the study, beef strip loins were cut into thirds, injected to 110% initial weight with a brine containing salt (0, 2 or 4% of brine) and/or SP (0 or 4% of brine), and cut into 2.54 x 2.54 cm pieces. Strips were vacuum packaged, pressurized (0.1, 0.152 or 303 MPa; 1 min) and immediately analyzed for instrumental color, purge loss, water holding capacity (WHC), pH, protein solubility and sulphydryl (SH) content. The experiment was structured as a split plot with 5 replications of the whole plot and 30 replications of the subplot. The whole plot was a 2 x 3 (SP x salt) factorial in a randomized incomplete block design; pressure levels were assigned in the subplot. Lightness (L*) and redness (a*) were both increased (P < 0.05) by pressure treatment at 303 MPa. Purge losses were decreased (P < 0.05) by 1.84% due to SP use, but were not affected by HPP application; there was also a trend of decreasing purge with increasing salt level. Water holding capacity tended to be lower (P < 0.057) at 303 MPa compared to 152 MPa, however this effect was mitigated by the use of 4% salt or SP. Salt and SP both increased (P < 0.05) WHC regardless of pressure level. Pressure at 303 MPa increased (P < 0.05) pH of samples not treated with SP; SP also increased (P < 0.05) pH. Total and reactive SH were greater (P < 0.05) due to SP at 0.1 MPa and at 153 or 303 MPa regardless of SP level. Myofibrillar (salt soluble) protein solubility was decreased (P < 0.05) at 303 MPa compared to 0.1 and 152 MPa whereas sarcoplasmic (water soluble) protein solubility was unaffected by any variable. This study suggests that quality attributes of brine enhanced products are negatively affected by pressure application at or above 303 MPa, but seemingly unaltered by treatment at 152 MPa.

Keywords: High pressure processing, Sodium, Injection

Shelf life extension of enhanced fresh chicken using cultured sugar and vinegar
H. Kroon*, D. Wach, L. van Dijk, P. Sijtsema, S. Kumar, Purac, Gorinchem, The Netherlands

Aerobic organisms mainly psychrotrophs, such as Pseudomonas species, acinetobacter and Psychrobacter species are the predominant spoilage organisms in aerobically packed fresh meat. In specific case, Pseudomonas causes putrid spoilage of the meat. The objective of this study was to evaluate the anti-microbial performance of a product containing cultured sugar with vinegar on aerobic plate count and Pseudomonas counts in aerobic packed meat through 25 days of storage at 4 °C and its sensory impact on the product. PuraQ Verdad NV55, the natural antimicrobial product contains a mixture of natural organic acid salts, vinegar, peptides and sugars. In this study, chicken breast meat was cut into ca. 20 g pieces and randomly allotted to 3 treatments each enhanced with water, salt, phosphates and containing different levels of antimicrobial: (A) Control, (B) 2% cultured sugar/vinegar and, (C) 3% cultured sugar/vinegar to 115% of fresh weight. Each treatment was independently tumbled at 2 °C; twenty pieces were randomly selected and individually placed into a stomacher bag and stored at 4 °C for microbiological analyses. Two replicates for each treatment were prepared and incubated for 20 days. Pseudomonas aerobic plate counts (APC) were measured using tryptone soy agar (TSA) (Oxoid) and Pseudomonas media (agar base + CFC selective agar supplement) (Oxoid), respectively. For microbial sampling, 20 g of meat sample was used and incubated using specified incubation conditions. Plating was done ca. 3 days thereafter until log 7 of Pseudomonas counts was reached. The use of 2 and 3% cultured sugar/vinegar in the chicken breast showed significant inhibition (p < 0.01) on the APC and Pseudomonas counts compared to control treatment during 25 days of incubation. The control treatment reached the APC counts of 7 log CFU/g in 5 days. In comparison, treatments with 2 and 3% cultured sugar/vinegar had APC counts of ca. 7 log CFU/g for 10 and 14 days, respectively. Pseudomonas populations in the control treatment reached 8 log CFU/g within 5 days of incubation. The treatments with 2 and 3% cultured sugar/vinegar reached 7.5 and 6.9 log CFU/g after 25 days of incubation, respectively. For the sensory impact evaluation, a descriptive taste test was performed. The results from this taste test indicated that the compositions with cultured sugar/vinegar formulation had a neutral chicken taste and a slight salty and brothy taste. Results from this study indicate that the use of cultured sugar/vinegar antimicrobial product, the shelf life of fresh chicken can be extended by 150% (9 days) compared to control treatment. By the use of cultured sugar/vinegar the spoilage is delayed and Pseudomonas growth is suppressed compared to the control treatment without significant taste impact. This study provides the meat industry with a natural antimicrobial intervention for the extension of shelf life of meat.

Keywords: Pseudomonas, Antimicrobial, Natural preservation

Effect of radio frequency technology on heating profile of beef homogenate systems with different combinations of lean to fat ratios
G. Nagaraj*, A. Mohan, R. Singh, Y.-C. Hung, University of Georgia, Athens, Georgia, United States

The application of radio-frequency (RF) technology as an innovative heating technique for food products has been well documented. The dielectric properties of foods are an important factor in RF heating. However, there is limited information available to meat scientists on the dielectric properties and heating characteristics of ground beef homogenates associated with RF heating. Specifically, the heating profiles of beef homogenate systems with respect to heating rates and process conditions are not yet reported. Therefore, the objectives of this study were to 1) determine how initial temperature (IT) of heating medium affects the RF heating profile of beef homogenate systems of varying lean to fat compositions, and 2) investigate the effects of heating characteristics of RF on beef homogenate systems of varying lean-to-fat compositions. A model system was developed to study the RF heating characteristics and processing conditions of different beef homogenate blends. Beef homogenates were prepared by homogenizing different ground beef blends of lean to fat ratios (90:10, 85:15, 80:20, 73:27) with phosphate buffer (100 mM, pH 6.0) at 1:3 ratio (w/w). The beef homogenates were packaged in RF resistant plastic bags and completely immersed in water in a RF heating tray fitted with a RF resistant plastic grid to hold the bags down. Water filled in the tray was used as the RF heating medium. Water was pre-heated to three different ITs (10 °C, 25 °C, 55 °C) prior to RF heating. The RF heating treatment at 0.5 A current was started immediately after completely submerging the homogenate bags in water at individual ITs. RF heating was continuously monitored by fiber optic probes inserted at the center of each of the bags. Heating was stopped once the homogeneous bags reached the target temperature (55 °C). After completing RF heating, color of the samples (CIE La*b*) was measured using the Hunterlab MinScan Spectrophotometer. Results indicate that heating behavior of different beef homogenate blends differed during RF heating. Additionally, individual ITs impacted the RF heating profiles of homogenate blends differently. During RF heating at IT of 10 °C, 85:15 homogenate blend reached the target temperature (55 °C) at a faster rate (~15 min) compared to the other blends (~17–25 min). Similarly, at IT 25 °C, 90:10 homogenate blend reached the target temperature (55 °C) faster (6 min) than the other blends (~17–18 min) and at IT 55 °C, 80:20 homogenate blend reached the target temperature (55 °C) quicker (5 min) than the other blends (~6–9 min). Water at IT 55 °C
was found to be the most effective heating medium for heating all the beef homogenate blends to the target temperature at a faster rate compared to ITs 10 and 25 °C. Color data showed that 90:10 homogenate blend had the highest a*-value compared to the other blends. The results of this study suggest that the RF heating behavior of different beef blends will vary with respect to changes in IT of the heating medium. Results also indicate that water at IT of 55 °C was most effective in terms of faster heating for all the beef homogenate blends, followed by IT of 25 and 5 °C. Color measurements indicate that beef homogenates of higher lean-to-fat compositions retained higher a*-values.

Investigation of quality attributes of no-nitrate or nitrite-added bacon
A. N. Gipe*, E. W. Mills, C. R. Raines, K. B. Kephart, C. N. Cutter, Pennsylvania State University, University Park, PA, United States

Brine injected bellies were used to evaluate the effects of natural curing ingredients on bacon color and residual nitrite. Curing brines were formulated as follows: Treatment A (natural nitrate at 0.2%; vegetable juice powder) with starter culture and treatment B (natural nitrate at 0.4%; vegetable juice powder) with starter culture were used as per manufacturer’s recommendations. Treatment C (natural nitrite; celery baste) and treatment D (natural nitrite with natural cure accelerator; celery baste and cherry baste) were utilized as recommended by the manufacturer. Treatment E was composed of sodium nitrite (120 ppm) and sodium erythorbate (550 ppm) (conventionally cured control). Treatment F (no cure) was composed of salt, sugar, and water. In all instances, salt and sugar were added to 20% and 5% of brine formulation, respectively. Whole bellies were injected with a target pump of 10%. Prior to smoking a 2 inch portion of the belly was removed for initial color measurement and nitrite analysis. Treatments A and B were incubated in the smokehouse at 43 °C for 75 min. Subsequently all treatments were cooked and smoked to an internal temperature of 53 °C. Following approximately 24 h of chilling, bellies were sliced and vacuum packaged with 5 random slices of bacon per package. Sampling occurred on days 1 (packaging day), 3, 7, 14, 21, 28, 35, and 42 of study. Two packages from each treatment were placed in coffin display cases (4 °C) (GE Ecolux F40SP35, 3500K, 3870 lx) to simulate retail display and were used for instrumental color measurement (L*, a*, b*). Remaining packages for nitrite analysis were without illumination at 4 °C. Three packages for each sample day were frozen (−15 °C) until nitrite analysis was done. There were no differences (P>0.05) in lightness for initial or day 1 color among all treatments. On days 7, 14, 21, and 35 L* values were greater (P<0.05) for treatment C than treatment E while all other treatments (A, B, D, F) were not different. Treatment C was lighter (P<0.05) than treatment E on days 3, 7, 14, 21, 28, 35, and 42. Treatments C, E, and F were less red (P<0.05) than treatments A and B for initial color. There were no differences on day 1 for a* values. Treatment E was redder (P<0.05) at days 3, 7, 14, 21, 28, 35, and 42 than treatments C and F. Initially b* values were greater (P<0.05) in treatments A and B than treatments C, E, and F. Days 14, 21, 28, 35, and 42 had no differences in yellowness for all treatments. Treatment E had significantly greater residual nitrite content than all other treatments for initial and days 1, 3, 7, 14, 21, 28, and 42. However A, B, C, D, and F were not different from each other for initial and days 1, 7, and 42. On day 35 of storage treatments B and E were not different from each other, but had greater (P<0.05) residual nitrite content than all other treatments (A, C, D, F). On days 21 and 35 treatments A and B had greater (P<0.05) residual nitrite content than treatments C, D, and F. No-nitrate or nitrite-added bacon achieved similar color characteristics as sodium nitrite cured bacon, but redness faded more rapidly in the no-nitrate or nitrite-added bacon than sodium nitrite cured bacon. This could lead to lower consumer acceptance. Also, natural nitrate cured bacon can result in residual nitrite content similar to sodium nitrite bacon.

Keywords: Nitrite, Bacon, Color

The impact of dry distillers grains on the quality of processed meat products
C. E. Ohman*, B. Van Hemelryk, A. M. King, S. Y. Park, M. P. Richards, J. R. Claus, J. J. Sindelar, University of Wisconsin, Madison, WI, United States

The highly unsaturated dietary fat that is found in dry distillers grains with solubile (DDGS), which are often used as a component of swine diets, can lead to changes in the characteristics of pork fat, namely resulting in softer, less oxidatively stable tissue. While these changes have been documented in fresh meat, the effect of this altered fat composition in processed meat products has not been well defined. The objective of this study was to determine the impact that meat from pigs fed different diets of DDGS had on the quality of processed meat products. Raw materials were sourced from pigs fed one of five diets/treatments (TRT 1: corn/soy; TRT 2; 33% DDGS throughout growing period until harvest; TRT 3: 33% DDGS from 25 kg to 91 kg body weight [BW], then corn/soy until harvest; TRT 4: 33% DDGS (29 kg–59 kg BW), 20% DDGS (59 kg–91 kg BW), 11% DDGS (91 kg-harvest); TRT 5: 20% DDGS throughout growing period until harvest). Iodine value was measured and used to determine the degree of unsaturation of Boston butts and bellies subsequently utilized for the manufacture of bratwursts and bacon (following typical industry procedures). Bratwursts were stuffed in natural hog casings and packaged in Styrofoam trays with oxygen-permeable overwrap film. The packages were frozen for a period of 7 days, thawed, and then displayed under fluorescent lights (200 foot candles) for an additional 14 days to determine oxidative color stability. External and internal CIE L*a*b* color values were measured at days 0, 7, and 14. Lipid oxidation was determined using two indicators: peroxide value of raw bratwurst and hexanal value of cooked bratwurst. Texture profile analysis of the cooked bratwurst was measured with an HDI Texture Analyzer using a double compression method, and fat firmness of unsliced smoked bacon was measured using a puncture test. Bacon slice integrity was quantified by stretching raw slices and measuring break-points. Iodine values for both Boston butts and bellies varied by treatment, with increased levels of dietary DDGS corresponding to a greater degree of unsaturation. During lighted display of bratwursts, the external color faded to brown by day 7 for all TRTs, indicating that oxidation had occurred. Both peroxide and hexanal values indicated that TRT 1 was more stable (p<0.05) from lipid oxidation by day 7 than the treatments that contained DDGS, and TRTs containing DDGS had similar levels of lipid oxidation at day 7. No differences (p>0.05) were found in cook yield across treatments for bratwursts or bacon. Dimensions of bellies before and after smoking as well as bacon slice integrity were not different. Texture profile analysis of the cooked bratwursts indicated that TRT 1 had greater hardness and chewiness measurements (p<0.05) than all other TRTs. Texture analysis of bacon fat indicated that TRT 1 and TRT 4 possessed firmer fat than all other TRTs (p<0.05). This study demonstrated that at the dietary levels investigated, DDGS can negatively impact certain quality characteristics of fresh bratwursts and bacon.

Keywords: Fat quality, Processed meats, Distillers grains
Effects of rosemary extract application method on the shelf life of high-oxygen modified atmosphere packaged ground beef

K. R. McCullough*, J. N. Martin, M. F. Miller, J. C. Brooks, Texas Tech University, Lubbock, TX, United States

Ground beef comprises a large proportion of the beef retail case; however, its susceptibility to oxidation and discoloration often results in decreased shelf life and value. Antioxidant compounds, such as rosemary extract (RE), are often incorporated to aid in the maintenance of desirable lean color. Although the benefits of RE are widely known, further research is needed to determine optimum application methods. Three days after production (d 3) at a commercial processing, finely ground beef chubs (80% lean) were obtained and allotted to three RE application treatments: control (CON; no antioxidant); topical spray application (SA); and direct application (DA). Control and SA ground beef were portioned into loaves (850 g) and placed in trays. Control samples received no treatment while SA ground beef loaves were topically sprayed with a 10% solution of RE at a level not to exceed 0.50% of total package weight. For the DA treatment, a 10% solution of RE was added to ground beef at 0.45% (wt/wt) prior to mixing and portioning into loaves. Loaves from all treatments were packaged in high-oxygen (80% O$_2$/20% CO$_2$) modified atmosphere packages. Packages were stored in the dark for 6 d (d 3 through 9 post-production) prior to a 6-d retail display period (d 9 through 15 post-production). Instrument color ($L^*$, $a^*$, $b^*$, saturation), metmyoglobin reducing ability (MRA), thiobarbituric acid reactive substances (TBARS), aerobic plate count (APC), pH, and proximate composition were analyzed on samples on d 3, 9, 11, 13, and 15 post-production. Trained panelists evaluated ground beef color on d 9 through 15 post-production. Direct application of rosemary (DA) produced ground beef packages which were brighter red than CON and SA packages (greater saturation index values and $L^*$ values; $P<0.05$). Moisture content (%) was greater in DA compared to SA (62.19 versus 61.26; $P<0.05$), which was greater than CON (60.58; $P<0.05$). Lipid oxidation was decreased in ground beef with RE, regardless of application method; however, DA ground beef had decreased TBAR values ($P<0.05$) than SA. Though trained color scores were similar at the beginning of retail display, panel scores indicated DA ground beef maintained more desirable color than CON or SA through d 15 post-production. Instrument color and MRA values indicated ground beef discoloration increased ($P<0.05$) as post-production length (d) increased. Similarly, APC increased ($P<0.01$) as post-production length (d) increased. Ground beef with RE, regardless of application method, was more red than CON (greater $a^*$ values; $P<0.05$). Overall, the color data indicates RE improved ground beef shelf-life. Furthermore, our results suggest that application of RE directly to ground beef was more beneficial to color stability and shelf-life than topical application after portioning.

Keywords: Beef, Modified atmosphere packaging, Rosemary extract

Enhancing the surface color of beef striploin steaks through simulated distribution temperatures and a topical application of rosemary

S. R. Greathouse*, J. T. Sawyer, B. D. Lambert, D. H. Kattes, *Tarleton State University, Stephenville, TX, United States, Texas AgriLife Research, Stephenville, TX, United States

The use of a generally recognized as safe (GRAS) ingredient technology rosemary was used in an effort to overcome the potential degradation of the surface meat color throughout the retail display period. Beef striploin subprimals (NAMP 180) were purchased from a major meat packer 3 d post fabrication and randomly assigned to a simulated distribution temperature ($-1.1 \degree$C and 4.4 $\degree$C (Exp. 1), $-2.2 \degree$C, 3.3 $\degree$C, and 8.8 $\degree$C (Exp. 2)) for 7 d in the absence of light. Following the 7 d distribution period, subprimals were removed from vacuum packages, cut into equal halves, then randomly allotted to either 0% or 0.25% rosemary (Rosemary, Fortium-10, Kemin Ingredients, Des Moines, IA). Striploin subprimals were fabricated into six (n = 6) 2.54 cm-thick steaks, using a Hobart meat slicer (Model 3818, Troy, OH, USA). Steaks were weighed, placed onto a Styrofoam tray (Sealed Air Corp, Cryovac Food Packaging Division, Duncan, SC, USA) with an absorbent pad (Sealed Air Corp, Cryovac Food Packaging Division, Duncan, SC, USA), and a 25% rosemary solution was applied topically at 0.25% of steak green weight to assigned steaks, overwrapped with a poly-vinyl chloride film (O2 transmission rate = 14,000 cm$^3$ O2/m2/24 h/ atm; Koch Supplies Inc., Kansas City, MO, USA), individually identified, and stored in a three-tiered retail display case operating at 2 $\degree$C under 1600 lx deluxe warm white fluorescent lighting (Philips Inc., Somerset, NJ, USA). Data were analyzed as a completely randomized design with the mixed model procedure of SAS (SAS Inc., Cary, NC). For all variables, least-square means were generated, and when significant ($P<0.05$) F-values were observed, least square means were separated with the PDIFF option. Steaks were evaluated daily at 17:00 h for instrumental color ($L^*$, $a^*$, and $b^*$) and trained visual sensory color. On days 0, 3, 5, and 7 steaks designated for microbial spoilage were removed and sampled for aerobic spoilage growth (aerobic plate count, APC) on the same days as microbial sampling, steaks assigned to Thiobarbituric Acid Reactive Substances analysis were removed, vacuum packaged and frozen at $-23.3 \degree$C until laboratory analysis could be completed. The application of 25% rosemary topically did not reduce TBARS values ($P>0.05$) during the simulated retail display. Instrumental redness ($a^*$) values decreased on steaks treated with rosemary and had less sensory rated discoloration scores throughout the retail display period ($P<0.05$). Steaks stored in warmer distribution temperatures such as 6.1 $\degree$C and 4.4 $\degree$C showed greater ($P<0.05$) $a^*$ values during simulated retail display conditions. Rosemary treated steaks had darker rated sensory surface color as well as ($P<0.05$) instrumental oxymyoglobin values across the retail display period. Moreover, neither storage temperature nor rosemary application reduced ($P>0.05$) microbial spoilage. Results from this study suggest that a 25% topical application of rosemary does not drastically improve the surface color or limit the lipid oxidation deterioration of beef striploin steaks.

Keywords: Antioxidant, Sensory color, Instrumental color


Effects of dietary inclusion of ethanol co-products on lipid oxidation in cured and uncured ready-to-eat beef patties

N. Dierks*, T. Jones, D. Schroeder, G. Sullivan, University of Nebraska, Lincoln, NE, United States

Growth of the ethanol industry has resulted in increasing amounts of ethanol co-products (ECP) being fed to livestock. Researchers have reported that feeding ECP results in an increase in polyunsaturated fatty acids, which could result in increased lipid oxidation. Studies have looked at the effects on lipid oxidation in fresh beef samples; it is unknown how oxidation is affected in ready-to-eat beef products. The objective of this study was to determine if feeding ECP impacts lipid oxidation in cured and uncured ready-to-eat beef patties. Four diets, IMPS #114, were collected from each of 4 dietary treatments from a $2 \times 2$ factorial dietary regimen. Cattle were fed a diet supplemented (0.5 kg ECP/kg body weight/day) or not supplemented with ECP during backgrounding (B) and then finished (F) on a diet with (35% ECP) or without ECP. The 4 dietary treatments were: Control (CON),
On day 7 postmortem, the dorsal portion (30–35 cm, 5–5.5 kg) was removed from each beef clod, course ground separately, and split into two, 2,27 kg batches. One portion (uncured) was mixed with salt (1.5%) and sodium phosphate (0.25%). The other portion (cured) included salt (1.5%), sodium phosphate (0.25%), sodium nitrite (155 ppm), and sodium erythorbate (550 ppm). Samples were reground and 113 g patties were formed and refrigerated. The following day, patties were cooked on a belt grill to a target endpoint temperature of 75 °C. Samples were stored in 3.8 L zipper bags and placed in dark storage in a 4 °C walk-in cooler. On the day of sampling, samples were homogenized and placed in a −80 °C freezer until analysis. Lipid oxidation was analyzed by measuring thiobarbituric acid reactive substances (TBARS) on the day of cooking and every 2 days through 14 days of post cooking storage. Proximate composition (moisture, ash, fat, and protein calculated by difference) was evaluated on day 0. Results were analyzed using the Proc GLIMMIX procedure of SAS. No differences (P > 0.05) in proximate composition were found among dietary treatments. Cured samples had greater ash (P = 0.0138) than uncured samples but there were no other differences in proximate composition. TBARS values increased (P < 0.001) with storage in uncured samples. Dietary treatments had a significant effect (P = 0.002) on lipid oxidation for uncured samples. ECP supplementation during backgrounding resulted in greater (P < 0.001) lipid oxidation than when not supplemented. ECP-B had the greatest lipid oxidation and was only statistically similar (P > 0.05) to ECP-BF. ECP-F had the least lipid oxidation and was less (P < 0.05) than all other dietary treatments. CON, not fed ECP at any time, had an intermediate level of lipid oxidation and was similar to ECP-BF. In cured patties, dietary treatment and day effects were not significant (P = 0.0892 and 0.1852, respectively). Antioxidant activity of sodium nitrite counter any increases in lipid oxidation associated with feeding ECP. These findings suggest that feeding ECP impacts lipid oxidation in ready-to-eat beef but the effect depends upon when ECP are fed. Feeding ECP during backgrounding increased lipid oxidation while feeding ECP during finishing resulted in a decrease in lipid oxidation.

Keywords: Summer sausage, Sodium chloride, Meat processing

Impact of lean block extraction using decreased sodium chloride addition on summer sausage characteristics

J. M. Pleitner*, R. E. Weyker, J. R. Claus, University of Wisconsin-Madison, Madison, WI, United States

Sodium chloride (salt) is the most widely used chemical in processed meats, as it performs a wide array of functions. Salt acts to enhance meat flavor and lengthen shelf-life, and extracts myofibrillar proteins to provide lean binding and fat stabilization. Human health studies have established the unhealthfulness of a high sodium diet and consumers are demanding low-salt products. However, sodium reductions in processed meats must be carefully evaluated to prevent negative impacts on product quality. Summer sausage is a fermented product which relies on a bacterial starter culture to acidify the meat and provide product stability. Sodium chloride and sodium nitrite aid in this preservation. The objective of this research was to determine if similar drying and textural properties could be achieved in lower salt formulations if a portion of the lean meat served as the main source of extracted myofibrillar proteins. A control batch (Con: 2.3% salt) and two treatments (TRT1: 2.5% salt reduction; TRT2: 50% salt reduction) were compared in this replicated (n = 2) study. Con served as the base formulation for all treatments, and all ingredients were added to the whole meat block. For all groups, the meat block was composed of 50% lean beef (90/10) and 50% beef (70/30). Then, 50% of the lean portion (25% of total meat weight) was combined with salt according to TRT to extract and activate the lean meat. The remaining meat block was mixed with the spices. Both portions were then combined and mixed with starter culture, stuffed into fibrous casings, and thermally processed. Finished summer sausages were stored at 4 °C for 48 h prior to analysis. Cook yield was decreased (P < 0.01) in both TRTs compared to Con. Con, TRT1, and TRT2 all exhibited similar (P > 0.05) CIE L* (lightness), a* (redness), color intensity (Chroma C), and hue angle. Spectrophotometric determination of nitrosylhemin-chrome (rNIT) using a ratio of percent reflectance at 650 nm/570 nm was studied and no differences between Con and both TRTs (P = 0.05) were found. Final pH of Con and both TRTs was also similar (P < 0.05). Although Con had less moisture than TRT1 and TRT2 (P < 0.05), water activity (a*) across treatments was similar (P > 0.05). Decreasing the salt content affected the texture profile of the TRTs. A texture analyzer was used to determine sample hardness, cohesiveness, and springiness. Con and TRT1 had increased hardness values (P < 0.001) relative to TRT2, and Con and TRT1 were similar (P > 0.05). Cohesiveness of Con was greater (P < 0.001) compared to TRT1 and TRT2, and TRT1 had an increased cohesiveness (P < 0.05) versus TRT2. Springiness value of Con was increased (P < 0.01) compared to TRT1 and TRT2, which were not different (P > 0.05). This data indicates that while reducing sodium did not have an effect on color, pH, and a*, it did significantly change the cook yield, moisture content, and textural properties. Altered processing procedures may not provide adequate protein extraction at reduced salt levels.

Keywords: Ethanol co-products, Ready-to-eat beef, Lipid oxidation

Quality, yield, shelf-life, and tenderness of pork loins enhanced with either a salt and phosphate brine, a salt and pork protein solution, or a salt, vinegar, and pork protein solution

M. M. Miller*, T. D. Pringle, University of Georgia, Athens, GA, United States

Clean labels and sodium reduction are two primary concerns for today’s consumers. This study compared the ability of a pork protein solution (PPS) to substitute for a salt/phosphate (CTL) marinade in enhanced pork loins by measuring quality, yield, shelf-life, tenderness, and sensory traits. Pork protein solutions were made by chopping lean pork trim in water (20% w/w) and then lowering the pH to 3.8. The fat was skimmed from the solution and the pH was raised to 7.3. Loins (n = 78) were sorted by weight, pH, marbling score, and objective color into three groups of similar initial quality. Loins were injected to approximately 113.0% of initial weight with either CTL brine (0.35% salt, 0.35% phosphate), salt and PPS (0.35% salt in PPS), or salt, vinegar, and PPS (0.35% salt and 0.13% dried vinegar in PPS). Loins (n = 14 per treatment) were then sliced and retail display characteristics (n = 3 chops per loin) were measured during a 5-d retail display. Cooking, tenderness, and sensory attributes (d 12 post-fabrication) were evaluated on four 2.5-cm chops. Proximate analysis and sodium content were measured. Finally, absorbic plate count and counts for coliforms, Pseudomonas, generic Escherichia coli, lactic acid bacteria, and Enterobacteriaceae were measured after 28, 30, or 32 d of storage (4 °C, n = 4 per treatment/ storage time). Proximate data, sodium content, cooking, tenderness, and sensory traits were analyzed using oneway ANOVA. Microbial data were analyzed using two-way ANOVA with treatment and storage time as main effects. Retail display data were analyzed using PROC MIXED with loin as a random variable. Objective color, marbling, pH and purge loss did not differ (P > 0.10) between treatments. Chops injected with CTL brine showed less (P < 0.01) retail purge than chops injected with either PPS. Retail color was not affected (P > 0.10) by brine composition. Cook time, slice shear force (kgf),
raw odor, sensory tenderness, and non-pork flavor intensity did not differ \((P>0.10)\) between treatments. Thaw loss and total loss were greater \((P<0.05)\) in chops from PPS loins compared to chops from CTL loins; however, cook loss was only greater in chops from loins injected with salt, vinegar and PPS compared to CTL. Sensory juiciness, pork flavor intensity and saltiness scores were higher \((P<0.05)\) in CTL than either PPS. Moisture and lipid content did not differ \((P>0.10)\) between treatments. As expected, loins enhanced with CTL brine had greater \((P<0.01)\) sodium content \((\text{ppm})\) than loins injected with either PPS. Loins injected with salt, vinegar and PPS had decreased \((P<0.03)\) aerobic plate counts than loins injected with either the CTL brine or the salt and PPS. Enterobacteriaceae counts were reduced \((P<0.04)\) in loins enhanced with salt, vinegar, and PPS compared to those enhanced with salt and PPS. There were advantages in microbial shelf-life of loins enhanced with salt, vinegar and PPS compared to loins injected with CTL or salt and PPS. With consumer trends towards reduced-sodium meat products, PPS injection appears to have advantages over traditional enhancement technologies. However, additional research should be conducted to improve the yield characteristics of PPS-injected pork products.

**Keywords:** Pork, Enhancement, Protein solution

---

**Meat Quality: General Abstract**

**Effect of dietary n−6 and n−3 fatty acid sources on nutritional value of intramuscular fat of Mahabadi kids**

Mir Hossein Najafi*, Saeed Zeinoldini, Mahdi Ganjkhaniou, Hossein Mohammadi, Abozar Najafi, Department of Animal Science, University College of Agriculture and Natural Resources, University of Tehran, Karaj, Alborz, Iran

In recent years the fatty acid composition of foods has become more important as consumers have become more aware of the relationships between dietary fat and the incidence of lifestyle diseases, notably coronary heart disease. Thus, there is incentive for the production of meat containing increased proportions of fatty acids perceived as healthy. The aim of this study was to determine effects of supplemental soybean oil or fish oil on nutritional indices of intramuscular fat of male growing kids. Twenty-four Mahabadi goat kids \((BW=19.43\pm1.2\ \text{kg})\) were assigned to three equal groups and received one of three dietary treatments as follows: control \((\text{CO})\), soybean oil \((\text{SO})\) or fish oil \((\text{FO})\). All three diets contained the same ingredients and were isonitrogenous and isoenergetic, but contained different fat sources. Prilled palm-oil \((\text{high in C16:0})\), soybean oil \((\text{high in C18:2})\) and fish oil \((\text{high in EPA 20:5})\) were supplemented at \% DM to control, soybean oil and fish oil diets, respectively. Kids were allowed ad libitum access to water and offered feed twice daily for 12 weeks. After 84 d, kids were slaughtered, non-carcass components were removed, and then carcasses were chilled at 4 °C for 24 h. The longissimus dorsi muscle was dissected for chemical analysis of fatty acid composition. To slaughter, non-carcass components were removed, and then carcasses were chilled at 4 °C for 24 h. The longissimus dorsi muscle was dissected for chemical analysis of fatty acid composition. To evaluate the effects of treatments of nutritional value of intramuscular fat, P/S and \(n−6/n−3\) fatty acid ratio were determined. Data were analyzed as a completely randomized design using the General Linear Model (GLM) procedure of the Statistical Analysis Software package \((\text{SAS Institute, 2002})\). Least-square means were computed and tested for differences by Tukey’s test. Differences of least squared means were considered to be significant at \(P<0.05\). P/S ratio was significantly higher \((P<0.001)\) in the SO treatment than in control or FO treatments. FO supplementation led to lower \(n−6/n−3\) ratio \((P<0.001)\) in intramuscular fat. The results demonstrate that the use of fish oil is a nutritional strategy to improve the health claimable long-chain omega-3 fatty acid content and \(n−6/n−3\) ratio in goat meat.

**Keywords:** Fat supplementation, Intramuscular fat, Goat

---

<table>
<thead>
<tr>
<th>Diets</th>
<th>Control</th>
<th>Soybean oil</th>
<th>Fish oil</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFA</td>
<td>41.1a</td>
<td>35.7b</td>
<td>40.2a</td>
<td>1.03</td>
<td>*</td>
</tr>
<tr>
<td>MUFA</td>
<td>58.8b</td>
<td>64.2a</td>
<td>59.8a</td>
<td>1.03</td>
<td>*</td>
</tr>
<tr>
<td>PUFA</td>
<td>4.7b</td>
<td>7.4a</td>
<td>5.4b</td>
<td>0.36</td>
<td>***</td>
</tr>
<tr>
<td>P/S</td>
<td>0.11a</td>
<td>0.21a</td>
<td>0.13b</td>
<td>0.007</td>
<td>***</td>
</tr>
<tr>
<td>n−6</td>
<td>4.1b</td>
<td>6.2a</td>
<td>3.8b</td>
<td>0.34</td>
<td>***</td>
</tr>
<tr>
<td>n−3</td>
<td>0.7b</td>
<td>1.2b</td>
<td>1.5b</td>
<td>0.04</td>
<td>***</td>
</tr>
<tr>
<td>n−6/n−3</td>
<td>5.5a</td>
<td>4.8a</td>
<td>2.4b</td>
<td>0.29</td>
<td>***</td>
</tr>
</tbody>
</table>

\(\text{SFA}\) and \(\text{MUFA}\) \(\text{SEM}\)

\(\text{P}>0.05\); *, \(p<0.05\); ***, \(p<0.001\).

---

**Evaluation of instrumental color characteristics of ground beef processed from beef trimmings decontaminated using lauric arginate accompanied by other antimicrobials**

P. N. Dias-MÔrse, F. W. Pohlman*, J. A. McDaniel, R. D. Guidry, C. L. Coffman, T. L. Devine, University of Arkansas, Fayetteville, AR, United States

Although application of pre-grinding antimicrobial interventions can enhance microbial safety of ground beef, antimicrobials can have a negative impact on ground beef color properties. Lauric arginate is a novel antimicrobial compound that can be used as a bactericidal agent against pathogenic bacteria on fresh beef surfaces. This study evaluated ground beef instrumental color properties when lauric arginate \((\text{LA})\) alone or followed by water \((\text{LAW})\), 0.4% cetylpirinidium chloride \((\text{CPC})\), 4% sodium metasilicate \((\text{LAN})\), 10% trisodium phosphate \((\text{LAT})\) or 0.02% paraetric acid \((\text{LAP})\) was applied to decontaminate beef trimmings prior to grinding. Inoculated \((\text{Escherichia coli and Salmonella})\) 105 CFU/ml beef trimmings, spray treated \((-0.1\ \text{ml/g})\) with assigned antimicrobial treatments \((1.6\ \text{kg/treatment/replicate}; 3\ \text{replicates/treatment})\), untreated inoculated control \((\text{INCON})\) and untreated uninoculated \((\text{CON})\) control trimmings were ground twice and 200 g of individual samples was placed on plastic foam trays and over wrapped with polyvinyl chloride film. The packages were stored under simulated retail conditions \((4 °C)\) until sampled on days 0, 1, 2, and 3 of display for CIE \(L^*\), \(a^*\) and \(b^*\) measurements \((n=3/\text{sample})\) using Hunter lab mini scan illuminant A/10° observer. The ground beef samples processed from LA, LAN, LAT and LAP had similar lightness \((P>0.05)\) compared to CON. The LA and LAW treatments were more \((P<0.05)\) red \((a^*)\) compared to all the other treatments and control samples. However, there was no significant difference \((P>0.05)\) in redness among LAC, LAN, LAP, LAT and control samples. All treated samples possessed a yellowness \((b^*)\) similar \((P>0.05)\) to CON except the LAC treatment. Both \(L^*\) and \(b^*\) intensities significantly decreased \((P<0.05)\) from day 0 through 3 of display. Additionally, the LA treated ground beef maintained a similar \((P>0.05)\) hue angle and oxymyoglobin proportions \((630 \text{nm}/580 \text{nm})\) compared to INCON and CON samples on day 0 through 3 of display. The ground beef from LAP also maintained a similar hue angle compared to CON and INCON samples on day 1 through 3 of display. Comparison of treatments indicates that use of lauric arginate alone or accompanied by water, sodium metasilicate, trisodium phosphate, or peroxyacetic acid may be used as potential pre-grinding interventions to enhance ground beef safety without adverse effects on ground beef color. Further, lauric arginate alone and followed by water were superior to other treatments in enhancing redness in ground beef. Further evaluations on sensory color, texture and processing abilities of these treatments under un-inoculated conditions are proposed in future research.
Keywords: Antimicrobials, Ground beef, Color

Improving the flavor of ground beef by selecting trimmings from specific carcass locations
A. Harbison*, C. Kerth, S. Smith, R. Miller, Texas A&M University, 2471 TAMU College Station, TX 77840, United States

Currently, an emphasis has been placed on creating premium flavor in ground beef. With recent research, carcass location differences in subcutaneous fatty acid profiles have been noted and, separately, differences in fatty acid profiles have been shown to impact beef flavor. Therefore the objective of this study was to determine the impact of carcass location of subcutaneous fat source in ground beef made with a common lean source on sensory traits. Five carcass fat sources were tested: brisket, chuck, plate, flank, and round. Ground beef was formulated with extra-lean beef trim (≥95% lean) and the designated fat source. Each ground beef formulation contained 80% lean and 20% fat. Patties (100 g) were made and packaged in a Styrofoam tray covered with Saran and placed in a simulated retail display (4 °C and 1000 lx cool white light) for 5 d. Ground beef color was measured using L*, a*, b*, and reflectance. Lipid oxidation was measured by the thiobarbituric acid reactive assay (TBARS). Fatty acid differences were measured using the fatty acid methyl ester assay (FAMEs). Consumers (n=148) evaluated purging, beef flavor, texture, juiciness-like, and level of beefy flavor in ground beef made with a common lean source on sensory traits. Percentage stearic acid was higher in percentage cis-vaccenic acid (P=0.016) and in the saturated fatty acid to monounsaturated fatty acid ratio (P=0.018), and lower (P=0.004) in the percentage of total saturated fatty acid than all the other sources of subcutaneous fat. Cook loss, color, TBARS, and consumer sensory data showed no differences (P>0.05) among carcass location. While differences in some key subcutaneous fatty acids exist among carcass locations, when the fat is mixed with a common lean source, any difference that a fat source may have on sensory traits is diluted to the point of being undetectable. Therefore, formulating ground beef using subcutaneous fat from a specific location on a carcass will not improve any sensory, and especially flavor, or shelf-life traits.

Keywords: Fatty acids, Ground beef, Sensory

The effect of internal endpoint temperature on smoked sausage quality stored under light emitting diode and fluorescent lighting
A. Gaschler*, E. Boyle, J. Higgins, Kansas State University, Manhattan, KS, United States

Quality attributes of vacuum packaged skinless smoked sausage made with a combination of pork, turkey, and beef, cooked to 64, 68, or 72 °C internal endpoint temperature following USDA FSIS Appendix A, and displayed at 4 °C for up to 120 days under light emitting diode (LED) and fluorescent (FLS) lighting were evaluated. External color, pH, thiobarbituric acid reactive substances (TBARS), proximate analysis, consumer cook yield, and sensory attributes were measured on days 0, 90, and 120 of display. Purge amount and color were measured on days 10, 90, and 120. Product was collected from a commercial processor on the day of production (day 0) and displayed in two retail display cases set to the same operational and temperature profiles. Lighting type had no effect (P>0.05) on any of the attributes measured in this study. Average case temperature was 3.9 °C and 3.5 °C for the LED and FLS cases, respectively. Internal processing temperature and sampling day were the only factors contributing significant differences within measurements. External color was less (P<0.05) red by 0.63 units in product thermally processed to 64 °C than product processed to 68 °C. Product cooked to 72 °C was less (P<0.05) yellow by 0.95 and 0.54 units respectively, compared to those processed to 64 and 68 °C. Purge color lightness increased by 1.88 units (P<0.05) in product thermally processed to 72 compared to 64 °C. There was a temperature and day effect for purge color redness. As product endpoint temperature increased, purge color redness decreased (P<0.05). Purge was more red by 0.36 units (P<0.05) on day 120 compared to day 10. Yellowness of purge color increased at 72 °C compared to 64 °C by 0.66 units. Purge was more yellow (P<0.05) on day 120 compared to days 10 and 90 by 0.36 and 0.49 units, respectively. TBARS values decreased (P<0.05) from 0.70 mg of malonaldehyde/100 g on day 0 to 0.35 and 0.23 on days 90 and 120, respectively. Fat content was 24.58% on day 0, and increased (P<0.05) to 26.51% and 26.23% on days 90 and 120, respectively. Protein content was 10.72% in product cooked to 64 °C while it was lower (P<0.05) at 10.34% and 10.27% in products cooked to 68 and 72 °C, respectively. There was a temperature and day effect on percent purge. Purge content increased (P<0.05) from 1.45% to 1.90% in products cooked to 64 and 68 °C, respectively. In product processed to 72 °C there was 2.23% purge which was similar (P=0.05) to product cooked to 68 °C. While the amount of purge increased (P<0.05) from 1.58% to 1.92% on days 10 and 90, respectively, there was no additional increase (P>0.05) in percent purge on day 120. Consumer cook yield was lower (P<0.05) in 68 °C than 64 or 72 °C products. Sensory panel scores showed that flavor intensity decreased (P<0.05) as day of storage increased, and saltiness decreased from day 0 to day 90. While there were slight changes found in quality characteristics of smoked sausages during storage, many of these were minimal. Processors could reduce their internal endpoint temperature following USDA FSIS Appendix A guidelines with minimal effect on product quality. Vacuum packaged precooked smoked sausages could be displayed under LED or FLS lighting with no effect on product quality.

Keywords: Internal processing temperature, Sausage quality, Refrigerated display

Effect of dietary fat on fatty acid profile and pork quality
V. Alonso*, L. Provincial, P. Roncalés, J. A. Beltrán, Department of Animal Production and Food Science, University of Zaragoza, Zaragoza, Spain

The objective of this study was to compare the influence of dietary fat sources on meat quality and intramuscular and subcutaneous fatty acid composition in pork. The experiment was conducted with 55 entire male pigs (Pietrain × (Landrace × Large White)) which were fed a basal diet (corn, barley and wheat grain and soybean meal 44% CP) without added fat (control diet) or supplemented with different sources of fat: animal fat (1%, AF1; 3%, AF3), soyabean oil (1%, SBO1; 3%, SBO3) and calcium soaps of palm oil (1%, CaSPO1; 3%, CaSPO3). The longissimus thoracis et lumborum (LTL) muscle and a sample of subcutaneous fat (SCF) were removed from each carcass 48 h after slaughter. Ultimate pH (pHu), instrumental colour (CIEL*a*b*), drip loss and lipid oxidation (TBARS method) were measured in LTL muscle at 72 h post-mortem. The fat was extracted in chloroform–methanol from LTL muscle and SCF and quantified. The fat samples were used to determine composition in fatty acids from intramuscular fat (IMF) and SCF. All data were statistically analyzed by the GLM procedure of SPSS, version 15.0. Duncan’s post hoc test was used to assess differences between mean values when P≤0.05. No significant differences were observed among diets for pHu, instrumental colour.
and drip loss. The chops from pigs fed AF1 diet had greater (P ≤ 0.05) TBARS values than chops from pigs fed CaSPO1 and SBO1 diets. IMF content was significantly (P ≤ 0.05) higher in AF3 than CaSPO3 and SBO1 diets. There were no significant differences in the percentage of palmitic acid (C16:0), stearic acid (C18:0) or total saturated fatty acids (SFA) among diets in IMF. The proportion of oleic acid (C18:1n-9) and monounsaturated fatty acids (MUFA) were (P ≤ 0.05) higher in control and AF diets than in SBO1 diet. On the other hand, pork from pigs fed SBO1, SBO3 and CaSPO3 diets had greater (P ≤ 0.01) proportion of linoleic acid (C18:2n-6) and total and n-6 polyunsaturated fatty acid (PUFA) than pork from pig fed control diet. The n-3 PUFA (P ≤ 0.01), such as α-linolenic acid (C18:3n-3) (P ≤ 0.001), was significantly higher in SBO1 diets. Moreover, the SBO1, SBO3 and CaSPO3 diets had the highest (P ≤ 0.01) PUFA/SFA ratio (0.53, 0.50 and 0.49) and produced meat with the best nutritional value for human consumption. However, the n-6/n-3 ratio was higher (P ≤ 0.05) in CaSPO diets than in control diet, while AF and SBO diets produced an intermediate ratio. The SCF of pigs fed SBO3 had the lowest percentage of C16:0 (P ≤ 0.01), C18:0 (P ≤ 0.05) and SFA (P ≤ 0.01). Furthermore, SBO diets had the lowest (P ≤ 0.001) proportion of C18:1n-9 and MUFA. By contrast, these SBO diets had the highest (P ≤ 0.001) percentage of C18:2n-6, C18:3n-3, total PUFA and n-6 and n-3 PUFA in SCF. Despite finding no significant differences in some parameters related to meat quality (pH, colour and drip loss), there were important differences in intramuscular and subcutaneous fatty acid profile for pigs fed soyabean oil and calcium soaps of palm oil.

Keywords: Dietary fat, Fatty acid composition, Pork quality

Characteristics of Nilgai antelope carcasses and meat quality
T. J. Machado*, A. A. Pena, C. A. Stephens, B. J. Ozuna, C. M. Albert, Texas A&M University-Kingsville, Kingsville, TX, United States

Nilgai antelope (Boselaphus tragocamelus Pallas) are a common exotic ungulate in south Texas. The objective of the study was to determine the characteristics of nilgai carcasses and meat quality. Twenty nilgai (9 females and 11 males) were harvested in south Texas to determine carcass yields and the characteristics of nilgai antelope carcasses and meat quality. The objective of the study was to determine the characteristics of nilgai carcasses and meat quality.

The mineralocorticoid (MR) and glucocorticoid (GR) receptors are central components of the hypothalamic–pituitary–adrenocortical (HPA) axis, one of the main stress-response systems, which promotes the maintenance of homeostasis and adaptation to physiological and psychosocial challenges. The stress has negative effects on animal production, influencing indirectly on meat quality. Therefore, the present work identified single nucleotide polymorphisms (SNPs) in MR and GR genes of Nellore cattle and evaluated the association of these SNPs with variable indicating of the level of animal stress, as well as some variables related to meat quality. This study included 241 animals of Nellore breed and it was conducted at the College of Animal Science and Food Engineering, University of Sao Paulo, Brazil. The animals were harvested at 24 months of age and measurements of pH and temperature of carcass were realized at 1 and 24 h post mortem. Samples of longissimus dorsi (LD) muscle were collected within 45 min post mortem for lactate and glycogen determination. Steaks were removed from the LD between the 12th and 13th ribs, two inches thick each, for Warner–Bratzler shear force analysis. They were vacuum packaged and aged at 2 °C for 24 h, 7 and 14 days. Blood samples for hormonal measurement were collected at the start in the feedlot and during exsanguinations at harvest. The cortisol was measured by an immunoenzymatic kit. The genomic DNAs were isolated by standard techniques from total blood collected. For identification of SNPs, polymerase chain reactions (PCR) of genomic DNA fragments from 50 animal were performed and the fragments were sequenced directly by DYEnamic ET Terminator Cycle Sequencing (GE Healthcare) with an ABI PRISM 3100 automated DNA sequencer (Applied Biosystems) and analyzed base called with Phred, assembled with Phrap and results viewed with the Consed. Afterwards, genotyping for SNPs identified was performed on 241 cattle. Statistical analyzes were performed using the Statistical Analysis System, version 9.1.3 with the PROC MIXED. There were five SNPs identified in the genes studied: three in MR gene (MR1 T>C; MR2 T>C; MR3 G>A) and two in GR gene (GR1 A>G; GR2 T>C). The MR1
Consumer acceptability of beef bottom round steaks treated with calcium chloride and bromelain


Bottom round steaks are among the least tender beef steaks. Plant enzymes have long been used to improve meat tenderness by proteolysis of myofibrillar and collagenous proteins. Calcium chloride (CaCl₂) activates calpain proteases and thereby induces myofibrillar protein degradation. We hypothesized that treating bottom round steaks with CaCl₂ in combination with bromelain (BR) would have an additive effect on improving tenderness. Our current objective was to evaluate consumer acceptability of bottom round steaks treated with BR, CaCl₂, or BR + CaCl₂. A total of 120 consumer panelists evaluated bottom round steak palatability in two sessions. For each session, 16 outside rounds (flat; IMS 171B) from USDA Select carcasses were procured a minimum of 14 d postmortem. The ishatic heads were removed and bottom round flats were denuded and cut into 3 sections (proximal, middle, and distal). Treatments were randomized among sections, and 12 sections per treatment were used. Bromelain (0.1% w/v), 2.2% CaCl₂ (w/v), or BR + CaCl₂ were suspended in water and injected into product, using a 5 needle injector, to achieve 105% of green product weight. Water-injected sections served as a control, and steaks removed prior to injection served as an additional control. Injected sections were vacuum-tumbled for 20 min, remained under vacuum for 20 min, and then were vacuum packaged and aged for 7 d at 4 °C before fabrication into steaks. Steaks (2.54 cm-thick) were cut perpendicular to the muscle fiber orientation, and cooked on open-hearth broilers to an internal temperature of 71 °C. Five 1.27 cm×steak thickness cubes were obtained from each steak. Consumer panelists evaluated cooked steaks from each treatment for overall acceptability, tenderness, juiciness, and flavor using a 9-point scale (9 = like extremely, extremely tender, extremely juicy, and like flavor extremely, respectively; 1 = dislike extremely, not at all tender, extremely dry, and dislike flavor extremely, respectively). Panelists scored the steaks treated with the combination (BR + CaCl₂) more desirable than water-injected control steaks for overall acceptability (P < 0.05), juiciness (P < 0.05), and tenderness (P < 0.01). The BR + CaCl₂ treatment also had greater (P < 0.05) tenderness ratings than the BR and CaCl₂ treated steaks. Furthermore, the combination tended (P = 0.1) to have a more desirable tenderness score (5.58 vs. 5.07) than the non-injected control. Water-injected control steaks were perceived as less tender than the combination (P = 0.05), BR (P = 0.05), non-injected control (P = 0.05), and CaCl₂ (P = 0.1) steaks. Interestingly, water-injected steaks were also perceived as less juicy than non-injected steaks and BR + CaCl₂ treated steaks. Flavor scores did not differ among the treatments (P = 0.36). In conclusion, treatment of bottom round steaks with the combination of BR and CaCl₂ improved consumer perception of beef tenderness but did not affect flavor.

Keywords: Hypothalamic–pituitary–adrenocortical axis, Meat quality, Stress

Application of proteomic in functional analysis of proteolysis in Nellore longissimus dorsi muscles with 1, 7 and 14 days post mortem


The current work was conducted to assess the variations of post mortem proteolysis using a proteomics approach (2-DE), and to determine the relationship of products of proteolysis until 14 days post mortem in Nellore longissimus muscle. This research was conducted at the College of Animal Science and Food Engineering, University of São Paulo, in Pirassununga, São Paulo, Brazil. We used 33 Nellore beef cattle, raised in pasture and finished in feedlot. The animals were slaughtered at 24 months of age in the Slaughterhouse School Campus. Steaks were removed from the longissimus dorsi muscle between the 12th and 13th ribs, two inches thick each, for Warner–Braztzer shear force analysis. They were vacuum packaged and aged at 2 °C for 24 h, 7 and 14 days. One gram of sample to be used in proteomic analysis was wrapped in aluminum foil and immediately frozen in liquid nitrogen and then transferred to the −80 °C freezer. The protein extraction was performed and the extract stored at −80 °C. To perform the 2-DE Strips IPG pH 4–7, 13 cm length, were used. The isoelectric focusing was performed with Ettan IEPgporfor separation of proteins according to the isoelectric point. SDS-PAGE 12.5% was used for the electrophoresis. After that, the gels were stained with Coomassie R-250 dye and then destained in acetic acid and methanol. The gels were performed in triplicate. The gels were scanned and the images were evaluated by Image Master 2D Platinum program, version 7.0 (GE Healthcare). Statistical analyzes were performed using the Statistical Analysis System, version 9.1.3 with the PROC MIXED. The Bonferroni correction was used to control the level of significance at 5%. The numbers of spots detected among the 99 gels ranged from 399 to 298 spots in 24 h, 7 and 14 days post mortem respectively. After a comparative study (match) between times, 274 common spots were found. These 274 spots were submitted to analysis of variance to assess the effects of time of storage (1, 7 and 14 days of maturation) on spot expression intensities. The results indicated that 29 spots showed significant differences (P < 0.0002) in patterns of the expression intensities over time. The regression analysis of the spots showed that the expression of only one spot (spot 10) increased linearly over maturation time, whereas spots 19, 30, 31, 62, 71 and 144 (N = 6) had the expression reduced linearly over the time. However, 22 spots indicated quadratic effects of the time on expression intensities. The spots 15, 55, 157, 162 and 167 (N = 5) presented maximum point at 3.72, 6.89, 7.44; 7.61 and 7.41 days respectively. For others 17 spots showed minimum points ranging 7.48 (for spot 74) to 11.77 (for spot 120) days post mortem. Multiple regression analysis was performed using expression intensities for all significant spots as independent variables and tenderness at 14 days post mortem as dependent variable. These analyses demonstrated that five spots explained 77.04% of tenderness variation.

Keywords: Beef, Bottom round, Consumer acceptability

Beta-adrenergic supplementation effects on steak yield of three subprimal from calf-fed Holsteins

In response to research that suggests beta-agonists increase lean tissue deposition on the carcass, beef rib and loin subprimals were collected from animals supplemented with beta-agonists and portioned into steaks to evaluate the effects of beta-agonists on steak yield. Calf-fed Holstein steers (n = 565) were randomly assigned to one of three diets containing zilpaterol HCl (ZH; 8.3 mg/kg for 20 d), ractopamine HCl (RH; 300 mg/head/day for 28 d), or no beta-agonist (CON). Subprimals from USDA Choice carcasses (n = 315; CON = 101, ZH = 108, RH = 106) representing each treatment were collected and shipped to Texas Tech University. At 15–16 d postmortem, rib, tenderloin, and top sirloin subprimals were portioned into 283.5, 226.8, and 340.2 g steaks, respectively, utilizing a portioning machine equipped with scanner and imaging software to maximize yield. Variables measured included: blotted subprimal weight, purge loss, trimmed subprimal weight, total steak number, total steak weight, rib subprimal length, and steak yield. Steak yield was calculated by comparing total steak weight for each subprimal to blotted subprimal weight. Top sirloin subprimals from ZH supplement cattle were greater (P < 0.01) among ZH subprimals compared to RH and CON. Purge loss, cap weight, total steak number, and total steak weight were greater (P < 0.01) in ZH treated top sirloin subprimals than RH and CON. Supplementation with ZH resulted in heavier (P < 0.01) rib subprimals – before and after trimming – as well as a greater (P < 0.01) number of ribeye steaks resulting in heavier (P < 0.04) total steak weight compared to CON; however, RH did not differ (P > 0.05) from ZH or CON for these traits. Ribeye steak yield and rib length were similar (P > 0.05) across all treatments while a higher percentage of purge was observed in ZH rib subprimals (0.87%) when compared to CON (0.65%) and RH (0.76%; P < 0.01). Blotted and trimmed tenderloin subprimal weights were heavier (P < 0.01) for ZH subprimals when compared to RH and CON tenderloin weights. Tenderloin yield was greatest (P < 0.01) for ZH tenderloins while tenderloin tail yield was greater (P = 0.04) for CON tenderloins. Tenderloins from ZH supplemented animals had greater (P < 0.01) total steak weight and steak yield compared to RH and CON. Tenderloins from RH and CON had similar yields (P > 0.05); however, RH steak and tail weight were heavier (P < 0.05) than CON. The total number of tenderloin steaks was greater (P < 0.01) among ZH tenderloins when compared to CON and RH tenderloins. These results indicate that supplementation of calf-fed Holstein cattle with beta-agonists will increase subprimal weights while supplementation with ZH increased total steak number in all subprimals tested and increased steak yield in loin subprimals.

Keywords: Zilpaterol hydrochloride, Ractopamine hydrochloride, Beef

---

**Effect of steak location on shelf-life and quality attributes of the beef biceps femoris value cut**

A. M. Stelzeni, R. J. Kersey*, J. R. Segers, R. L. Stewart, Jr, University of Georgia, Athens, Georgia, United States

The objective of this research was to examine the effect of steak location on shelf-life and quality attributes of the beef biceps femoris (BF; bottom round IMPS 171B) when sectioned and portion cut perpendicular to the natural orientation of the muscle fibers. Thirty-six whole beef BF muscles were collected from steers utilized in another feeding trial at the University of Georgia. Steers were of similar weight, genetic composition, and age. Two days postmortem the BF was excised, denuded, the and ishiatic head was removed, and vacuum packaged. Four days postmortem the BF was sectioned into thirds based upon the natural orientation of the muscle fibers. The thirds were designated as dorsal (DOR; section nearest the vertebrae), medial (MED; middle section), and distal (DIS; section that makes up the heel). The BF sections were fabricated into steaks (2.54 cm) perpendicular to the natural fiber orientation. Four steaks were randomly assigned to 1, 3, 5, or 7 d of retail display, 1 steak was assigned to trained sensory analysis, and 1 steak was assigned to Warner–Batzler shear force analysis (WBS). Steaks for shelf-life were packaged in Styrofoam trays with PVC overwrap and placed on display (3 ± 1 °C, 970 lx) with 24 h luminescence. Objective CIE L", a", b" color, hue, chroma, 630/580 nm, trained subjective color, purge, and lipid oxidation were measured. Steaks for sensory and WBS were vacuum packaged and stored (1 ± 1 °C) for 21 d postmortem, then frozen (−20 °C) for further analysis. Data were analyzed using Proc Mixed of SAS. When a location by day interaction occurred, data were reanalyzed by day. For objective color, MED was lighter (L"; P < 0.05) across all days. Redness (a") decreased (P < 0.05) as time on display increased with DIS maintaining more red color (P < 0.05). Hue angle increased (P < 0.05) with time and MED had a larger (P < 0.05) hue angle than DOR or DIS steaks. Chroma decreased (P < 0.05) over time and DOR was less (P < 0.05) than DIS at all time points. Across display, DOR and MED accumulated more (P < 0.05) metmyoglobin (630/580 nm) than DIS. Worst point color, subjective redness, and discoloration scores all decreased as display increased (P < 0.01). Dorsal steaks were darker red (worst point and redness; P < 0.05) than MED and DIS, however, after 5 d DOR and MED had greater percentage of discoloration (P < 0.05) than DIS steaks. Location did not influence steak purge (P > 0.05), but after 5 d DOR steaks had more (P < 0.05) lipid oxidation than MED or DIS steaks. Distal steaks had greater thaw loss (P < 0.05) than DOR and MED, however, cook losses were similar (P > 0.05) between steak locations. Steaks from MED were less tender (P < 0.05) and had less beef flavor (P < 0.05) than steaks from DOR or DIS locations. Steaks from DOR were also rated as juicer (P < 0.05) than MED or DIS. Fabricating BF steaks perpendicular to the grain may increase the value of this cut, however, steak location will have an effect on several traits, especially tenderness. This research shows that steaks from DOR and DIS sections may be suitable for steak options, while the MED section could be better utilized as a roast option.

Keywords: Beef, Quality, Shelf-life

---

**Variation in composition and sensory properties for beef short ribs**

J. Hosch⁷, C. Calkins, K. Varnold, L. Senaratne-Lenagala, M. Semler, M. Chao, University of Nebraska, Lincoln, NE, United States

To determine if the 40% price differential between beef rib short ribs and chuck short ribs is justifiable, a sensory evaluation was conducted and yield determinations calculated. Short rib sub-primals were collected from both the left and right sides of Choice, YG 3 carcasses weighing between 364 and 386 kg. Chuck short ribs (ribs 2–5) from the chuck primal and rib short ribs from the rib primal (ribs 6–12) were fabricated, collected and vacuum packaged. Chuck and rib short ribs from the left side were weighed whole (kg) and each rib (ribs 2–12) was individually cut from its subsequent sub-primal. Each rib was then boned, and the bone, lean, and fat from each rib were weighed (g). Chuck and rib short ribs from the right side of the carcass were aged for 21 d post mortem at 2 °C. Both chuck and rib short ribs (ribs 2–12) were sliced from anterior to posterior using a band saw into 6 mm slices. Ribs were then separated by separating the lean between ribs equidistant to each adjacent rib and product was frozen at −20 °C. Within 24 h prior to taste panel preparation,
Effect of enhancement on shelf-life and quality attributes of the beef *biceps femoris* value cut

A. M. Stelzleni, R. J. Kersey*, J. R. Segers, R. L. Stewart, Jr., University of Georgia, Athens, Georgia, United States

The objective of this research was to examine the effects of enhancement on the shelf-life and quality attributes of the beef *biceps femoris* (BF; IMPS 171B) when sectioned and portion cut perpendicular to the natural orientation of the muscle fibers. Thirty-six whole BF muscles were collected from steers utilized in another feeding trial at the University of Georgia. Steers were of similar weight, genetics, and age. Four days postmortem the BF was denuded and the ishiatric head was removed, then sectioned into thirds based upon the natural orientation of the muscle fibers. The thirds were assigned to an enhancement treatment based on a rotating order to ensure that each third was equally represented within each enhancement solution. The enhancement treatments consisted of a control with no enhancement (NoE), 0.3% NaCl plus 0.35% sodium tripolyphosphate enhanced to 110% (STP), and a commercial blend of buffered vinegar plus 2% lemon juice (VLM) enhanced to 110%. Enhanced BF sections were allowed to rest for 20 m before being cut into steaks (2.54 cm)

<table>
<thead>
<tr>
<th>Rib</th>
<th>Tenderness</th>
<th>Percent lean</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5.07⁤abc</td>
<td>56.36⁤abc</td>
</tr>
<tr>
<td>3</td>
<td>5.11⁤abc</td>
<td>51.79⁤bc</td>
</tr>
<tr>
<td>4</td>
<td>5.21⁤ab</td>
<td>57.79⁤a</td>
</tr>
<tr>
<td>5</td>
<td>5.27⁤ab</td>
<td>49.19⁤d</td>
</tr>
<tr>
<td>6</td>
<td>5.40⁤ab</td>
<td>50.42⁤c</td>
</tr>
<tr>
<td>7</td>
<td>5.28⁤ab</td>
<td>49.95⁤c</td>
</tr>
<tr>
<td>8</td>
<td>5.32⁤ab</td>
<td>39.88⁤f</td>
</tr>
<tr>
<td>9</td>
<td>5.02⁤bc</td>
<td>39.35⁤e</td>
</tr>
<tr>
<td>10</td>
<td>4.81⁤d</td>
<td>40.57⁤d</td>
</tr>
<tr>
<td>11</td>
<td>4.31⁤c</td>
<td>41.75⁤e</td>
</tr>
<tr>
<td>12</td>
<td>4.29⁤c</td>
<td>45.87⁤de</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

¹Tenderness ratings based on trained taste panel 8-point hedonic scale. ²Percent lean calculated on rib basis. ³Means in the same columns having different superscripts are different at P < 0.05.

Keywords: Beef, Enhancement, Shelf-life
Antioxidative effect of thermized Edam whey protein concentrates used in edible coating dips for pork loin and tenderized beef steak

S. Weerasinghe, J. B. Williams*, Z. Z. Haque, Mississippi State University, MS, United States

Oxidative degradation negatively impacts appearance, eating quality, and overall shelf-life of retail cut meats, subsequently causing losses to processors, retailers, consumers, and ultimately, the producers. Whey, an inexpensive by-product of cheese manufacturing, has great potential to be used as a natural and abundantly available raw material in edible coatings for retail meat products. Based on previous observations, the primary objective of this study was to investigate the efficacy of thermally modified (thermized) Edam whey protein concentrate (WPC), with and without added enzymatically hydrolyzed casein (CH), in providing antioxidative protection to cubed (tenderized) beef steak (semimembranosus) and pork loin (longissimus dorsi). These two meats were chosen because of their different levels of fatty acid unsaturation and because the process of making cubed meat increases the potential for oxidative degradation. Fresh Edam whey was skimmed, pasteurized, and thermized in triplicate by batch heating at 70 °C for 0, 5, 10, and 15 min. Resulting batches were concentrated and spray dried to produce WPC according to common manufacturing practices in the U.S. Coating dips were made by dissolving 5% (w/v) WPC, 2.5% (w/v) sorbitol, 0.125% (w/v) CaCl₂, 0.25% (w/v) carboxymethylcellulose, and an additional 0.25% (w/v) CH for CH treatments, in distilled water. Solutions were degassed, heated at 90 °C for 30 min, homogenized for 2 min, filtered, cooled to room temperature and the pH adjusted to 6.5 using 1 N HCl or 1 N NaOH. The meat samples obtained from the MSU Meat Laboratory (pork loin) and a local grocery store (tenderized beef steak) were cut into 1 cm cubes, briefly rinsed in distilled water, coated with the solution, drained, air dried and refrigerated (4 °C) until analysis. Controls were prepared by dipping the meat in distilled water. Oxidative stability was determined using thiobarbituric acid reactive species (TBARS) and peroxide value (PV) every 24 h up to 4 days of storage at 4 °C. The TBARS values and PV of tenderized beef steak samples were positively impacted by the treatments: all treatments had smaller (P < 0.05) PV compared to blanks and 0 min control after 24 h of storage. All treatments had smaller TBARS values (P < 0.05) compared to controls at 72 h of storage. Thermized treatments with CH had less (P < 0.05) TBARS formation throughout the storage period. For pork loin, PV's of all treatments were less (P < 0.05) than those of controls at 72 h of storage. Thermized treatments with CH had smaller (P < 0.05) TBARS values at 24, 72, and 96 h of storage. Of the six thermized treatments, those with added CH clearly indicated greater antioxidative action on tenderized beef steak and pork loin thus showing use to enhance the quality of fresh tenderized beef steak and pork loin.

Keywords: Beef, Pork, Antioxidative

Shelf life of fresh sausage from immunologically castrated barrows

K. A. Jones*, A. L. Schroeder*, A. C. Dilger,a University of Illinois, Urbana, IL, United States, b Pfizer Animal Health, Kalamazoo, MI, United States

The objective of this study was to evaluate shelf life and quality characteristics of fresh sausage from GnRF immunologically-castrated barrows (Improve®) in comparison to surgically-castrated barrows. Pigs (n = 56) used in this study were of commercial breeding and comparable to those in industry settings. Treatments evaluated were surgically castrated (SC) barrows fed 0.55% SID lysine, immunologically-castrated (IC) barrows fed 0.45% SID lysine, IC barrows fed 0.55% SID lysine, and IC barrows fed 0.65% SID lysine. Improve®-immunized barrows received the first injection at ~4 months of age (16 weeks) and the second injection 4 weeks (20 weeks) subsequently. Dietary treatments were applied when pigs reached approximately 200 lbs and continued to market weight. Pigs were transported and harvested under federal inspection and according to industry standards at 7 weeks post second injection. Following harvest, carcasses from the 2 pigs closest to the pen mean were identified and shipped to the University of Illinois Meat Science Lab. Boston butts (NAMP #407) were fabricated from the shoulder, ground and mixed with spices, stuffed into casings, and sliced into fresh sausage patties. From each sausage homogenate, a sub-sample was collected for proximate analysis. Sausage patties were placed on trays, PVC overwrapped, and assigned to one of three frozen storage times: 0, 4, and 12 weeks. Upon conclusion of frozen storage, packages were placed under constant light (883 lx) at 4 °C for 5 days to simulate retail display conditions and color stability was measured. At the conclusion of 5 days of simulated retail display, sausage patties were evaluated for sensory characteristics, textural properties, and thiobarbituric acid relative substance (TBARS). Treatments discolored in a similar fashion (P > 0.05) with each frozen storage time significantly higher than the previous (P < 0.05). Overall color changed with frozen storage time; however, not in an obvious trend. Between treatments, SC barrows had the lightest color and IC barrows fed 0.55% SID lysine had the darkest (P < 0.05). Treatment did not affect the sensory characteristics of sausage (P > 0.05). Off flavor did increase with each frozen storage time; however, all sausage stayed within an acceptable range for off flavor. Treatment also had no affect on the lipid oxidation (TBARS) of the sausage (P > 0.05); however, lipid oxidation increased with frozen storage time (P < 0.05). Treatment had no effect on the textural properties of sausage (P > 0.05). Treatments did affect the fat and moisture content of the
sauce where barrows had more fat and less moisture than IC males (P<0.05). Overall, the similarities between treatments in this study indicate that immunological castration does not affect the shelf life or quality of fresh pork sausage.

Keywords: Immunocastration, Sausage, Quality

Impact of sodium lactate and acetic acid derivatives on the quality of fresh Italian pork sausage links

C. A. Crista, B. C. Williamsa, M. W. Schillingb, S. Campanob, B. Smithc,  
Mississippi State University, MS, United States, Hawkins, Inc., MN, United States, cJohn R. White and Co., Inc., Birmingham, AL, United States

Lactic and acetic acid have been utilized in pre- and post-harvest interventions to prevent spoilage and extend food product shelf life. These organic acids are associated with delaying bacterial spoilage, increasing shelf life, and maintaining color and sensory quality longer than normal sausage products. Such benefits could extend market shelf life and therefore profitability. The objective of this study was to determine the quality and sensory parameters of fresh Italian sausage links made with commercial fresh pork trimmings over time using these antimicrobials. Research is limited in which organic acids have been directly added into sausage formulation and processing. Many larger sausage facilities have the resources to use hot-boned, fresh trimmings for sausage processing, but most small processing facilities purchase fresh or frozen trimmings. While the use of purchased trimmings incorporates animal source and quality variation, this project is valuable to the industry since the use of fresh trimmings is normal for small manufacturing processes and represents numerous products in the retail market. Three separate replications of four treatments, 2.5% acetic acid/sodium lactate mixture (48.5/51.5%) (V), 2.5% sodium lactate (60% solids) (S), 0.02% butylated hydroxyanisole (BHA)/butylated hydroxytoluene (BHT) based on fat content (B), and a control with seasoning only (C) were evaluated for differences. Analysis over shelf life included total plate count (TPC), oxidative rancidity (TBARS), sensory and consumer analysis, cooking loss, pH, and color. Commercial fresh pork trimmings were purchased and delivered to the MSU Meat Lab. The trimmings were coarse ground, mixed with commercial Italian pork sausage seasoning and reground until evaluation. Treatments S and V had lower total plant counts (P<0.05) than B. Of consumers tested, 85.6% of consumers rated all large percentage of consumers liked B, S, and V. Based on microbial spoilage standards and sensory acceptability, this research indicates that sodium lactate and acetic acid derivatives can extend microbial shelf life without negatively influencing the consumer acceptability of Italian flavored fresh pork sausage links made from commercial pork trimmings when compared to the control.

Keywords: Pork sausage, Organic acids, Quality

Consumer acceptability and tenderness from retail domestic grain-finished, imported New Zealand grass-finished, and Missouri-produced grass-finished lamb racks

K. L. Basinger a, B. C. Shanks a, J. D. Caldwell e, E. A. Backes a,b, J. J. Hollenbeck b, S. Ahuja a, D. K. Sommerer a, E. D. Groose a, G. T. Otto a, R. K. Ness a, J. K. Apple a, F. Eivazi a, cLincoln University, Jefferson City, MO, United States, dUniversity of Arkansas, Fayetteville, AR, United States

There appears to be increased consumer demand for grass-finished products and elevated preference for locally produced foods. The objective of this study was to determine consumer acceptability and tenderness from retail domestic grain-finished (D), imported New Zealand grass-finished (N), and Missouri-produced grass-finished (M) lamb racks. Lamb racks (n=58) were purchased from three different retailers located in Missouri. After purchase, racks were transported to Lincoln University and were stored frozen at –20 °C for three weeks. Racks were then thawed at room temperature and fabricated into 2.54-cm thick chops which were trimmed to include only the longissimus muscle (LM). Three LM chops from each rack were stored at 1.6 °C for two days prior to consumer panel evaluation and two chops from each rack were re-frozen (–20 °C) and shipped to the University of Arkansas for Warner–Bratzler shear force determination. Consumer panel LM chops were placed on a propane grill, seasoned with black pepper and season salt, cooked to an internal temperature of 71.1 °C, and held in warming ovens until panelists arrived. Consumer panelists (n=98) consisted of Lincoln University employees and students and were recruited from the annual departmental Christmas party. Prior to serving, LM chops were further processed into approximately 1.27×1.27×2.54-cm cubes and were placed on pre-labeled compartmentalized trays. Each panelist was also given three unsalted crackers and a cup of water for cleansing of palates between samples. Panelists were instructed not to converse with each other and were asked to evaluate lamb chops from each treatment on a nine-point hedonic scale (1=dislike extremely to 9=like extremely) for overall acceptability, tenderness, juiciness, flavor, leanness acceptability and leanness (fatness). Overall acceptability, tenderness, juiciness, flavor, and leanness acceptability ratings from D were greater (P<0.05) compared to M and N. Racks from M and N were rated leaner (P<0.05) than D. Shear force values from D and N were lower (P<0.05) compared to M. Therefore, racks from grass-finished lamb may not be as acceptable to consumers as racks from grain-finished lamb, but depending on origin, may be as tender as racks from domestic grain-finished lamb.

Keywords: Grain-finished, Grass-finished, Lamb rack

Determination of potential microbiological shelf-life and instrumental color characteristics of fresh quail

A. Mohan a, C.-C. Lee a, V. Sharma a, J. Frank e, R. Otlor b, 2University of Georgia, Athens, GA 30602, United States, bPlantation Quail, Greensboro, GA 30642, United States

Quail (Coturnix coturnix) commonly known as Pharaoh Quail is commonly used for meat around the United States. Quail meat is known for their unique flavor, moisture, and tenderness. However, bacterial spoilage of fresh quail may greatly affect the prediction of shelf-life during retail distribution, display, and storage. Therefore, the objectives of this study were: 1) to determine the bacterial counts of coliform, Escherichia coli, aerobic plate, and presumptive Salmonella; and 2) to determine and instrumental color characteristics (L*, a*, b, hue angle and chroma) of fresh vacuum packaged quail during 0, 1, 2, 4, 5, 7 and 10 days of retail display and storage at temperature 2–3 °C. Four semi-boneless quail carcasses were placed
The effect of brining temperature and salt concentration on brine uptake, flavor penetration, and cooking loss in pork loins
L. L. Slaughter*, G. Rentfrow, Y. L. Xiong, University of Kentucky, Lexington, Kentucky, United States

The objectives of this study were to explore the brine uptake, flavor penetration, and cooking loss of pork loins using a 20% (HS) or 10% (LS) NaCl brine concentration, along with three brine temperatures: freezing (0°C; in blast freezer), refrigerated (4°C; in processing cooler), and room (21°C). Brine temperatures were monitored with a digital meat thermometer and controlled using heated or ice water bags. Twenty-four (12 flavor penetration, cooking loss, respectively) 0.45 kg pork loin roast (longissimus thoraces) samples removed anterior to the 10th rib interface were obtained from individual pork carcasses from the University of Kentucky Meat Laboratory. All samples were soaked for 1 h before brine uptake was calculated by measuring displacement weight (kg) before and after soaking. Flavor penetration (after soaking) was determined by utilizing water-soluble tracing dye (FD&C Blue No. 1) at a final liquid concentration of 0.15% total liquid brine. Twelve samples were geographically center-ored, perpendicular to the cut surface, into 5 mm cores, and the first three 2.0 mm portions were sliced and labeled as outer, middle, and inner distance penetration. Samples were individually homogenized in a one to ten dilution of de-ionized water and centrifuged for 20 min at 3000×g. The resulting supernatants were decanted and measured at 927 nm absorbance. The remaining 12 roasts were evaluated for cooking loss as a percentage (100–final raw

Keywords: Protein oxidation, Aging time, Antioxidants

The objectives of this study were to explore the brine uptake, flavor penetration, and cooking loss of pork loins using a 20% (HS) or 10% (LS) NaCl brine concentration, along with three brine temperatures: freezing (0°C; in blast freezer), refrigerated (4°C; in processing cooler), and room (21°C). Brine temperatures were monitored with a digital meat thermometer and controlled using heated or ice water bags. Twenty-four (12 flavor penetration, cooking loss, respectively) 0.45 kg pork loin roast (longissimus thoraces) samples removed anterior to the 10th rib interface were obtained from individual pork carcasses from the University of Kentucky Meat Laboratory. All samples were soaked for 1 h before brine uptake was calculated by measuring displacement weight (kg) before and after soaking. Flavor penetration (after soaking) was determined by utilizing water-soluble tracing dye (FD&C Blue No. 1) at a final liquid concentration of 0.15% total liquid brine. Twelve samples were geographically center-ored, perpendicular to the cut surface, into 5 mm cores, and the first three 2.0 mm portions were sliced and labeled as outer, middle, and inner distance penetration. Samples were individually homogenized in a one to ten dilution of de-ionized water and centrifuged for 20 min at 3000×g. The resulting supernatants were decanted and measured at 927 nm absorbance. The remaining 12 roasts were evaluated for cooking loss as a percentage (100–final raw

The objectives of this study were to explore the brine uptake, flavor penetration, and cooking loss of pork loins using a 20% (HS) or 10% (LS) NaCl brine concentration, along with three brine temperatures: freezing (0°C; in blast freezer), refrigerated (4°C; in processing cooler), and room (21°C). Brine temperatures were monitored with a digital meat thermometer and controlled using heated or ice water bags. Twenty-four (12 flavor penetration, cooking loss, respectively) 0.45 kg pork loin roast (longissimus thoraces) samples removed anterior to the 10th rib interface were obtained from individual pork carcasses from the University of Kentucky Meat Laboratory. All samples were soaked for 1 h before brine uptake was calculated by measuring displacement weight (kg) before and after soaking. Flavor penetration (after soaking) was determined by utilizing water-soluble tracing dye (FD&C Blue No. 1) at a final liquid concentration of 0.15% total liquid brine. Twelve samples were geographically center-ored, perpendicular to the cut surface, into 5 mm cores, and the first three 2.0 mm portions were sliced and labeled as outer, middle, and inner distance penetration. Samples were individually homogenized in a one to ten dilution of de-ionized water and centrifuged for 20 min at 3000×g. The resulting supernatants were decanted and measured at 927 nm absorbance. The remaining 12 roasts were evaluated for cooking loss as a percentage (100–final raw
wt (g) – cooked wt (g)) ÷ (initial raw wt (g))), baked to an internal temperature of 70 °C. The data was analyzed using the GLM procedure of SAS as a two by three factorial experiment. No change in displacement weight was observed in any samples, with the exception of slight increases in LS brine samples, both samples at 0 °C and one sample at 21 °C (P ≥ 0.024). However, there was no brine temperature (P = 0.13) or temperature × salt brine concentration interaction (P = 0.13). Flavor penetration as measured by the uptake of tracing dye was not affected by manipulation of brining concentration or temperature (P = 0.64). Furthermore, cooking loss was not affected by salt brine concentration (P = 0.30) or brine temperature (P = 0.21). These data indicate that no difference in flavor penetration or cooking loss in pork loins based on salt brine concentration and temperature was detected in this study; a slight increase in displacement weight with the LS brine was seen at 0 °C and 21 °C.

Keywords: Brine, Pork, Temperature

An analysis of quality of non-traditional beef grind material versus traditional beef grind material for ground beef products D. A. Tigue*, S. L. DeGeer, C. L. Bratcher, Auburn University, Auburn, AL, United States

An experiment was conducted to evaluate quality differences between traditional and non-traditional grind materials. Three traditional grind sources (T) were compared with seven non-traditional grind sources (N): 7% fat (T1), 11% fat (T2), 16% fat (T3), and 6% fat (N1), 8% fat (N2), 11% fat (N3), 20% fat (N4), 21% fat (N5), 28% fat (N6) and 29% fat (N7). All grinds were then packaged in overwrapped foam trays (OW), clear chubs (CH), or overwrapped foam trays in a low oxygen modified atmosphere bag (MAP). Retail display was immediately conducted for 5 d on OW, CH was stored in dark storage for 3 d and MAP was stored in dark storage for 11 d and then placed in retail display for 5 d to simulate industry practices for each respective packaging treatment. Starting on the day packages were placed on display (d 0), 3 packages from each grind/package treatment were removed and frozen for further lab analysis. Also starting on d 0, 5 packages from each package/grind treatment were selected at random and color was evaluated daily with a Hunter Miniscan XE Plus. After completion of the retail display period, the frozen packages were thawed and samples were taken from each for evaluation of oxidative rancidity using TBARS. Data were analyzed using the PROC GLM procedure of SAS. Between grinds, L* values were not different between T3 and N7 (P = 0.09) and T2 and P4 (P = 0.34), but were different (P < 0.05) for all other grinds. Similarly, all a* values were different (P < 0.05) between grind except N1 and T3 (P = 0.32), N2 and N3 (P = 0.06), and N5 and N7 (P = 0.51). For grinds, b* values were not different (P > 0.05) between N2, N3 and N4; T1 and T3; N5, N6 and N7. For days of display, all L* values were not different (P > 0.05) until d 3 of retail display. For days on display, a* values were different (P < 0.0001) and b* values all days were different (P < 0.05) except d 2 and d 3 (P = 0.06). Between packaging, all treatments were different for L*, a* and b* (P < 0.05). Two of the greatest percentage fat grinds, N5 and N7 had the greatest TBARS values but were not different (P = 0.28). These were followed by N2, which was not different than T2 or N6 (P > 0.05) and the least TBARS value was N4, however this was not different than N3, N1, T1, T3 (P > 0.05). Days 4 and 5 had the greatest values for TBARS (1.7 and 1.5 mg MDA/kg meat, respectively), but were not different (P > 0.05). Day 3 (1.3 mg MDA/kg meat) was not different than d 5 (P = 0.33), and d 0 to d 3 were not different (P > 0.05). All packaging treatments were different for TBARS values, MAP had the highest level, followed by OW and CH (1.73, 1.34 and 0.90 of mg MDA/kg of meat, respectively). Overall, as the fat percentage in ground beef increases, the TBARS and L* values increase, and a* and b* values decrease. Additionally, as day of display increases from d 0 to d 5, TBARS values do not change until d 3. Packaging also can reduce lipid oxidation with chubs slowing oxidation the most followed by overwrapped foam trays and overwrapped foam trays in low oxygen modified atmosphere bags, respectively.

Keywords: Ground beef, Oxidation, Color

Color and sensory properties of beef steaks treated with antimicrobial sprays M. Semler*, M. Chao, J. Hosch, L. Senarate-Lenagala, K. Varnold, C. Calkins, University of Nebraska, Lincoln, NE, United States

This study was conducted to determine the effects of three different antimicrobial sprays on color and sensory properties of beef steaks (bromine, BeefXide [lactic acid 45–60%, acetic acid 23–30% and potassium hydroxide > 1%; Birko, Henderson, CO], lactic acid, and control). Individual treatments were applied to 30 *psos major* (PM) steaks and 30 *gluteus medius* (GM) steaks for three replications with a total of 720 steaks. Prior to treatment, 360 steaks were inoculated with approximately 3 log of generic *Escherichia coli* and measurements for CFU’s were taken. Treatments were applied via direct spray on average at 560 ppm bromine, 2.48% BeefXide, and 4.17% lactic acid at 130 °F. Following treatments, steaks were measured once more for CFU’s. Initial CFU measurements prior to treatment and CFU measurements after treatment where completed within a 24 hour period. The remaining 360 non-inoculated steaks were used for consumer sensory evaluation and frozen and thawed prior to color measurements. Color scores were evaluated using a Minolta Chromameter CR-400 with an 8 mm diameter measurement area, illuminant D65 and a 2° standard observer. Values for, L* (brightness), a* (redness) and b* (blue to yellow) were recorded. Percent discoloration was estimated by a trained panel on raw steaks while in vacuum packages. To reflect what the consumer would see when purchasing the steaks, color was evaluated while in packages. For consumer evaluation 352 steaks were prepared for sampling and cooked to an internal temperature of 71 °C, cubed, and served. Taste panels were completed over two days with 176 PM steaks prepared for day one and 176 GM steaks for day two. Consumers (n = 204) evaluated samples on a scale of one to eight for juiciness and flavor (1 = extremely undesirable, 8 = extremely desirable) and off-flavor intensity (1 = extremely mild, 8 = extremely intense). Steaks treated with lactic acid had the greatest mean log reduction of 1.27 logs. BeefXide treatment resulted in a 1.05 log reduction and bromine and control group steaks were statistically similar at .57 and .51. The PM steaks treated with lactic acid revealed a greater (P < 0.0001) percent discoloration (67% vs. 37.7%) than BeefXide, and lactic acid samples also had a lower L* value and a* values than controls, bromine and BeefXide samples (P = 0.058, P = 0.0002). Discoloration within GM steaks was greater (P < 0.0001) for bromine at 57.9%. The lactic acid treated steaks had the lowest L* values (P < 0.0001), and bromine treated steaks the lowest a* values (P < 0.0001). When comparing b* value of GM steaks, control samples were lower (P = 0.0002) than the other treatments. Consumer evaluation for PM steaks showed lactic acid samples were more preferred (P = 0.0477) for juiciness and flavor (P = 0.007) when compared to control, bromine and BeefXide samples. There were no preferences for off-flavor intensity (P = 0.1564) for PM steaks, and no differences were shown for juiciness (P = 0.3286), flavor (P = 0.9850), and off-flavor intensity (P = 0.5087) for GM steaks among the control and three treatment groups. These results suggest that lactic acid is most effective for microbial treatments but also revealed the lightest color with the lowest L* value, while BeefXide treated sample showed an advantage in overall discoloration and redness (a*).
Temperature abuse during simulated distribution can affect surface color of beef striploins under simulated retail display condition
S. R. Greathouse1, J. T. Sawyer2, B. D. Lambert1, D. H. Kattesa, "Tarleton State University, Stephenville, TX, United States, 2Texas AgriLife Research, Stephenville, TX, United States

The surface color of beef is a significant factor affecting consumer purchase intent of fresh beef retail cuts. Understanding the impact of distribution temperatures on beef subprimals and pre-packaged cuts can alter the production phases in an effort to improve the surface color stability throughout the retail shelf-life. With a growing variety of packaging methods, the increasing demand for pre-packaged items and the ability to minimize, temperature abuse for meat and poultry will continue to be at the forefront of achieving customer satisfaction. Often times the rate at which temperatures vary throughout the phases of retail meat production (processing, distribution and storage), has resulted in limited research focusing towards the influence of temperatures on fresh meat characteristics. Therefore, two experiments were conducted to further understand the impact of simulated distribution temperatures on fresh surface color (instrumental and visual), purge loss, oxidative stability (TBARS), microbial spoilage (aerobic plate count), and internal steak temperature. Both experiments focused on evaluating distribution temperature abuse of beef in experiment 1 (−1.1 °C and 4.4 °C), and experiment 2 (−2.2 °C, 3.3 °C, and 8.8 °C). Beef striploin subprimals (NAMPS 180) were purchased from a major packer 3 d following fabrication and randomly assigned to a storage temperature in the absence of light for 7 d. Striploin subprimals (N=10/trt) were fabricated into six (n=6) 2.54-cm-thick steaks, weighed, placed onto a Styrofoam tray, overwrapped with a poly-vinyl chloride film, individually identified and stored in a three-tiered retail display case operating at 2 °C. APC values were lower (P<0.05) for steaks from subprimals stored at colder temperatures across day of retail display in experiment one. Instrumental redness (a*) values were greater (P<0.05) for steaks stored at −2.2 °C and 3.3 °C distribution temperatures (exp. 2). Steaks from subprimals stored 8.8 °C received greater (P<0.05) surface discoloration scores from panelists than those stored at 1.1 °C and 2.2 °C in experiments 1 and 2 respectively. Whereas discoloration scores increased (P<0.05) throughout the retail period for steaks from subprimals at 4.4 °C and 8.8 °C storage temperatures as rated by sensory panelists during exp. 1 and 2. Overall color scores for striploin steaks that were stored at 4.4 °C and 8.8 °C temperatures decreased (P<0.05) as rated by sensory color panelists throughout the retail display period of exp. 1 and 2. Furthermore, storing subprimals during simulated distribution caused TBAR values to increase (P<0.05) across the retail display period for both experiments 1 and 2. Results from these studies suggest that storing subprimals at colder temperatures throughout a simulated distribution period can delay the shelf life implications of microbial and fresh color characteristics.

Keywords: Beef, Instrumental color, Sensory color

Composition and quality of carcasses from pigs selected for divergent residual feed intake
1Iowa State University, Ames, IA, United States, 2Farmland Foods, Denison, IA, United States

The purpose of this study was to determine the impact of divergent selection for residual feed intake (RFI) on pork quality traits. It is possible to calculate an expected feed intake required for growth performance and composition. The difference between this expected feed intake and the individual feed intake is the RFI. Therefore, low RFI pigs consume less than expected and are more feed efficient compared to high RFI pigs which have a greater than expected feed intake. Sixty-three pigs [n=27 low RFI line (n=17 barrows, n=10 gilts), n=36 high RFI line (n=21 barrows, n=15 gilts) across six mixed sex pens] from the eighth generation of the Iowa State University selection project were used in this study. Pigs were harvested (118–138 kg) in two groups at a commercial abattoir where fat depth, loin depth and calculated percent lean were determined using a Fat-O-Meater® probe. At 2 days postmortem, ultimate pH, drip loss, subjective marbling, and lean and fat color (CIE L* a* b*), D75 light source, 10 degree observer) were collected. Data were analyzed using the PROC MIXED procedure of SAS with fixed effects of line and sex, and random effects of harvest group (n=2) and pen (n=6), with live weight as a covariate. No differences were found in ultimate pH and drip loss. Carcasses from low RFI line pigs had larger loin eye depth (P<0.001; 63.5 mm±0.9 versus 59.5 mm±0.8), higher percent lean (P<0.05; 53.5%±1.1 versus 52.0%±1.0) and tended to have lower marbling scores than carcasses from high RFI line pigs (P=0.0513; 1.2±0.2 versus 1.4±0.2). Further, gilts had greater loin eye depth (P=0.001; 63.6 mm±0.9 versus 59.4 mm±0.5). The objective of this study was to determine the effects of various components of field peats in finishing diets on beef palatability attributes. A total of 126 Piedmontese×Angus heifers were blocked by weight and allotted by pen into 1 of 4 dietary treatments (CON = no field peas; WRL = 15% of DM as dry rolled field peas (hulls + seed); HULL = 15% of DM as field pea hulls; CHIP = 15% of DM as field pea chips (seed only)). Heifers were on the field pea diet for 120 d before being slaughtered at a commercial processing facility on two dates. After a 48 h chill, carcass data were collected by trained university personnel. Samples for quality analyses were taken from the longissimus thoracis (LT), semimembranosus (SM), biceps femoris (BIF), and supraspinatus (SPS) of each carcass. Steaks (2.5-cm thick) were cut from each sample, vacuum packaged, and aged for 14 d before frozen. Beef palatability attributes were assessed by Warner–Bratzler shear force (WBSF), cook loss (CLOSS), and a trained 7-member sensory panel. Panelists evaluated samples for tenderness, juiciness, and beef flavor intensity. Data were analyzed using generalized least squares (PROC MIXED, SAS). The model included treatment, block, and date-of-slaughter as fixed main effects, with the random main effect of pen. Panelists found no effect of finishing diet type for tenderness, juiciness, and flavor for LT (n=53; P=0.63, 0.66, 0.56, respectively), SM (n=53; P=0.89, 0.47, 0.19, respectively), BIF (n=48; P=0.53, 0.84, 0.20, respectively), and SPS (n=45; P=0.37, 0.79, 0.87, respectively). Various field pea components also did not affect WBSF measurement, and CLOSS for LT (P=0.91 and 0.52), SM (P=0.56 and 0.88), BIF (P=0.55 and 0.22), and SPS (P=0.49 and 0.52), These data suggest that the addition of various components of field peats to a finishing diet of Piedmontese×Angus heifers does not have an effect on beef palatability attributes.

Keywords: Beef palatability, Field peas, Sensory panel

Effects of various components of field peas on sensory panel ratings, cook loss, and Warner–Bratzler shear force of Piedmontese×Angus heifers

The objective of this study was to determine the effects of various components of field peas in finishing diets on beef palatability attributes. A total of 126 Piedmontese×Angus heifers were blocked by weight and allotted by pen into 1 of 4 dietary treatments (CON = no field peas; WRL = 15% of DM as dry rolled field peas (hulls + seed); HULL = 15% of DM as field pea hulls; CHIP = 15% of DM as field pea chips (seed only)). Heifers were on the field pea diet for 120 d before being slaughtered at a commercial processing facility on two dates. After a 48 h chill, carcass data were collected by trained university personnel. Samples for quality analyses were taken from the longissimus thoracis (LT), semimembranosus (SM), biceps femoris (BIF), and supraspinatus (SPS) of each carcass. Steaks (2.5-cm thick) were cut from each sample, vacuum packaged, and aged for 14 d before frozen. Beef palatability attributes were assessed by Warner–Bratzler shear force (WBSF), cook loss (CLOSS), and a trained 7-member sensory panel. Panelists evaluated samples for tenderness, juiciness, and beef flavor intensity. Data were analyzed using generalized least squares (PROC MIXED, SAS). The model included treatment, block, and date-of-slaughter as fixed main effects, with the random main effect of pen. Panelists found no effect of finishing diet type for tenderness, juiciness, and flavor for LT (n=53; P=0.63, 0.66, 0.56, respectively), SM (n=53; P=0.89, 0.47, 0.19, respectively), BIF (n=48; P=0.53, 0.84, 0.20, respectively), and SPS (n=45; P=0.37, 0.79, 0.87, respectively). Various field pea components also did not affect WBSF measurement, and CLOSS for LT (P=0.91 and 0.52), SM (P=0.56 and 0.88), BIF (P=0.55 and 0.22), and SPS (P=0.49 and 0.52). These data suggest that the addition of various components of field peats to a finishing diet of Piedmontese×Angus heifers does not have an effect on beef palatability attributes.

Keywords: Beef palatability, Field peas, Sensory panel

25
0.8) and percent lean (P<0.001; 54.6% ± 1.1 versus 51.2% ± 1.0), and less fat depth (P<0.001; 19.4 mm ± 1.7 versus 24.3 mm ± 1.8) than carcasses from barrows. A line x sex interaction was seen in fat a’ values (P<0.01), where carcasses from high RFI gilts had the greatest values (~2.06 ± 0.21) and carcasses from low RFI gilts possessed the least (~2.93 ± 0.28). Our current results suggest that divergent selection for improvement in RFI over eight generations impacts carcass composition while having minimal impact on pork quality. This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-68004-30336 (J.F. Patience) from the USDA National Institute of Food and Agriculture.

Keywords: Residual feed intake, Pork quality, Pork composition

National Beef Quality Audit — 2011: Survey of producer- and packer-related defects on the harvest floor

R. O. McKeith*, G. G. Savell, K. E. Belk, D. R. Woerner, J. D. Tatum, J. L. Igo, D. L. VanOverkkee, G. G. Mafl, T. E. Lawrence, R. J. Delmore, L. M. Christensen, S. D. Shackelford, D. A. King, T. L. Wheeler, Texas A&M University, College Station, TX, United States, °Colorado State University, Ft. Collins, CO, United States, ¹Oklahoma State University, Stillwater, OK, United States, ²West Texas A&M University, Canyon, TX, United States, ³California Polytechnic State University, San Luis Obispo, CA, United States, ⁴USDA-ARS US Meat Animal Research Center, Clay Center, NE, United States

The National Beef Quality Audit — 2011 was conducted to assess the current status of quality and consistency of US fed steers and heifers. Between May and November 2011, survey teams assessed approximately 18,000 cattle carcasses in eight beef processing plants for hide color, identification, brand, horns, mud/manure, dentition, bruises, and carcass/offal condemnations. Hide colors or breed type were black (61.1%), red (12.8%), yellow (8.7%), Holstein (5.5%), brown (5.0%), gray (5.0%), white (1.4%), and brindle (1.0%). Identification method and frequency were lot visual tags (85.7%), individual visual tags (50.6%), electronic tags (20.1%), metal-clip tags (15.7%), other means (5.3%), none (2.5%), and wattles (0.5%). Brand frequencies were no brands (55.2%), one (40.4%), two (4.4%), and three or more (0.04%), and brands were located on the butt (33.8%), side (8.6%), and shoulder (2.4%). There were 77.2% of cattle without horns, and the majority of those with horns (71.6%) were between 0 cm and 12.7 cm in length. Hide location and incidence of mud or manure were no mud/manure (49.2%), legs (36.8%), belly (23.7%), side (14.9%), top-line (11.0%), and tail region (13.7%). Permanent incisor number and occurrence were zero (87.3%), one (1.4%), two (0.8%), three (0.9%), four (1.9%), five (0.3%), six (0.2%), seven (0.1%), and eight (0.02%). Most carcasses (77.0%) were not bruised, 18.7% had one bruise, 3.4% had two bruises, 0.6% had three bruises and 0.3% had more than three bruises. Bruise location and incidence were loin (50.1%), rib (21.3%), chuck (13.8%), round (7.3%), and brisket, flank, and plate (7.5%). Condensation item and incidence were whole carcass (none recorded), liver (20.9%), viscera (9.3%), lungs (17.3%), tongue (10.0%), and head (7.2%). When compared to the 2005 NBQA, this audit had trends of a higher percentage of black hides to cattle (2005, 56.3% vs. 2011, 61.1%), cattle with brands (2005, 38.7%, vs. 2011, 44.8%), and cattle with some form of identification (2005, 93.3% vs. 2011, 97.5%) whereas there was a lower percentage of carcasses with bruises (2005, 35.2% vs. 2011, 23.0%), and carcasses with more than one bruise (2005, 9.4% vs. 2011, 4.2%). Also, a similar percentage of the cattle were deemed greater than 30 months of age using dentition (2005, 2.7% vs. 2011, 3.3%). This information helps the beef industry measure the progress it has made compared to the past four surveys and provides a benchmark for future educational and research activities.

Keywords: Beef quality, Carcass, Market survey

Loadcell effect on Warner-Braztler shear force values of beef steaks

A. L. Grayson*, R. K. Miller, G. E. Carstens, Texas A&M University, College Station, TX, United States

Commonly used loadcells for United Testing instruments are 98.07 N and 1961.33 N. Loadcells are calibrated to within ±1% of their load for accuracy. Therefore, 98.07 N loadcells should be sensitive to ±0.98 N and 1961.33 N loadcells should be sensitive to ±19.61 N. Based on these differences in sensitivity, the question was how much loadcell, either 98.07 N or 1961.33 N, influenced Warner–Braztler shear force (WBS) measurements. The objective of this study was to determine if loadcell, 98.07 N versus 1961.33 N, on a United Testing machine affected the overall mean and variance of WBS in beef steaks of varying tenderness. Beef samples, 2.54 cm longissimus lumborum steaks, aged either 1, 7, or 14 d to induce differences in tenderness, were randomly selected from two large beef studies. Steaks were cooked to an internal temperature of 70 °C on a Hamilton Beach electric open-hearth grill. Temperature was monitored using copper-constantan thermocouples placed in the geometric center of the steak. After cooking, steaks were placed on plastic trays and covered with saran wrap and chilled at 2 °C for 24 h before shearing. After chilling, steaks were placed at room temperature and each steak was cut in half (dorsal and ventral halves). One half was randomly assigned to either the 98.07 N or 1961.33 N loadcell treatment. Within a shear day (n=5), loadcell treatment was assigned to order and the next shear day, the loadcell treatments were reversed in order. From each steak section, three to four, 1.27 cm cores were removed parallel with the muscle fibers. Cores were sheared on a United Testing machine with a head speed of 200 mm/s for both loadcells. Mean shear force values were 33.54 N ± 11.57 N, 28.34 N ± 8.83 N, and 27.75 N ± 6.61 N for 1 d, 7 d, and 14 d aging. Ranges for 1, 7, and 14 d aged steaks were 14.81 N–63.15 N, 24.3 mm–11.77 mm, and 54.6% ± 1.1 versus 51.2% ± 1.0), and

Keywords: Beef, Tenderness, Warner–Braztler

Effect of ractopamine hydrochloride (Paylean®) on fresh meat and further processing characteristics of muscles from the shoulders of finishing pigs


The objectives of this study were to characterize the effects of ractopamine hydrochloride (RAC) on fresh meat and further processing characteristics of muscles from the shoulders of finishing pigs. Two hundred and forty shoulders originating from 120 carcasses (60 barrows and 60 gilts) were selected from a commercial population of pigs. This study was conducted as a 2 × 2 factorial in a completely

Keywords: Beef quality, Carcass, Market survey
randomized design. Factors were RAC inclusion in the diet (0 mg/kg or 7.4 mg/kg) and sex (barrow or gilt). Paired shoulders (120 rights and 120 lefts) were transported from a federally inspected harvest facility under refrigeration to the University of Illinois Meat Science Laboratory for evaluation. Subsequently, right and left shoulders were separated and designated for 2 separate experiments. Experiment 1 used right shoulders to determine further processing and sensory characteristics. Cottage bacon was manufactured from cellar trimmed (CT) butts of the Boston butt shoulders. Experiment 2 used left shoulders to determine fresh meat characteristics. In general, interactions between RAC and sex were not statistically different (P>0.05) during both experiments; therefore data were reported as main effects. Pigs fed RAC had greater trimmed shoulder weight (P<0.01) and increased yields of cuts from the shoulder such as CT butt (P<0.01) and cushion (P=0.04). Feeding RAC decreased Boston butt fat content (P=0.01), but had no effect on picnic fat content (P=0.86). Pigs fed RAC had greater (P<0.01) iodine values than controls. Inclusion of RAC had no effect on cottage bacon cooked yield (P=0.33), reduced (P=0.01) cottage bacon fat content, but had no effect on protein content (P=0.50). In addition, cottage bacon from RAC shoulders had greater slice total area (P=0.01) and less percent seam of total area (P=0.01) than controls. Cottage bacon from RAC pigs had texture (P=0.36), juiciness (P=0.09), saltiness (0.07), and off-flavor (P=0.18) similar to controls. Shoulders from pigs fed RAC might be of benefit to the industry because they provide more pounds of sellable product with no detrimental effects on processing characteristics.

Keys: Shoulder, Cottage bacon, Ractopamine hydrochloride

Objective color, trained and consumer sensory evaluation of ground beef from commodity, non-fed and premium trimmings  

The objective of this study was to determine the differences in objective color, trained and consumer sensory assessment of ground beef made from three different lean sources: commodity (USDA low choice and select; COM), premium (USDA average and high choice; TC), or non-fed (USDA utility; COW) and two different fat sources, COM and TC. Two replicates were made with IMP 168 inside rounds and 171B bottom round flats from COM, TC, and COW carcasses (n=6) for lean trim and beef plates and navelos from COM and TC carcasses (n=6) for fat trim. Products were transported under refrigeration to the University of Florida. Lean products were trimmed and all products were coarse ground through a 0.64 cm plate and analyzed for fat percentage. The next day, lean and fat sources were mixed and ground through a 0.32 cm plate to make 80 and 90% lean patties, with all lean and fat source combinations (n=12 treatments/rep). One treatment combination from the first replicate was not included in the analysis due to an elevated fat percentage. Thirty-eight 113 g patties were made per treatment using a Patty-O-Matic® Eazy Slider. Patties (n=30) were individually identified, vacuum-sealed and frozen at −40 °C for assessment of fat analysis (n=2), consumer sensory analysis (n=25) and trained sensory analysis (n=3), respectively. The remaining patties (n=8) were individually placed on Styrofoam and overwrapped with polyvinylchloride for objective color evaluation. Packages (n=96) were placed in a coffin display case, and Hunter L*, a*, and b* reflectance data was collected for 5 d. Trained panelists evaluated patties for juiciness, beef flavor, and texture on scales of 1 through 8 (1 = extremely dry, extremely bland and extremely soft; 8 = extremely juicy, extremely intense and extremely firm). Also, panelists evaluated off-flavor using a scale of 1 through 5 (1 = extremely grey; 5 = not grey). Consumer panelists evaluated patties for overall acceptability, taste and texture on 9-point scales (1 = dislike extremely; 9 = like extremely), and juiciness and crumbliness using just about right scales (1 = too juicy, too crumly; 5 = too dry, not crumbly enough).

Patties containing COW lean trim were darker (lower L* values; P=0.002) for all display days and redder (greater a* values; P<0.001) for d 0 and 1 of retail display. Fat trim source had no affect on L* and b* values (P≥0.25). Trained panelists found 80% lean patties juicier, greasier and to have more off-flavor (P≤0.028) than 90% lean patties. Trained panelists found patties containing TC lean firmer (P≤0.025) than COW or COM lean patties. Lean or fat source did not affect trained assessment of flavor (P≥0.27) or consumer panelists’ assessment of overall acceptability (P≥0.29). Consumer panelists tended (P≥0.07) to give 80% lean patties greater scores for overall acceptability and flavor than 90% lean patties. All variables were analyzed using the main and interactive effects of lean source, fat source and lean percentage, and replicate was used as a covariate.

Products using COW lean source were darker and redder, yet within this trial lean and fat source had marginal influence on trained panelists’ values for flavor or overall consumer acceptability.

Keys: Ground beef, Premium quality trim

Relationships between beef post-harvest biochemical factors and Warner–Batzler shear force  
P. Orozco-Hernandez*, R. K. Miller, A. L. Grayson, S. M. Parketon, S. B. Smith, G. E. Carstens, Texas A&M University, College Station, TX, United States

Biochemical changes in muscle post-harvest have been associated with initial beef tenderness early post-harvest, and with improvements in tenderness with subsequent post-harvest storage, defined as meat aging. Differences in the initial contractile state of the sarcomere, the ionic environment of the sarcoplasm including pH, the activity of neutral proteolytic enzymes, and collagen content and solubility have been associated with beef tenderness. Our objective was to examine the relationship in the aforementioned biochemical factors associated with differences in beef tenderness in a population of beef steaks aged 3, 10 or 17 days that varied in Warner–Batzler shear force (WBS) to understand factors associated with differences in beef tenderness. Samples (n=169) were obtained from two beef studies where steers and heifers had been similarly fed at Texas A&M University (n=692). Samples were selected based on 17 d WBS measured on the top loin longissimus lumborum (LM) of 2.54 cm steaks to be either tough (TO; >30 N of WBS, n=81) or tender (TN; <30 N of WBS, n=88). Cattle were commercially harvested at Sam Kane Beef Processors and electrically stimulated. Carcasses were chilled at approximately 2 °C. Samples, 50 g, were removed from the LM muscle after 45 min, 24 h, and 48 h post-harvest during chilling to measure ionic levels of Ca, Na, and K. The 24 h sample was used to determine μ and m-collapin. Carcass characteristics of hot carcass weight (HCW), 12th rib fat thickness (FT), marbling score, pH, L*, a*, and b* color space values, lean color, ribley area (REA), and kidney, pelvic and heart fat (KPH) were determined after 36 h of chilling. The USDA yield grade (YG) and quality grades (QG) were calculated. The loin was removed and 2.54 cm thick steaks were cut. Steaks were randomly assigned to post-harvest aging times of 3, 10 or 17 days. After aging, levels of Ca, Na, K, μ and m-collapin, and Warner–Batzler shear force (N) were detected. Intact desmin (ID) was measured in 24 h, 3 and 14 d samples. Sarcomere length (SL) was measured in 3 d samples. Total collagen (TC) and percentage soluble collagen (SC) were determined in steaks aged 17 d. Data were analyzed using Proc MIXED with study as a random effect and tenderness group as a main
effect. Simple correlation coefficients were calculated. TO carcasses had greater levels of adjusted FT (P=0.02) and less marbling and QC levels (P=0.01) than TN carcasses. REA, KPH, HCW and YG did not differ (P>0.05). TN steaks had decreased pH (P=0.05), lighter color (P=0.01), and were more yellow (P=0.04) and red (P=0.01) than TO steaks. TN and TO did not differ in SL, TC and SC (P>0.05). At 24 h and 48 h, TN steaks had greater concentration (P=0.02) of Ca. At 24 h, TN had less concentration (P=0.02) of K. Ca 24 h and Ca 48 h were correlated (P=0.001). The interaction of TC and SC affected the concentration of QC (P=0.001). Addi-

**Effect of grilling and USDA quality grade on neutral lipid and phospholipid fatty acids of beef strip steaks**

J. F. Legako*, T. N. T. Dinh, M. F. Miller, J. C. Brooks, Texas Tech University, Lubbock, TX, United States

Thermal degradation of beef lipids is known to result in flavor contributing compounds. Degradation of lipids is dependent upon the degree of saturation of fatty acids. Previously, phospholipids (PL) have been shown to make greater contributions to volatile flavor compounds, than neutral lipids (NL). However, there is little information outlining how specific fatty acids among different USDA quality grades are affected by grilling. Therefore, it was the objective of this study to determine the effect of grilling (G) and quality grade (QC) on fatty acids of two lipid fractions (LF). Fatty acids among NL and PL fractions were determined from raw and grilled *longissimus lumborum* steaks (n=2 per animal in duplicate) from eight steers of A maturity representing three USDA quality grades (prime, low choice, and standard). Lipids were extracted from homogenized raw and grilled steaks (71 °C internal temperature), having the external fat removed, by a chloroform–methanol method. Extracted lipids were fractionated based on polarity using a silica cartridge. Each lipid fraction was converted to fatty acid methyl esters prior to separation and analysis by gas chromatography. Among 22 quantified fatty acids the interaction of QC×LF×G was shown to affect two polyunsaturated fatty acids (PUFA; PL=0.22 mg/g, NL=0.09 mg/g; *P*<0.001). The interaction of LF×G and QG×LF affected the concentration of several mono-unsaturated fatty acids and PUFA, including: myristoleic acid (C14:1), palmitoleic acid (C16:1), cis-10-heptadecenoic acid (C17:1), elaidic acid (C18:1n9t), oleic acid (C18:1n9t), gadoleic acid (C20:1), linolenic acid (C18:3n3), and cis-11,14-eicosadienoic acid (C20:2); *P*<0.001. The interaction of QC×LF affected the concentration of cis-8,11,14-eicosatrienoic acid (C20:3n6; *P*<0.001). Lipid fraction differences were observed for PUFA arachidonic acid (C20:4n6; PL=0.22 mg/g, NL=0.09 mg/g; *P*<0.001). Additionally, the concentration of other PUFA (0.89 mg/g of linoleic acid; 0.02 mg/g of γ-linolenic acid; and, 0.04 mg/g of linolenic acid; and 0.09 mg/g of cis-8,11,14-eicosatrienoic acid) greatly contribute to the PL fraction (10–15 mg/g of lean tissue). These results indicate that grilling, quality grade, and lipid fraction interact to affect fatty acids known to contribute to beef flavor. These findings also support the importance of PL to beef flavor development.

**Effect of modified distillers grains with solubles and crude soybean glycerin inclusion in beef cattle finishing diets on beef bologna quality**


The objective of this experiment was to evaluate the inclusion of modified distillers grains with solubles (MDGS) and crude glycerin in beef finishing diets, on quality characteristics of beef bologna. Crossbred steers and heifers (n=48) were assigned randomly to one of four dietary treatments and fed individually using a Calan gate feeding system. Treatments were arranged in a 2×2 factorial design as follows: traditional steam flaked corn and soy finishing diet with no MDGS or glycerin (CON); CON with 40% MDGS substitution (MDGS); CON with 10% glycerin added (GLY); and both 40% MDGS and 10% glycerin added (MDGS/GLY). Crude glycerin and MDGS inclusion was in place of steam flaked corn in the MDGS, GLY, and MDGS/GLY treatments. At a mean weight of 590 kg, cattle were humanely harvested at a commercial abattoir in two groups. Shoulder clods (IMPS #114) were removed from the right side of each carcass 48 h postmortem, vacuum packaged, and stored at 4 °C. Shoulder clods were ground individually, twice through a 0.375-cm grinder plate. A portion of this grind was used for beef bologna production. For bologna production the second blended meat block was chopped with seasoning, ice, and stuffed into clear, fibrous casings. Product was cooked and smoked to an internal temperature of 71 °C and chilled to 4 °C. Each batch was sliced and one slice per batch was placed on a polystyrene tray, vacuum packaged and stored at 4 °C under cool white fluorescent lighting for 7 days. Objective color values (L*, a*, and b*) were taken at six locations on each package every 24 h. Subjective color scores (lean color, surface discoloration and overall appearance) were evaluated by an eight member trained visual sensory panel every 24 h. Bologna for consumer sensory evaluation was sliced, cut into eight pieces and served to an untrained consumer panel (84 panelists). Each panelist was asked to evaluate overall liking, flavor liking, texture liking, toughness, and off flavor. The addition of modified distillers grains decreased L* value (P=0.02), while glycerin increased L* (P<0.001) in resulting bologna. The addition of glycerin also decreased a* value (P=0.07), but had no effect on b* (P=0.94). Modified distillers grains had no effect on a* or b* (P=0.78 and 0.38, respectively). Modified distillers grains also had no effect on subjective lean color, surface discoloration, and overall appearance (P=0.42, 0.41, and 0.39, respectively). However, with the addition of glycerin, lean color decreased (P=0.001; 3.38 vs. 3.21) and surface discoloration increased (P=0.002; 3.34 vs. 3.15). The addition of modified distillers grains decreased overall liking (P<0.001) and flavor liking (P<0.0001) and CON and MDGS had lower texture liking than GLY and MDGS/GLY (P<0.0001). The addition of distillers grains also resulted in increased toughness (P=0.0001) and off flavors (P=0.0002). The results of this experiment show that the addition of modified distillers grains does not negatively affect objective or subjective color scores of beef bologna, but may have an impact on sensory attributes. Additionally, the inclusion of glycerin may negatively impact subjective color scores.

**Free amino acids in water-soluble extract from beef strip steak**

T. T. N. Dinh*, J. F. Legako, M. F. Miller, J. C. Brooks, Texas Tech University, Lubbock, TX, United States

Maillard reaction between amino acids and reducing sugars upon heating has a noteworthy impact on beef flavor. The Strecker degradation
of amino acid oxidation products, especially those derived from sulfur-containing amino acids such as cysteine (or its oxidized derivative, cystine) during cooking creates important flavor notes in thermally processed meat. In addition, consumer preference of beef flavor increases with an increase in quality grade. Therefore, the objective of this study was to determine the effect of quality grade on the concentrations of free amino acids in water-soluble extracts from beef strip steak. Small molecular weight (≤3 kDa), water-soluble compounds were extracted from raw *longissimus lumborum* steaks (*n* = 2 per subprimal) from steers of A maturity representing three USDA quality grades (prime – PR, low choice – LC, and standard – ST; *n* = 8 per quality grade). Raw steaks (2.54-cm thickness) were trimmed of the external fat, frozen in liquid nitrogen, homogenized to powder, and extracted using cold water. Free amino acids were determined by a two-step derivatization process and a gradient reversed-phase high pressure liquid chromatography (RP-HPLC) method with fluorescence detection. The USDA quality grade had significant effects on most amino acids (*P* = 0.006), except for proline, cysteine, alanine, β-alanine, and ornithine (*P* = 0.066 to 0.627). The concentration of cysteine in LC steaks was greatest (2.360 μmol/kg; *P* = 0.002 and 0.005), whereas that of cysteine was similar among three quality grades (0.123 to 0.170 μmol/kg; *P* = 0.095). The LC and PR steaks had similar concentrations of amino acids that are the precursors of Streccher aldehydes (serine, threonine, valine, isoleucine, phenylalanine, and leucine), which are important to cooked meat aroma (*P* = 0.05 to 0.704). Such concentrations were all greater than those found in ST steaks (*P* > 0.001). Hydroxyproline, aspartic acid, and tryptophan were the least of all free amino acids (0.028 to 0.056 μmol/kg; *P* < 0.001), whereas alanine, glutamine, and cystine were the greatest (1.780 to 8.726 μmol/kg; *P* < 0.001). Increased concentrations of amino acids that are important to cooked meat aroma, such as cystine, in LC and PR steaks (0.351 to 2.360 μmol/kg; *P* < 0.05) suggest that quality grade has an important impact on flavor precursor compounds.

Keywords: Beef, Flavor precursor, Amino acid

---

**Biochemical and structural changes on the protein fractions during broiler pale, soft and exudative (PSE) chicken meat ageing**

Denis F. Marchi, Gleice R. dos Santos, Adriana L. Soares, Francisco J. Hernandez-Blazquez, Mayka R. Pedrão, Elza I Ida, Massami Shimokomaki, *Dept Food Science and Technology, Londrina State University, Londrina, PR, Brazil, School of Veterinary Medicine Faculty and Animal Science, São Paulo University, São Paulo, Brazil, Parana Federal Technological University, Campus Londrina, Parana Federal Technological University, Campus Londrina, Londrina, Pr, Brazil*

The biological cause of broiler PSE meat seems to be an excessive release of Ca²⁺ promoted by a genetic mutation of ryanodine receptors located in the sarcoplasmic reticulum of skeletal muscle cells. Excessive Ca²⁺, associated with protein denaturation in meat, enhances protease activity and influences the functional properties of PSE meat. The PSE meat is the consequence of a postmortem accelerated glycolysis while the carcass is still warm (app. 35 °C), and under these conditions the myofibril proteins would denature jeopardizing their functional properties. The objective of this work was to assess the biochemical and structural changes throughout the conditioning period of 120 h at 0 °C of broiler breast fillet meat (pectoralis major m.). Samples were obtained from 42-day old broilers from a commercial plant and slaughtered according to the standard industry practice. The pH was measured by inserting electrodes into the meat samples using a contact pH meter system (Testo 205). A Minolta CR400 colorimeter was used to evaluate the L*. Thirty six samples were classified as normal at initial pH<sub>H</sub>1.5 ≤ 5.8. Myofibril fragmentation index (MFI) was determined as the indirect measurement of calpain activity. Cooking loss (CL) was measured by weighing before and after 30 min cooking when the internal temperature reached 75 °C. Post-mortem samples were fixed in 2% glutaraldehyde in a 0.14 M sodium cacodylate buffer at pH 7.4, containing 0.18 M sucrose for histological evaluation by electron microscopy. Ultrathin sections (50 nm) were stained with saturated uranyl acetate in 50% ethanol and 1% lead citrate in water for 1 h. The sample ultrastructure was observed with a JEOL JEM-1010 scanning electron microscope. The SDS/PAGE analysis was carried out in samples stored at 0 °C for 4, 24, 72 and 120 h postmortem. The Tukey test was used to determine significant difference (*P* ≤ 0.05) between the two samples (Statistica software 6.0). The PSE meat samples presented higher values of L* and CL than control meat. Protease activity, measured as MFI, presented higher values in PSE meat than in control samples at 72 h postmortem. Ultrastructural examination revealed shrinking and depolymerization of myofilaments and Z-line disorganization within the sarcomere in PSE meat samples started from 4 h postmortem. Intense calpain activity was also observed, indicating that the process may initiate at the filaments, because of protein denaturation, and spread through Z-lines, resulting in the collapse of the sarcomere structure in PSE samples at 120 h conditioning. The SDS/PAGE shows a typical run of calpain activity on troponin T as two bands appear between the region of 25 and 30 kDa in PSE meat at 4 h postmortem and not observable in normal samples. Collagen fibers also seem to be affected as electron micrographs show faint fibrils within the endomysium where the control samples present muscle fibers with entirely filled endomysial networks with noticeable collagen fibers. In conclusion, the excess of Ca²⁺ promotes the greater activity of proteases observed by SDS/PAGE and by the changes of the structure of muscle sarcomere reaching its collapsing after 120 h of conditioning.

Keywords: Animal welfare, Thermal stress, Meat qualities

---

**Meat Safety: General Abstract**

**Inhibition of Listeria monocytogenes by propionic acid based liquid antimicrobial in reduced sodium deli-style ham**

Mani Badvela, *Kemin Food Technologies, Des Moines, Iowa, United States*

The objectives of this study were 1) to validate the inhibition of *Listeria monocytogenes* (Lm) and spoilage microflora by propionic acid based liquid antimicrobial in ready-to-eat (RTE) ham, having 32% reduced sodium (avg. 850 mg sodium/100 g) compared to traditional water added RTE ham available in the market, and 2) to evaluate the effects on sensory and quality attributes (color and purge loss). Four formulations of sliced, cured (156 ppm sodium nitrite) RTE ham were tested including untreated control without antimicrobial, 2.5% potassium lactate–sodium diacetate blend (positive control), 0.3% and 0.4% propionic acid based liquid antimicrobial. Ham treatments were surface inoculated with a five strain mixture of Lm to provide approximately 5 log CFU per 100-g package (equivalent to 3 log CFU/ml of rinse material when using 100 ml rinse for testing). Inoculated products were vacuum packaged and stored at 4 °C for up to 12 weeks. Triplicate inoculated samples were assayed for changes in Lm populations by plating on Modified Oxford agar. Sampling was discontinued for a formulation if there was > 1-log CFU/pkg for two or more consecutive sampling intervals or > 2-log increase. Duplicate uninoculated samples were assayed for changes in lactic acid bacteria and pH at 0-time, and at 2, 4, 6, 8, 10 and 12 week storage at 4 °C. The study was replicated twice. (CIE) L*, a*, and b* values (lightness, redness, yellowness, respectively) and purge loss by weight difference method.
were measured on triplicate uninoculated samples for each treatment at five different times post processing (0, 3, 6, 9, and 12 weeks). Informal sensory evaluation was conducted on the ham treatments during each replication using rank preference testing. Treatments were blindly labeled and presented to untrained panelists. The microbiological data was reported as average values and standard deviations (log CFU/ml rinse) for triplicate samples and two separate trials (n = 2) for each test formulation. Differences between the antimicrobial treatments and the untreated control were analyzed by one-way analysis of variance (ANOVA). The color, purge loss and sensory overall rank preference results were also subjected to ANOVA. The results showed that 0.3% and 0.4% propionic acid based liquid antimicrobial and 2.5% potassium lactate–sodium diacetate limited the growth of Lm to <1 log increase through 12 weeks for both replicates. Lm grew rapidly on the untreated control and showed an average increase of 1.11 ± 0.05 and 1.79 ± 0.31 logs at 4 and 6 weeks, respectively. Statistical analysis confirmed that the antimicrobials inhibited (p<0.05) the growth of Lm compared to the untreated control. Color, purge and sensory results showed no significant differences (p>0.05) between the antimicrobial treatments.

The overall results indicated that the propionic acid based liquid antimicrobial was effective in inhibiting L. monocytogenes in a reduced sodium RTE ham at much lower levels than lactates without adversely impacting the quality attributes. This research showed that the propionic acid based liquid product is a potential antimicrobial for enhancing the safety of reduced sodium processed meats.

Keywords: Propionic acid, Listeria, Antimicrobial

Reduction of Escherichia coli O157:H7 following application of various sanitizing treatments to harvesting knives

W. N. Tapp III*, S. E. Gragg, J. C. Brooks, M. M. Brashears, M. F. Milller, Texas Tech University, Lubbock, TX, United States

Escherichia coli O157:H7 is an enteric pathogen that can cause severe illness and possible death if ingested. This organism acts as a potential contaminant to meat during animal harvest. Knives used can become contaminated during the process. If not properly sanitized knives can become a vehicle to spread contamination to carcasses processed thereafter. Research has shown that a short thermal sanitation treatment, utilizing 82 °C water, is effective for sanitizing knives used during harvest. However, in some countries hot water is not readily available. The purpose of this study was to assess the effectiveness of non-thermal sanitation along with changes to treatment methodology, on E. coli O157:H7 reduction from stainless steel boning knives. Knives used were new boning knives similar to those used in harvesting facilities. Dip treatments included, 1.1% sodium metasilicate (SMS), 200 ppm quaternary ammonium compounds (QAC), 200 ppm chlorine (Cl2), 5% lactic acid (LA), 82 °C water (HW), and 21 °C water (RTW). Three replications of 18 knives (36 sides) were processed to show initial and treated pathogen loads on a CFU/cm² basis. Knife blades were fully immersed in a cocktail of E. coli O157:H7 for 5 min, in effort to reach attachment on blades of at least 10² CFU/cm². Viable E. coli O157:H7 cells were detected in the cocktail by confirmation on selective media. Following inoculation, one side of the knife blade was sponged with a spongesicle pre-hydrated with 10 ml of a neutralizer specific to the sanitizing treatment; in the case of water treatments buffered peptone water (BPW) was used for sampling. 30 second immersion in each sanitizer was applied to knives. Opposite sides of the knife blade were sponged just as pre-treated sides to show reduction. Samples were stomached at 230 RPM for 1 min, dilutions were made in neutralizers or BPW, plated on selective media utilizing both spiral and spread plating, and subsequently plates were allowed to incubate at 37 °C for 24–48 h before enumeration. Mean attachment of E. coli O157:H7 was 5.09 log CFU/cm² per knife. Following treatment mean log reductions of E. coli O157:H7 were 1.16, 3.51, 3.38, 1.38, and −0.41 CFU/cm², following treatment in SMS, QAC, Cl2, LA, HW, and RTW, respectively (P<0.05). Data indicated that each treatment, aside from water controls, resulted in a significant pathogen reduction (P<0.001). Results depict that changes to sanitation time along with use of sanitizing agents in ambient temperature water treatments provide significant reduction of E. coli O157:H7 on knives used in animal harvest. Sanitation alternatives are available to achieve E. coli O157:H7 reduction if there is no hot water source.

Keywords: Escherichia coli O157:H7, Sanitation, Contamination

Methods for controlling Escherichia coli O157:H7 and Salmonella surrogates during the production of non-intact beef products

C. Ulbrich*, K. Harris, M. Taylor, J. Savell, Texas A&M University, College Station, TX, United States

This study evaluated methods for controlling surrogates of Escherichia coli O157:H7 and Salmonella during production of marinated non-intact beef products. Boneless, beef strip loins (n=63, IMPS 180) were used in this study. Two preparations, 6.0 and 2.0 log10 CFU/cm², of nonpathogenic, rifampicin-resistant E. coli organisms (ATCC # 1427, 1428, 1430) were used to simulate post-harvest contamination. Strip loins were inoculated hot (~30 °C), chilled at 2 °C for 24 h, vacuum packaged and aged for 7 to 24 days. Beef strip loins were subjected to one of six treatments or controls (no treatment). Treatments were sprays of (1) 2.5% l-lactic acid, (2) 5.0% l-lactic acid, (3) 1050 ppm acidi peroxycetic acid, and (6) tap water. Lactic acid treatments were applied at 53 °C, whereas the other sprays were applied near room temperature (17.9 °C to 26.1 °C). Treated and control pieces were marinated using a commercial marinade. Sample counts were collected throughout the experiment to track microbial reductions as affected by antimicrobial treatment. For 6.0 log10 CFU/cm² inoculated strip loins, the 5.0% l-lactic acid treatment was most effective (P<0.05) at reducing pathogen surrogates on meat surfaces prior to marination, resulting in a 2.6 log10 CFU/cm² mean reduction. Water and HOBr treatments accounted for the least (P<0.05) reductions of surrogates on meat surfaces prior to marination. Mean reductions of surface surrogate organisms across all treated and control finished, marinated product ranged from 1.7 to 2.4 log10 CFU/cm². Reduction of surface surrogate organisms in finished, marinated product was greatest following peroxycetic acid application (P<0.05). Marinated loins treated with water were observed to have greater numbers of internalized pathogen surrogates as compared to controls (P<0.05). While reductions in surface counts were achieved for all treatments, internalization of surrogate organisms was observed in the finished product. Furthermore, some antimicrobial sprays such as water may facilitate or allow for greater internalization of surface-contaminating bacteria, even more so than non-treated subprimals. It is important that producers of non-intact beef focus on using effective antimicrobial systems that maximize pathogen reduction so as to minimize risk of internalizing surface-contaminating bacteria into a finished product.

Keywords: Beef, Non-intact, E. coli

Antimicrobial effect of volatile plant essential oils on L. monocytogenes in MA packaged bologna

L. L. Slaughter*, G. Rentfrow, M. Newman, J. G. Skudlarek, University of Kentucky, Lexington, Kentucky, United States
The objective of this study was to evaluate the antimicrobial effect of volatile plant essential oils on *Listeria monocytogenes* (LM, ATCC 4644) in modified atmosphere (MA) packaged bologna. LM was obtained from the University of Kentucky Food Microbiology stock strains. Essential oils of East Indian lemongrass and tea tree were measured for basic volatile anti-listerial effect by undiluted volume (0.05 ml, 0.075 ml, 0.10 ml). The first experiment evaluated three quantities per essential oil on days 1 and 3. Agar plates were inoculated at approximately 5 log<sub>10</sub> colony-forming units per ml (CFU/ml). A sterile 12.7 mm filter paper was taped to the inside center of each inverted plate lid, and one of 3 volumes (0.05 ml, 0.075 ml, 0.1 ml) of undiluted oils was pipetted onto the filter surface. The inverted plates were stored at 37 °C. There was a significant interaction between the compound×day (P≤0.001) on colony growth, and no interaction between compound×quantity (P≥0.24). Lemongrass completely inhibited L. monocytogenes growth until day 3 at 0.10 ml (2.97 log<sub>10</sub> CFU/g). The second experiment evaluated the volatile effect of lemongrass and tea tree oil on LM (ATCC 4644) in MA packaged bologna containing 85/25 fat percentage bologna formulated without sodium diacetate for days 1, 3, and 7. Single bologna slices were inoculated to labeled trays, surface- spread inoculated at 7 log<sub>10</sub> CFU/ml with LM. Samples were packaged in 4.32 cm MA packaging trays using a Ross InPack Junior A10 with an 80% O<sub>2</sub>, 20% CO<sub>2</sub> modified atmosphere. Rubber adhesive seals were applied to each package above plastic cups positioned in the tray, and an undiluted 1 ml of either lemongrass oil or tea tree oil was injected into a plastic without releasing packaged gas. Samples were stored under constant, cool white florescent lighting (1300 lx) at 4 °C for either 1, 3, or 7 days. Collected bologna slices were stomached with Bacto-Perptone solution at a 1:10 dilution for approximately 1 min, and then plated in duplicate on MOX using a spiral plater. Colony growth was measured with a plate reader after a 24 hour incubation at 37 °C. Lemongrass oil resulted in average colony counts at days 1, 3, and 7 as 5.43 log<sub>10</sub> CFU/g, 5.44 log<sub>10</sub> CFU/g, and 4.56 log<sub>10</sub> CFU/g, respectively. Tea tree oil measured average colony counts at days 1, 3, and 7 were 5.60 log<sub>10</sub> CFU/g, 5.54 log<sub>10</sub> CFU/g, and 5.11 log<sub>10</sub> CFU/g, respectively. Comparatively, the control samples showed average colony counts at days 1, 3, and 7 of 5.43 log<sub>10</sub> CFU/g, 5.26 log<sub>10</sub> CFU/g, and 4.57 log<sub>10</sub> CFU/g, respectively. Day significantly decreased growth (P≥0.006). However, no significant effect on growth was seen for either compound (P=0.13) or compound×day (P=0.93). These data suggest that the anti-listerial volatility of these essential oils on LM was absent at the concentrations utilized in this study.

**Keywords:** *Listeria*, Modified atmosphere, Essential oil

---

**Thermal inactivation of *Listeria monocytogenes*, *Salmonella* and shiga-toxin producing *E. coli* in ready-to-eat ham and turkey breast**

A.M. King<sup>a</sup>, R.P. McMinn<sup>b</sup>, J.J. Sindelar<sup>a</sup>, K.A. Glass<sup>b</sup>, R. Hanson<sup>c</sup>,

*University of Wisconsin, Madison, WI, United States, *Food Research Institute, Madison, WI, United States, *HansonTech, Hudson, WI, United States

USDA, FSIS Appendix A is widely used as validation support for thermal processes of processed meats, but its time–temperature tables were developed only for *Salmonella* in roast, cooked, and corned beef. Pathogen- and product-specific time–temperature tables are needed to improve the validation of thermal processes. The objective of this study was to determine the temperature–death times of *Listeria monocytogenes*, *Salmonella*, and shiga-toxin producing *E. coli* (STEC) in ready-to-eat ham and turkey breast at 54.4, 60, 65.6, and 71.1 °C. This study was designed to investigate thermal inactivation pathogen rates and determine D- and Z-values of ground meat mixtures. Ground ham (containing 2.5% salt, 1.65% sugar, 0.35% sodium phosphates, 547 ppm Na erythorbate, 200 ppm Na nitrite, 20% water) or ground turkey breast (containing 1.5% salt, 1.5% dextrose, 20% water) were inoculated with 8 log CFU/g of *L. monocytogenes* or *Salmonella* (5-strain mix) or STEC (7-strain mix). One-gram portions (0.5–1.0 mm in moisture-impermeable vacuum pouches) were heated at one of four temperatures (54.4, 60, 65.6, or 71.1 °C) in a water bath. Triplicate samples were removed and immediately chilled to ≤4 °C when meat reached the target temperature and at seven additional times. Surviving *L. monocytogenes*, *Salmonella*, or STEC were enumerated using Modified Oxford, XLD, or Sorbitol MacConkey agar base, respectively, with thin layer overlay of nonselective media to enhance recovery of injured cells. Each study was replicated twice. Linear regressions of the data were used to calculate D-values and significant differences (p<0.05) were determined using one-way ANOVA. In both ham and turkey, inactivation rates for STEC and *Salmonella* were comparable to or less than the times reported in Appendix A, while *L. monocytogenes* was the most heat tolerant of the three pathogens. For example, at a reference temperature of 65.6 °C, the D-values for *L. monocytogenes* were ten-folds greater (p<0.05) than for *Salmonella* and STEC in ham. At the same reference temperature, D-values for STEC and *Salmonella* were not significantly different from each other (p>0.05). At 60 °C, >5-log reduction of *L. monocytogenes* required 30 and 50 min in turkey and ham, respectively, as compared to only 8 min for *Salmonella* and STEC. At the lowest temperature tested (54.4 °C), the time required for >5-log reduction of *Salmonella* and STEC was 6 min, comparable to Appendix A, while the same reduction of *L. monocytogenes* was achieved in 5 and 6 h for turkey and ham, respectively. Results from this study support Appendix A as an acceptable tool for *Salmonella* and STEC lethality and provide new thermal processing guidance to appropriately address pathogenic bacteria in RTE meat products. For future studies, the temperature–death times calculated from this data should be validated using commercial products, and take into account integrated lethality, where additional pathogenic log reductions are expected. Project results from generating D- and Z-values as well as understanding additional lethality effects from integrated validation will be important for establishing new data for use in pathogen modeling programs.

**Keywords:** Thermal processing, Food safety, Validation

---

**Prevalence and characterization of *Salmonella* recovered from lymph nodes and feces of cattle at harvest in Mexican slaughter facilities**

S. Gragg<sup>a</sup>, G. Loneragan, K. Nightingale, J. Elder, H. Ruiz, M. Miller, A. Echeverry, M. Brashears, Texas Tech University, Lubbock, Texas, United States

The objectives were to 1) determine *Salmonella* prevalence within lymph nodes (LN; subiliac [SUB], mediastinal [MED], mesenteric [MES] and mandibular [MAN]) and feces (F) of cattle at harvest and 2) perform pulsed-field gel electrophoresis (PFGE) typing to characterize a subset of *Salmonella* isolates in order to probe the genetic relatedness and transmission dynamics of *Salmonella* from F, hides (H) and LN. We hypothesize that certain *Salmonella* strains evolved for survival within LN and exploration into genetic relatedness will provide insight into how *Salmonella* gains entry into the body, disseminates throughout the lymphatic system and colonizes various LN. Lymph nodes (n=444) and F (n=71) were collected from each carcass at three slaughter facilities in Mexico (Veracruz, Merida, and Cuahtla). Samples were trimmed to remove adipose tissue, surface-sterilized in boiling water, enriched in tryptic soy broth, subjected to immunomagnetic separation and streaked onto xylose
Salmonella prevalence in lymph nodes and feces of cattle presented for harvest in Mexico

Henry Ruiz*, Mark Miller, Guy Lonneragan, Sara Gragg, Mindy Brashears, Lyda Garcia, Texas Tech University, Department of Animal and Food Sciences, Box 42141 Lubbock, TX 79409, United States

Introduction: Salmonella has the ability to survive and disseminate throughout the lymphatic tissue and lymph nodes (LN). Because a majority of LNs are encased within adipose tissue and can easily be incorporated into ground beef, there is a need to determine the prevalence of Salmonella and to distinguish which are more prone to Salmonella infection.

Purpose: The purpose of this study was to determine the overall prevalence of Salmonella isolated from LNs and feces of cattle at harvest in Mexican harvest facilities in Veracruz, Merida, and Cuautla, Mexico.

Methods: From each carcass, one lymph node from the following: (subiliac, mandibular, mediastinal and mesenteric) was collected (n=458) and feces was also collected from (n=85) the same carcasses. LN samples were enriched using tryptic soy broth (TSB), processed through immunomagnetic separation (IMS) and streaked on xylose lysine desoxycholate agar. Presumptive colonies were confirmed using latex agglutination. Prevalence of Salmonella in Veracruz was 58.1%, 5.4%, 67.0%, 87.1%, and 80.0% for MAN, MED, MES, SUB and F, respectively. In Merida, Salmonella prevalence was 54.3%, 0.0%, 57.1%, and 57.1% for MAN, MED, MES, and F, respectively. In a Cuautla facility, prevalence was 40.0%, 20.0%, 10.0% and 40.0%, for MAN, MED, MES, and F, respectively. Salmonella isolates obtained from LN and F of a subset of cattle slaughtered in Veracruz, Mexico, were characterized by PFGE. Carcasses containing Salmonella within multiple LN were analyzed and their resultant patterns were evaluated to identify similarities among tissues within and between animals. Indistinguishable PFGE patterns were obtained from the MES and SUB LN within the same animal, F and MES LN within the same animal, and MED LN among different animals. Indistinguishable PFGE patterns were also identified in the MES and SUB LN, with a similar pattern on the H, of one animal, and in the SUB LN, F, and H of another animal, which may suggest transdermal entry from fecal contamination on the H. Considering that some LN are combined into food products (e.g., SUB LN associated with the fat trim in ground beef), a potential for Salmonella to contaminate the food supply exists. Efforts to identify factors that may lessen contamination, such as prevention of LN contamination, removal of LN from trim or downstream lethality interventions of beef products, are necessary. These isolates of Mexican-origin provide the opportunity to explore relatedness questions that would not be acceptable on US isolates. The PFGE patterns indicate that certain Salmonella are more likely to be isolated from specific LN, suggesting various routes of entry into the body. For example, the presence of an indistinguishable Salmonella strain within the MED LN of different animals may indicate that these strains enter the body by a shared route. In conclusion, these data can provide information for the development of practical interventions that are designed to decrease risk of Salmonella in finished beef products.

Keywords: Lymph nodes, Salmonella, Mexico

Results: The overall prevalence was 51.4%, 6.8%, 61.1%, 65.2% and 69.1% for mandibular LN, mediastinal LN, mesenteric LN, subiliac LN and feces, respectively.

Significance: Results suggest that Salmonella is commonly harbored in cattle lymph nodes throughout the body with certain lymph nodes having a significantly higher concentration of Salmonella. Also, results suggest that anatomical location may play a role in variation of prevalence with mesenteric lymph nodes having the highest overall prevalence, and mediastina lymph nodes the lowest. These findings should be further investigated to better understand the routes of infection, mode of action and opportunities for Salmonella control in ground beef products.

Keywords: Salmonella, Lymph, Nodes

Meat Science Education and Extension Tools: General Abstract

The development of reference standards for the nutritional labeling of single-ingredient, ground meats containing varying fat percentages

C. E. Ohman*, J. B. Wentherb, A. M. Kinga, L J. Sindelar a, University of Wisconsin, Madison, WI, United States, bAmerican Association of Meat Processors, Elizabethtown, PA, United States

The United States Department of Agriculture’s Food Safety and Inspection Service (USDA-FSIS) recently passed a regulation that requires meat processing establishments and retailers to provide nutrition labeling information to their customers for specific single-ingredient and ground/chopped meat and poultry products. This regulation is in response to an increase in consumer demand for information regarding the nutritional content of food and aligns with the current goals of the health-focused New York Health Initiative, established for improving public health. Although exemptions were provided for small volume (<100,000 lbs) ground meat products, nutrition content of these products is highly desired by consumers. However, meat processors face many challenges in meeting these requirements/demands in providing accurate nutrition information to consumers; specifically, the cost of raw material testing, equipment and batch size, and batch-to-batch variability. The objective of this study was to determine the feasibility of developing simple visual reference guides that correlate to known proximate fats for assisting meat processing establishments in meeting the nutrition labeling requirements. Raw materials from three species (beef, pork, and lamb) with targeted lean/fat ratios of 95/5, 90/10, 85/15, 80/20, 75/25, 70/30, and 50/50 were acquired from a local wholesale meat supplier. Raw material trimmings were reduced to 5 cm wide strips, of varying lengths, and followed by grinds through a kidney-style plate (52 mm), coarse plate (19 mm), and fine plate (3 mm) to represent various stages of processing. For all species and lean/fat ratios, a high quality Canon® digital camera was used to photograph 6.8 kg of meat after each size reduction (n=4) under 24 W compact fluorescent light bulbs, positioned approximately 38 cm above the sample surface. Approximately 100 g of the finely ground sample was then ground two additional times through the fine grind plate to yield a uniform and homogeneous sample for fat analysis. Proximate fat analysis was conducted on six randomly selected 2–3 g samples via the Soxhlet fat extraction (ether) method. Values within +1.5% of the target fat content designation were accepted for use in the creation of visual reference guides. These fat content determination tools were successfully developed for all species (n=3) and all fat contents (n=7) investigated. The visual reference guides will improve the ability to accurately identify the nutrition fat content of single ingredient, ground/chopped meat products by comparing the initial raw materials and matching to the visual reference guide photos on
an ongoing production basis instead of relying on random analytical fat testing of ground product throughout the year.

Keywords: Nutrition, Labeling, Ground meat

Driving change: The 2011 National Beef Quality Audit
J. L. Igoa*, D. L. VanOverbekeb*, G. G. Mafi, D. S. Halec, J. W. Savellf, D. L. Pendellf, D. R. Woernera, J. D. Tatumf, K. E. Belkf, aColorado State University, Fort Collins, CO, United States, bOklahoma State University, Stillwater, OK, United States, cTexas A&M University, College Station, TX, United States

The National Beef Quality Audit — 2011 evaluated the current status and progress being made towards quality and consistency of cattle, carcasses, and beef products produced by the U.S. beef herd population since the introduction of the National Beef Quality Audit in 1991. The objectives of this research were to determine how each beef market sector defines seven quality categories, to estimate willingness to pay (WTP) for specified quality categories within each beef market sector, and to establish a best–worst (BW) scaling for the identified quality attributes. Face-to-face interviews were conducted using a modern, dynamic routing instrument over an 11-mo period (February to December 2011) with representatives of the following beef market sectors: government and allied industries (n=47); feeders (n=59); packers (n=26); food service, distribution, and further processors (n=48); and retailers (n=30). To accomplish the objectives, all responses were characterized using seven pre-established quality categories as the basis for asking interviewees the WTP and BW scaling questions. To determine WTP of the beef market sectors for U.S. fed beef, it was important to first understand what quality meant to each sector as it related to the U.S. fed beef products they purchase. To achieve this, quality was divided into seven pre-established categories: (1) how and where the cattle were raised, (2) lean, fat, and bone, (3) weight and size, (4) cattle genetics, (5) visual characteristics, (6) food safety, and (7) eating satisfaction, and interviewees in each beef market sector were asked to explain exactly which quality-related details/practices were important within each category. The BW scaling was designed to quantify the importance of the seven quality categories using an orthogonal fraction of 27 to create eight sets of questions. Each respondent was asked to choose one category as most important for all eight questions. The model was a logistic regression with sector × attribute interaction as the predictor. Individual comparisons of sectors within attributes were performed in the logit scale using least squares means (PDIF; α = 0.05) and back-transformed to probabilities. Overall, food safety was the attribute of greatest importance to all beef market sectors except feeders, who ranked how and where the cattle were raised as the most important. Eating satisfaction was the attribute of second most importance to all beef market sectors, except feeders. Feeders ranked weight and size as the second most important. Overall, how and where the cattle were raised had the greatest odds (0.25) of being considered a non-negotiable requirement before the raw material for each sector would be considered at all for purchase, and differed (P<0.05) from visual characteristics (0.14), lean, fat, and bone (0.12), eating satisfaction (0.12), cattle genetics (0.10), and weight and size (0.06). Of all market sectors combined, eating satisfaction calculated the highest average percentage premium (11.1%), but only differed (P<0.05) from weight and size (8.8%). Most notably, when a sector said that food safety was a non-negotiable requirement, no sector was willing to purchase the product at a discounted price if the food safety of the product could not be assured.

Keywords: Beef quality, Best–worst scaling, Willingness-to-pay

Muscle and Lipid Biology and Biochemistry: General Abstract

Association of single nucleotide polymorphisms (SNPs) in calpain and calpastatin genes with meat tenderness in Nellore cattle

The aim of this study was to analyze the association between a single nucleotide polymorphism (SNP) in calpain and calpastatin genes and meat tenderness in Nellore cattle. For this purpose, 155 animals (80 steers and 75 young bulls, 23-months old) from the beef herd of University of São Paulo were feedlot finished, and then slaughtered. Cattle were genotyped for a single nucleotide polymorphism (SNP) in calpain (CAPN4751; GenBank accession number: AF248054, position 6545) and calpastatin genes (UOGCAST; GenBank accession number: AY008267, position 282). Additionally, Warner–Bratzler shear force (WBSF) was determined in longissimus dorsi muscle samples aged 0, 7 and 14 days post mortem according to AMSA. Effects of CAPN4751 and CAST on WBSF were evaluated using a mixed model (Mixed Procedure, SAS Inst., Inc., Cary, NC) and repeated measures in animal effect with shear force as the dependent variable.

Results showed that the two alleles of UOGCAST polymorphism were observed in all animals and allele C was slightly more frequent (0.61) than allele G (0.39). However, for the CAPN4751 polymorphism it was observed that the frequency of the allele C (0.17) is lower than allele G (0.83). Regarding genotype frequencies, it was observed that frequencies for the UOGCAST marker were well distributed among genotypes (GG = 13.6%; GC = 51.6% and CC = 34.8%), whereas for CAPN4751 polymorphism, genotypic distributions were asymmetric with low frequency of favorable genotype CC (TT = 69.06%; CT = 28.4% and CC = 2.6%).

In general, there was tenderness improvement during aging regardless of the genotype. There was a significant association (P<0.05) for meat aged from 1 to 7 days (Table 1). SNPs in calpain and calpastatin genes can be used as markers for meat tenderness in Nellore (Bos indicus) cattle for genetic selection programs.

Mean values of shear force (tenderness) according to the molecular marker and aged time.

<table>
<thead>
<tr>
<th>Marker</th>
<th>Genotype</th>
<th>Day 1</th>
<th>Day 7</th>
<th>Day 14*</th>
</tr>
</thead>
<tbody>
<tr>
<td>UOGCAST</td>
<td>CC</td>
<td>9.7</td>
<td>8.1</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>9.3</td>
<td>8.0</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>GG</td>
<td>9.1</td>
<td>8.5</td>
<td>7.7</td>
</tr>
<tr>
<td>CAPN4751</td>
<td>CC</td>
<td>7.5</td>
<td>6.2</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>9.5</td>
<td>8.0</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>TT</td>
<td>9.5</td>
<td>8.2</td>
<td>6.9</td>
</tr>
</tbody>
</table>

*N = 155.

Keywords: Molecular maker, Meat quality, Bos indicus

Ability of dietary vitamin E (natural vs. synthetic) to deposit in tissues and inhibit lipid oxidation in muscle from turkeys, chickens and ducks
D. Perez*, M. Sifri, M. P. Richards, aUniversity of Wisconsin—Madison, Madison, WI, United States, bArcher Daniels Midland, Quincy, IL, United States

Vitamin E (vit E) is an antioxidant that is deposited from the diet into tissues, such as muscle and erythrocyte. Increased vit E in muscle
Effects of aging temperature and extended aging on bovine mitochondrial function

R. Ramanathan¹, R. A. Mancinia, C. B. Van Buitena, M. N. Nairb, S. P. Sumanb, aUniversity of Kentucky, Lexington, KY, United States

Meat color, in particular intensity of bloom, is influenced by mitochondrial activity. More specifically, oxygen consumption decreases red color development and intensity of bloom when mitochondrial respiration out-competes myoglobin for oxygen. Extended aging can improve bloom intensity because mitochondrial oxygen consumption decreases with postmortem time. However, this decrease in mitochondrial activity can also negatively influence color stability. Although mitochondria play a significant role in postmortem beef color, no research has assessed the combined effects of extended aging and temperature of aging on mitochondria-mediated oxygen consumption and metmyoglobin reduction. Therefore, our objective was to examine the role of aging time and temperature in mitochondrial function.

Bovine hearts (n = 5) were used to isolate mitochondria because the mitochondrial concentration in cardiac muscle is greater than in skeletal muscle. To assess the role of aging time and temperature in mitochondrial function, fresh bovine hearts were procured on the day of slaughter and each heart was divided into six equal portions. Using a randomized complete block design where each heart served as a block, 1 of the 6 portions within a heart was vacuum packaged and aged at either 0 or 5 °C for 15, 30, and 45 days (6 time × temperature combinations). After aging, mitochondria were isolated and were used to assess the effects of aging temperature and time on oxygen consumption and oxymyoglobin (determinant of bloom intensity) following the addition of mitochondrial substrates such as succinate (30 mM), lactate (30 mM), LDH (100 units), and NAD (0.02 mM) at pH 5.6 and 25 °C. To determine the effects of mitochondria on myoglobin redox stability, mitochondria (1 mg/ml) and bovine oxymyoglobin (2.5 mg/ml) were incubated in screw capped vials (to prevent the potential diffusion of air from outside into the mitochondria–oxymyoglobin mixture) at 25 °C and scanned spectrophotometrically from 650 to 500 nm.

There was a significant aging temperature × time interaction for oxygen consumption. Regardless of added mitochondrial substrates, aging time decreased (P < 0.05) oxygen consumption. However, during extended storage, lower temperature aging (0 °C) resulted in greater oxygen consumption compared with greater temperature aging (5 °C; P < 0.05). The increased oxygen consumption observed in samples at 0 °C was supported by greater deoxymyoglobin (less bloom; P < 0.05) and lower metmyoglobin (more color stable) compared with samples aged at 5 °C.

The results from the current study suggest that aging temperature and time can influence mitochondrial function, which will lead to subsequent effects on bloom intensity and color stability. This highlights the importance of mitochondria in postmortem beef color. Myoglobin and mitochondria isolated from bovine cardiac muscle can provide a better fundamental understanding of the mechanism by which aging influences color biochemistry.

Keywords: Beef color, Aging, Mitochondria

Investigation of mechanisms responsible for change in Warner–Bratzler shear force values of the longissimus lumborum in implanted beef cattle fed zilpaterol hydrochloride

S. M. Knobel¹,², J. D. Starkey³, B. J. Johnson⁴, J. L. Beckett⁵, J. C. Brooks⁶, R. J. Rathmann⁷, J. M. Hodgen⁸, J. P. Hutcheson⁸, M. N. Streeter⁹, M. F. Miller⁸, ¹Texas Tech University, Lubbock, TX, United States, ²Beckett Consulting Service, Fallbrook, CA, United States, ³Merck Animal Health, De Soto, KS, United States

Beta adrenergic agonists such as zilpaterol hydrochloride (ZH) are often used in conjunction with an implant regimen to induce muscle growth of beef animals, which can affect meat tenderness as measured by Warner–Bratzler shear force (WBSF). Previous research indicates 7-d-aged steaks from ZH fed animals were approximately 0.5 kg higher in WBSF value than steaks from cattle not fed ZH yet by d 35 were similar in WBSF value. Implants have also been shown to increase WBSF at various time points throughout the aging period. The objective of the present research was to evaluate the effects of ZH (0 or 8.3 mg/kg of DM) and implant status (no implant [NI]; Revalor-S [2.5 mg/kg DM]) on Warner–Bratzler shear force values of the longissimus lumborum in implanted beef cattle fed ZH.
calpastatin II, 120

Muscle protein degradation and activities of calpain and calpastatin in three muscles from growing and mature beef animals
S. M. Cruzen, a,b P. V. R. Paulino, a S. M. Lonergan, a E. Huff-Lonergan, a
aIowa State University, Ames, Iowa, United States, bUniversidade Federal de Viscosa, CNPq, Vicos, Brazil

The objective of this project was to determine the extent to which muscle and growth stage contribute to variation in the calpain system, including μ-calpain, m-calpain, and two observed isoforms of calpastatin. Five weaning calves and five cull cows were slaughtered in pairs on five different days at the ISU Meat Laboratory. Longissimus (LD), semimembranosus (SM), and triceps brachii (TB) samples were taken within 90 min postmortem, and sarcoplasmic proteins were extracted and loaded on a Q-Sepharose ion exchange column. Protein was eluted with a linear gradient of KCl. Calpastatin activity was detected in two separate peaks (calpastatin I, 50–90 mM KCl and calpastatin II, 120–190 mM KCl), followed by μ-calpain (180–240 mM KCl) and m-calpain (300–400 mM KCl). Calpain activity was determined using casein as a substrate. Calpastatin inhibitory activity against porcine lung m-calpain was determined similarly. Western blots and SDS-PAGE were used to determine Troponin-T degradation product and titin degradation product (T2), respectively, in the muscles of four cows and calves after 6 d of aging. Data were analyzed in SAS v. 9.2 using PROC MIXED with a split plot design with age group as the whole plot and muscle as the split plot. Data were blocked by slaughter date. No significant differences for age or muscle were found in calpastatin I or μ-calpain activities (P>0.05). Muscle differences were observed for calpastatin II, total calpastatin, and m-calpain activities, with the TB exhibiting greater calpastatin activities than the SM or LD (P<0.001), and lower m-calpain activity compared to the LD (P=0.02). In addition, m-calpain activity was greater in muscles from cows (P=0.04). Troponin-T degradation product at 6 d was greater in muscle from calves (P<0.01) compared to cow muscles and decreased in TB (P=0.001) across age groups compared to LD or SM. The presence of titin T2 at 6 d tended to be greater in muscles from calves (P=0.08) and was also decreased in TB (P=0.01) across age groups compared to LD or SM. These data show that significant differences in the calpain system exist between muscles in beef animals. In particular, the TB experienced less proteolysis, likely due to greater calpastatin activity. These differences seem to remain through maturity, even though overall calpain or calpastatin activities may change. In addition, although no significant differences for calpastatin or μ-calpain activities were found between old and young animals (P>0.15), cows had numerically higher calpastatin and lower μ-calpain activities, which may explain why less proteolysis was seen in cow muscles. Altogether, these data may demonstrate greater protein turnover in growing versus mature animals, which is not fully explained by calpain system activities.

Keywords: Calpain, Calpastatin, Beef

Zilpaterol hydrochloride increases phosphorylation and activation of adenosine monophosphate protein kinase α in bovine skeletal muscle
A. D. Hosford*, M. J. Anderson, J. G. Hergenreder, T. L. Harris, B. J. Johnson, Texas Tech University, Lubbock, Texas, United States

The effects of feeding β-adrenergic agonists, like zilpaterol hydrochloride (ZH) on live animal performance and carcass characteristics have been well documented for beef cattle. However, the cellular mechanisms by which these products affect skeletal muscle tissue are still unclear. The objective of this research was to evaluate the effect of ZH on the gene and protein expression of specific myogenic regulators of muscle growth. Semimembranosus muscle tissue was collected 30 min postmortem from Holstein steers, ~24 months of age and approximately 1400 lb, that had been fed a diet containing 8.3 mg/kg of ZH for the last 0 or 20 days of the finishing period with a 3 day withdrawal period. Total RNA and protein were isolated. Real-time-QPCR (RTQPCR) was used to measure the relative mRNA abundance of adenosine monophosphate protein kinase α (AMPKα), myosin heavy chain (MHC), MHCIIA, MHCIIX, insulin-like growth factor I (IGF-1), and β-adrenergic receptors (βAR1) I and II. Western blotting was used to measure relative protein abundance for AMPKα and phosphorylated-AMPKα (pAMPKα). Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) was used to identify MHCI, IIA and IIX isoforms. No significant differences (P>0.05) were detected in relative mRNA abundance of AMPKα, MHCI, MHCIIA, IGF-1, βAR1 and βAR2. However, RTQPCR data indicated that muscle samples from ZH fed cattle tended to have increased (P=0.08) MHCIIX mRNA compared to muscle samples from non-ZH fed cattle. This alteration in mRNA abundance was not carried through in the protein data, as there was no change in any MHC isoforms as measured with SDS-PAGE. Protein data from western blotting experiments revealed that there was increased (P<0.05) pAMPKα with no observed change (P>0.05) in

Keywords: Zilpaterol hydrochloride, Implanted, Muscle fiber type
total AMPKα for ZH fed cattle compared to non-ZH fed control cattle. While there was no increase in MHCIIX protein, the tendency for MHCIIX mRNA to be increased in ZH fed cattle indicated the start of a fiber type shift towards larger diameter muscle fibers. This shift may have been due to increased phosphorylation and subsequent activation of AMPKα. Activation of AMPKα has been shown to regulate myosin isoform expression in other species. These results suggest that the activation of AMPKα may be responsible for the regulation of myosin isoform expression in beef cattle.

Keywords: AMPKα, Myosin heavy chain, Zilpaterol hydrochloride