General Abstracts

Meat Judging: An Assessment of Point Accumulation by Individual Contestants.

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A standard meat judging contest is formatted providing 27.27% of possible points from beef judging (BJ); 22.73% from pork judging (PJ) and reasons (RS); 13.64% from lamb judging (LJ), quality grade (QG), and yield grade (YG); 40.91% from placing classes (PL) and 9.09% from IMP Specifications (SP). Official placings are the basis for each category, thus contestants' point percentages may be used to test: a) categorical point values' equality in difficulty relative to the format and b) if there is a difference in earned point percentages as contestants progress through the contest year. Using the format percentages for each category as the expected % (EX%) and the contestant's point total for each category as a percent of the total point they accumulated in the contest (O-(category)%) Chi-square values were calculated. 1794 individual scores over six years are reported as averages for the National Western (NW), Southeastern (SE), Iowa State Invitational (ISU), American Royal (AR) and International (INT) contests. OBJ, OPJ, OLJ and OQG% approach the EX% although the Chi-square value far exceeds the critical value for the 99th percentile. No OBJ and OPJ% was less than EX%, only in INT98 was OLJ% less than EX%. OQG% was less than EX% only in ISU95 and NW94. No OYG% contest averaged > 11.7% (EX% = 13.64), the lowest OPL% average was 44.6% (EX% = 40.91). ORS% ranged from a low of 19.6 to a high of 21.8 (EX% = 22.73). OSP% exceeded EX% only in the AR95 and AR98 contests. Chi-square values for each category diminished for each category as the contest year progressed. It appears classes are too obvious or the point values assigned as cuts are too small. PL scores and, concomitantly, BJ, PJ and LJ% are higher than EX%. Contestant % are more consistent with EX% at INT than NW.

Marbling Effects on Consumer Quality Characteristics of Pork. I. Purchase Intent, Visual and Sensory Acceptability.

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This study was designed to evaluate whether consumers find differences in visual sensory attributes among variously marbled pork loin chops. Chops were cut (2.5 cm), shrink wrapped, and displayed under fluorescent light for visual evaluation. Purchase intent, color, marbling, and overall acceptability were evaluated using a 5-point category scale. Panelists evaluated pork chops cooked to 71°C internal temperature for flavor, juiciness, tenderness, and oiliness/fattiness. Two-thirds of consumers (n = 120) were female; >50% were between 26 and 55 and consumed pork 1-2 times/week; >65% were the primary food purchaser and/or food preparer. Chops with a low or medium marbling had higher appearance acceptability scores than highly marbled chops; purchase intent scores followed the same pattern. Highly marbled chops were most juicy, tender, intensely flavored, and oily in the mouth. More than 65% of very light pink samples were in the unacceptable categories; >55% of darker pink samples were in the acceptable categories. Samples rated as very lean tended to be at the ends of the acceptability scale; 51% of very acceptable samples were very lean. More marbled chops tended to be in the lower acceptability categories. Of medium, dark, or very dark pink samples, >50% were in the would or probably would buy categories. Of samples placed in the would not buy category, 50% appeared highly marbled and ~20% were very lean. These data indicate that purchase intent of most consumers is highest for lean appearing pork. A clear relationship existed between acceptability and purchase intent: ~78% of those samples in the would not buy category were very or somewhat unacceptable; ~76% of samples in the probably would buy category were somewhat or very acceptable; and 65% samples in the would buy category were very acceptable.

Marbling Effects on Consumer Quality Characteristics of Pork. II. Purchase Intent, ant Sensory Characteristics of On-site and In-home Prepared Chops

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This study evaluated whether consumers find differences in sensory attributes among variously marbled pork loin chops when prepared under controlled and under in-home conditions. Chops were cut (2.5 cm), shrink wrapped, and displayed under fluorescent light in a retail case. Prior to sensory evaluation, each panelist selected a package of chops that he/she would like to take home after the on-site evaluation. Panelists (n = 120) evaluated all three marbling levels of pork chops cooked to 71° C internal temperature for flavor, juiciness, tenderness, and oiliness/fattiness. Panelists took home, cooked, and evaluated the selected package of chops for the same characteristics. 40% of consumers chose lean, 40% chose medium, and 20% chose highly marbled chops to take home; >70% grilled or pan-fried the chops. Highly marbled chops were most juicy, tender, intensely flavored, and oily whether prepared on-site or in-home. Primary food purchasers and/or preparers discriminated to a greater extent among on-site prepared products as evidenced by their tendency to distribute sample scores across more of the sensory categories. All sensory characteristic means were high for in-home-prepared chops regardless of marbling category selected. Purchase intent means were high; (4.65-4.76; 5 = high) for all marbling categories of chops prepared at home, indicating that consumers would purchase the chops which they had selected and prepared. When chops were prepared at home, purchaser and/or preparer status affected only juiciness; the range was small. Results of this study imply that consumers are more likely to visually select leaner chops; in a controlled environment, highly marbled chops generally receive higher sensory and purchase intent scores. However, once they make a choice they evaluate the chops they chose very highly after they prepare them regardless of marbling level chosen.

National Beef Tenderness Survey - 1998

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Eight US cities were sampled to determine the tenderness of beef at retail and foodservice levels based on Warner-Bratzler shear (WBS) values and consumer evaluation panels, and to determine if improvements in tenderness at the retail level have improved since 1990. Retail consumer panels were conducted at five universities, and each steak was evaluated using 10-point scales. Steaks were grouped by the following quality grades or brands for statistical analysis: Prime, Certified Angus Beef (CAB), other top Choice programs, Choice, Select, lean programs, or no roll. Quality group had no ($P > .05$) effect on WBS values of clod, chuck roll, top round, bottom round, and ribeye retail steaks, but did affect values for the top loin, T-Bone/Porterhouse, and top sirloin. Foodservice ribeye, top loin, and top sirloin steaks had WBS values less than 3.4 kg for all quality groups, with Prime ribeye steaks and CAB top sirloin steaks having lower ($P < .05$) WBS values than the other grades within their respective cuts. Average post-fabrication times were 32 d for foodservice subprimals. With the exception of the retail ribeye steak, quality group did not affect ($P > .05$) consumer sensory ratings of retail and foodservice steaks. Compared to 1990, all retail steaks from the chuck, rib, and loin had lower WBS values, and a lower percentage of cuts outside the confidence levels of 3.9 and 4.6 kg. Moreover, all retail cuts from the round, with the exception of the bottom round, showed improvements in WBS values with fewer cuts outside the confidence levels. Average post-fabrication times were 19 d (compared to 17 d in 1990) for retail cut subprimals. These data indicate that improvements in tenderness at the retail level have been made since 1990.

Improving the Retail Case Life of Pork

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The objective of this study was to survey supermarkets across the United States to determine the temperature of retail display cases, cutting rooms, coolers, and service cases and factors that could cause pork products to be pulled from the display case. Ten cities/retailers across the United States were visited varying in display case types and age. Case and lighting traits, and fill level were recorded for each case. Temperature monitors were placed in the retail case, cutting room, holding/storage cooler, and service cases to record temperature every 15 minutes for 14 d. Meat manager interviews were conducted to assess reasons for pulling pork products, expected shelf life, and product color description.

Coffin cases had the lowest average temperature of 37.4°F, followed by triple level cases (39°F), quad level (40.5°F), and lastly service cases (47.7°F). Maximum temperatures averaged 59°F for quad level, 61.2°F for coffin, 64.2°F for triple level cases, and 67.6°F for service cases. The average minimum temperatures were 30.7°F for coffin cases, 33.8°F for triple level cases, 36.9°F for quad level cases, and 36.9°F for service cases.

Temperature evaluations indicate that the rack at the bottom of a coffin case is often 7 to 9°F below the temperature in the airflow. The product temperature at the load line is often 10 to 12°F higher than the products on the bottom level and the defrost cycle raises the temperature from 12 to 19°F

for 45 min to 1 h. Coffin cases averaged 3.9 d shelf life compared to 3.6 d for triple level and 3.7 d for quad level cases. Pork product pulls were highest from quad level cases (6.3 pulls/day), followed by coffin cases (6.0 pulls/day), then triple level cases (4.9 pulls/day). Relative to sells, pork was three times as likely to be pulled as beef.

Fresh Ham Quality as Influenced by Genetic Type, Diet, Slaughter Weight, and Sex

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Six genetic lines (Berkshire, Duroc, Danbred, Newsham Hybrid, Hampshire, and Dekalb genetics) (n=1800) were randomly assigned to one of four diets differing in protein level (1.25, 1.1, 0.95, and 0.8% lysine). Hogs were randomly assigned to one of three slaughter weights (113.6, 131.8, and 150.0 kg) within genetic line and dietary protein level. Approximately 600 animals (barrows and gilts included) comprised three replicates with all treatments were represented within a replicate. Approximately 24h post-slaughter, the ham was removed from one carcass side, bagged, boxed, and shipped under refrigerated (0 to 10ºC) to Rosenthal Meat Science & Technology Center, Texas A&M University, College Station, TX. Hams were evaluated for purge loss (4-6 days postmortem). The *Gluteus medius* muscle of the ham face was evaluated for Minolta Reflectance, L*, a*, and b* utilizing a Minolta Chromameter model CR-300 (standardized to a white tile). Duplicate pH (HI 9025C, Hanna Instruments, Limena, Itlay) measures were taken using a glass tip probe (calibrated to 4.00 and 7.00 buffer solutions) in the *Gluteus medius* and averaged. Three trained sensory panelists evaluated the *Gluteus medius* surface for color and firmness based on a 5-point National Pork Producers Council (NPPC) color and firmness scale. Hams were dissected into skin, subcutaneous fat, seam fat, bone, other lean, inside ham muscle (*Semimembranosus*), outside ham muscle (*Biceps femoris* and *Semitendinosus*), and knuckle (*Quadriceps femoris*). The anterior portion of the three major ham muscles was removed for water holding capacity (WHC) measurements. Minolta Reflectance, L*, a*, b*, and pH were obtained on the cut surface of the three major ham muscles. In addition, sensory color and firmness were obtained for the cut surface of the three major ham muscles. Ham muscles were then injected with brine solution, packaged in CN560 cook-in bags (Cryovac Division, WR Grace & Co., Duncan, SC), tumbled, and cooked to an endpoint temperature of 71ºC. Cook yields were determined for each muscle. Differences ($P < .05$) between breeds were found for purge yield (%), sensory color, sensory firmness, pH, and Minolta Reflectance, L*, a*, b*, and drip loss (%) but, not for cook yield. Two-way interactions for ham face sensory color occurred for genetic type X cut, genetic type X sex, genetic type X weight, and diet X weight. Diet X cut and weight X cut were significant for cut ham sensory color and firmness.

Effects of Pre-Harvest Calcium Administration and Post-Harvest Freezing on Callipyge Tenderness

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Twenty callipyge lambs (54 kg) were used to assess the effect of pre-harvest calcium propionate administration and/or post-harvest freezing before aging on tenderness. The lambs were randomly assigned to one of the following treatments: controls (C) and calcium gel administered (GEL). At about three h prior to slaughter, the GEL lambs were drenched orally with 250 mL of a calcium propionate-propylene glycol gel that contained 25 g of calcium. At 24 h postmortem, carcass data were collected and chops (2.54 cm thick) removed from both longissimus muscles. The chops from the left side were vacuum packaged and aged at 4°C for 1, 3, 7, 14, and 28 d (FRESH). The chops from the right side were vacuum packed, frozen at – 20°C for 14 d, thawed and then aged for 1, 3, 7, 14, and 28 d (FROZEN). Data were analyzed using the repeated measures analysis of General Linear Model Procedure of SAS with calcium, freezing, postmortem age, and all interactions tested. Serum normalized calcium levels taken at slaughter were higher ($P < .05$) for GEL than C by 24%. However, Warner-Bratzler shear force values did not differ ($P > .05$) between C and GEL treatment. The two– and three-way interactions for calcium by freezing and/or age were nonsignificant ($P > .05$). The interaction between freezing treatment and postmortem age was significant ($P < .05$). Warner-Bratzler shear force values for FROZEN were lower ($P < .05$) than FRESH by 1.3 to 2.2 kg at 3, 7, 14, and 28 d of aging. Postmortem aging rate was faster ($P < .01$; -.287 vs -.146 kg/d) for FROZEN (d 1 – 14) than FRESH (d 1 – 28). Pre-harvest tenderization of callipyge was unsuccessful; however, freezing prior to aging accelerated the rate of aging and reduced shear force values to acceptable levels.

Hot Water and Lactic Acid to Reduce Microbial Levels on Beef Trimmings

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Beef trimmings of different fat and lean content were obtained commercially. Trimmings within fat and lean type then were randomly assigned to one of four treatments (control; 95°C hot water for 10 sec; 4% L-lactic acid at 55°C for 11 sec; and 95°C hot water for 10 sec plus 4% L-lactic acid at 55°C for 11 sec). Excised samples were removed from the trimmings after each treatment and total aerobic plate counts (APCs) were determined. APCs from the control group within fat and lean type were considered to be the APCs before treatment. After the excise samples were removed, the trimmings were ground and APCs were determined. The ground meat was vacuum- packaged overnight and evaluated for meat color

the following day using a Minolta colorimeter and a trained sensory panel. In addition, odors as evaluated by a trained descriptive attribute sensory panel were determined. Sample pH, fat and moisture, and TBA value (as a measure of lipid oxidation) were measured. The 90/10 trimmings derived from more mature animals were darker prior to and after treatment. All trimming types were darker after treatment with hot water or hot water plus lactic acid. However, after grinding the lean color surface of the ground beef was not noticeably darker due to treatment. Treatment of beef trimmings with hot water, lactic acid, and hot water plus lactic acid reduced levels of APCs in excised samples. Ground beef produced from beef trimmings treated with lactic acid had reduced levels of APCs. Meat quality characteristics of color and odor as evaluated by trained sensory descriptive attribute panels were not affected by treatment.

Goat Meat Palatability

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Young wether kid goats (n = 122) just after weaning from six breed-types (Boer/Spanish, Spanish/Angora, Boer/Angora, Spanish, Angora) were assigned to one of two feeding systems (typical feedlot grain ration and native Texas range pasture). After approximately 100 days, goats were slaughtered. Live weight, hot carcass weight, and dressing percentage were determined. After 24 hours, carcass characteristics were evaluated (ribeye area (mm^2), fat thickness (mm^2), adjusted fat thickness (mm^2), carcass length (cm), body wall thickness, leg circumference, lean color, and quality grade characteristics). Hunter L*, a*, and b* values were determined on the lean surface of the ribeye using a Minolta Chromameter model CR-300 standardized to a white tile. Goat carcass bone-in subprimal yield (%, kg) was identified. Whole leg and loin roast were oven roasted to an internal temperature of 70°C and 2.54 cm leg and loin chops were oven-broiled to the same internal temperature endpoint. Chops or roasts were evaluated by an eight-member flavor descriptive attribute sensory panel for flavor, basic tastes and aftertastes using the Spectrum Universal intensity scale (0 = none; 15 = extremely intense). Warner-Bratzler shear force was determined. Grain-fed Boer x Spanish goat carcasses had higher carcass and leg confirmation scores, longer carcasses, thicker body walls, larger ribeye areas, and had larger leg circumferences. Angora goats had lower carcass and leg confirmation scores, shorter carcasses, thinner body walls, smaller ribeye areas, and had smaller leg circumferences. Meat from grain-fed Angora goat carcasses was lighter, more youthful colored and meat from grain-fed Spanish goat carcasses was darker, and less youthful in color. Breed-type for grain-fed goats did not affect goat meat serum/bloody, liver, beefy, and soured aromatics; astringent mouthfeel; sour basic taste; and bitter, musty, and sour aftertaste sensory attributes.

The Effect of Induced Stress and Supplemental Chromium on Meat Quality of Finishing Heifers

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Dark cutting beef can occur if pre-slaughter stress exhausts muscle glycogen, prohibiting the normal pH drop in post mortem muscle. Chromium is an essential mineral that plays a role in glucose metabolism by potentiating the action of insulin and perhaps influencing glycogen deposition. This study evaluated the effects of supplemental dietary chromium and induced stress on meat quality of heifers. Fifty crossbred heifers were used in a 2 x 2 factorial arrangement of stress (stress versus unstressed) and supplemental dietary chromium (with or without 400 ppb Cr per head per day from high-chromium brewers yeast) treatments. The stress condition was created by removal of melengesterol acetate 7 days prior to slaughter to induce estrus and by mixing with unfamiliar animals 3 d prior to slaughter to simulate social stress. High-chromium brewers yeast was fed for 62 d prior to slaughter. Differences among treatments were subtle. Stress treatment failed to induce dark cutting beef. Steaks from chromium-fed cattle tended to be lighter (higher L* values, P = .16) than steaks from non-supplemented cattle (38.55 vs 37.79, respectively). Stressed cattle had meat with lower (P = .09) redness (a*) values, higher (P = .11) shear force values after 7 d of aging, and higher (P = .09) ultimate pH than non-stressed cattle (a* = 31.54 vs 32.17; shear force = 4.51 vs 4.13 kg; ultimate pH = 5.53 vs 5.50, respectively). Muscle pH at 45 min was significantly higher in the stressed cattle than the unstressed cattle (P = .04) when no supplemental chromium was fed, while differences were of a smaller magnitude between stressed and unstressed cattle with supplemental dietary chromium. Ultimate pH did not differ among treatments (P > .10). These data suggest that dietary chromium and stress may have subtle effects on meat quality.

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Effects of Percent Dark, Firm, Dry Beef on Microbial Growth and Lipid Oxidation in Ground Beef, Stored at 4°C

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Two experiments were conducted to determine the effects of the percent Dark, Firm, and Dry (DFD) beef on microbial growth and lipid oxidation in ground beef stored at 4°C. In experiment one, muscle from the chuck of DFD and normal (N) carcasses were ground and mixed together to obtain varying percentages of DFD ground beef (0, 20, 40, 60, 80, 100%). In experiment two, only muscles from DFD carcass that had pH values above 6.0 were ground and mixed with N ground beef to obtain varying percentages of DFD ground beef (0,

50, 100%). The ground beef samples were packaged in oxygen permeable packages and stored at 4°C under display lights for measurement of lipid oxidation (TBARS) and aerobic plate counts (APC). In experiment one, APC counts were higher ($P < .05$) at 96 and 192 h for the higher percentages (60, 80, and 100%) of DFD in the ground beef than the lower percentages (0 and 20% DFD). At 96 and 192 h, TBARS values were higher ($P < .05$) for 0, 20, 40, and 60% DFD than 80 and 100%. In experiment two, APC were higher ($P < .05$) for 100% DFD at 96 and 144 h than 0% DFD. At 192 h, APC were higher ($P < .05$) for 0% DFD than 50% DFD with 100% DFD being intermediate. At 192 h, TBARS were higher ($P < .05$) for 0% DFD than 50% DFD which was higher ($P < .05$) than 100% DFD. The higher percentages of DFD in the ground beef resulted in increased microbial growth and reduced lipid oxidation.

Effects of Feeding Vitamin D_3 on Carcass Characteristics of Beef Cattle

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Supplemental Vitamin D_3 (Vit. D) has shown to improve tenderness in beef cuts when fed to cattle < 10 d pre-harvest. A trial was conducted to determine how supplemental Vit. D affects blood Ca, carcass traits, Warner Bratzler Shear force values, pH (0, 3, 12, and 24 h post-harvest), and calpastatin activity of three different muscles: Longissimus, Gluteus medius, and Biceps femoris. Treatments included no Vit. D supplementation or 6 million IU (MIU) daily for either 4 or 6 d pre-harvest. Utilizing a completely randomized design, 24 steers (545 kg) were allocated to treatments (8 pens) and fed a 90% concentrate ration twice daily (12.35% CP; 61 Mcal NEg/cwt) with Vit. D fed once daily in a pellet as a percent of the total ration. At harvest, 3 steaks (2.54 cm) were cut from each of the specified muscles and aged 7, 14, and 21 d. Steaks were cooked at 185°C to a final internal temperature of 70°C and shear force values were obtained. Effect of feeding and duration of feeding (6 vs 4 d) of Vit. D on shear force was detected in Longissimus and Gluteus medius ($P < .05$). However, only duration of feeding slightly affected the shear force of Biceps femoris ($P = .16$). Age effects on shear force were apparent for feeding Vit. D at 14 and 21 d for Longissimus and Gluteus medius. Duration of feeding Vit. D by age interaction occurred at 7 d for Longissimus shear force ($P < .05$). Effect for duration of feeding Vit. D on pH was detected with 6 d being higher than 4 d in all muscle types at 0, 3, and 12 h but lower at 24 h ($P < .05$). Vit. D also altered pH at 3 h for a feeding effect of Vit. D ($P < .05$) being detected. No impact for duration or feeding of Vit. D on calpastatin activity in muscle tissue was detected. Plasma blood samples obtained at harvest during exsanguination were analyzed for total Ca concentrations and indicated that Ca increased ($P < .05$) from both a duration and feeding of Vit. D. These data suggest that Vit. D will improve tenderness of various muscles and alter blood plasma Ca concentrations.

Effect of Poultry Meat on Residual Nitrite in Cured Meat Products

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The objective of this research was to determine how inclusion of poultry, initial nitrite concentrations, various heat treatments, and their interactions influenced residual nitrite levels in cured meat products. A response surface experimental design was employed to estimate residual nitrite level at various initial nitrite concentrations, percent poultry, and heat quantity (F_0) values using a typical wiener as the test system. Mechanically deboned turkey, beef, and pork were used as the meat ingredients. The wieners were prepared under conditions that simulated commercial wieners. Residual nitrite and pH values were measured at one day, 7 days, 14 days, and 49 days after processing. Protein, fat, salt, moisture, and CIELAB color values were also determined. Results showed that the effect of poultry meat on residual nitrite level was not significant initially; however, it became an important factor after 14 days of storage. Increasing the amount of poultry resulted in lower residual nitrite level after 14 days of storage at a fixed pH. Residual nitrite level was found to be proportional to initial nitrite concentration initially; but, it became an insignificant factor during longer storage. Differences in heat quantity did not play a significant role on residual nitrite level. Poultry and heat quantity experiments were repeated separately to avoid any interaction that might have happened in the response surface experimental design study. These additional studies showed that either an increased amount of poultry or heat quantity decreased residual nitrite level in finished cured meat products at a fixed pH.

Dietary Intake of Vitamin E Affects the Peroxide Value of Subcutaneous Fat in Lambs

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Lipid oxidation is a major problem causing flavor deterioration in fresh and stored meat. The objectives of this research were to analyze the effects of dietary Vitamin E on the lipid oxidation of subcutaneous lamb fat, and to compare peroxide value (PV) and TBA (2-thiobarbituric acid) as methods for this analysis. Lambs were fed an all-concentrate diet, offered ad libitum formulated to provide 16% CP; and either 15 (NRC) or 300 (20 NRC) of supplemental vitamin E per kg of diet DM. Subcutaneous fat, at loin area, from twelve lambs was removed, wrapped in a styrofoam meat tray with oxygen-permeable film, and stored at 34 ± 2°F from 0-11 days. Fat samples were ground in a Waring blender and subjected to TBA and PV analyses. Statistical analysis was performed on the results. PV analysis demonstrated a significant difference ($P < .05$) in the lipid-oxidation state in the fat from animals fed two different levels of vitamin E. There was no significant difference the

PV or TBA values in the fat obtained from animals fed either 15 or 300 IU Vitamin E on slaughter day 0, day 7, or day 9. However, the group fed 15 IU vitamin E had a significantly higher initial PV and TBA value on day 0 than those fed 300 IU vitamin E. In addition, both PV and TBA demonstrated a significant increase in the PV's on the day 11 ($P < .05$). These results indicate that dietary intake of vitamin E significantly effects not only the initial lipid oxidation state of the subcutaneous fat in lamb carcasses and the efficacy of employing either PV or TBA to monitor lipid oxidation in animal fat.

Effect of Erythorbic Acid on Cooked Color in Ground Beef

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The color of cooked ground beef is used as an indicator of cooking doneness. It is recommended that the center of ground beef products be heated to 71.1°C for safety reasons. In some instances beef may appear done before reaching 71.1°C, a condition termed premature browning (PMB). PMB appears related to the redox state of myoglobin in the raw patty immediately prior to cooking. Myoglobin which is predominantly in the met- or oxy- form can result in PMB. Our objective was to determine if erythorbic acid (ERY), a reducing agent, could maintain red color and potentially prevent PMB in cooked ground beef

ERY at 0.04% and 0.06% was added to ground beef (15% fat), formed into patties, wrapped in oxygen permeable film and stored in the dark at 4°C. Patties were stored for 10 hr and 58 hr and then cooked to internal end point temperatures of 60°, 65.6°, 71.1° and 76.7°C. Internal cooked color a*, b* and L* values were measured. For beef patties stored 10 hr, there was no effect of ERY on internal cooked color. After 58 hr storage, ground beef with 0.04% and 0.06% ERY resulted in higher a* values than controls at 60°C ($P<0.05$). Beef with 0.04% ERY and cooked to an internal temperature of 65.6°C had higher a* values than 0.06% ERY and controls ($P<0.05$). There was no effect of ERY on color of beef patties cooked to 71.1° or 76.7°C. A higher a* value in the interior of beef patties cooked to temperatures lower than 71.1°C could be interpreted to indicate a less thoroughly cooked appearance; the addition of 0.04% ERY appeared to maintain red color in patties cooked to 60° an 65.6°C.

New NPPC Color and Marbling Standards

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The National Pork Producers Council has developed and promoted fresh pork color and marbling standards for most of three decades. These standards have been recognized and widely utilized in research and industrial applications in the U.S. and all over the world. A better understanding of color and the Japanese interest in pork color have resulted in the development of new standards for fresh pork color and marbling. Historically, pork marbling standards were characterized similar to beef with grades ranging from slight or trace to abundant. These numbers were not necessarily correlated to actual lipid content. The new NPPC Marbling Standards are closely aligned with actual lipid content. Marbling standard #1.0 corresponds roughly to one-percent lipid, marbling standard #2.0 corresponds to two percent lipid, etc. Therefore, the marbling standards serve as rough estimates of the lipid content. The color standards are also linked to objective measures. Photographs of actual pork longissimus muscle were used to characterize the six new levels of pork color. Color standard #1.0 is the practical lightest muscle available. It had a Minolta Colorimeter L* reading of 61 while the Color standard #6.0 is the practical darkest with a Minolta Colorimeter L* reading of 31. The other four standards are incrementally spaced in between these two extremes in color and L* values. The new standards are available from NPPC.

A System for Assuring Pork Quality

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The National Pork Producers Council is interested in improving the quality of fresh pork. In this case pork quality is defined as meat color, water-holding capacity, and palatability or those traits specifically implicated with the PSE condition of pork. There are many factors that can and do affect pork quality. These range from areas affected by on-farm decisions to other factors relating to activities in the packing plant. All these factors are summarized in a systems approach to pork quality under nine Quality Control Points (QCP's). Each QCP has several "opportunities for intervention" for improvement of pork quality. The nine QCP's and the related intervention opportunities include:

1. Genetic Inputs
   Choice of breeds, choice of sires within breeds, stress gene, Napole gene, intramuscular fat, and DNA technology
2. Nutritional Inputs
   Vitamin and mineral supplementation, amino acid levels pre-market, dietary fat sources and levels, dietary starch, nutritional partitioning agents, and feed withdrawal
3. On-Farm Hog Handling
   Health and stress management, slaughter weight, and facility construction
4. Handling Hogs During Transport
   General, electric prods, truck/trailer type, load size, and weather extremes
5. Pre-Slaughter Handling
   Facility construction, water sprays, electric prods, rest times, andpre-stun handling
6. Stun, Stick, and Early Post-Mortem Handling of Carcasses
   Stunning system, stun to stick interval, horizontal vs. vertical sticking/bleeding, bleeding time, scald temperature/time or skin time, and time on buffer rails

7. Handling of Carcasses During Evisceration
   Evisceration time, splitting accuracy, fecal contamination, trimming, measuring composition, and measuring quality
8. Chilling of Carcasses
   Chilling system and chilling time/temperature
9. Fabrication of Pork Cuts.
   Workmanship, packaging, and enhancement of f r e s h pork

A set of recommendations has been developed for each intervention area. These recommendations are being incorporated into producer checklists and into the NPPC/AMSA Pork Quality Audits where applicable.

The Utilization of Carcass Traits to Predict Beef Warner-Bratzler Shear Force

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The objective of this experiment was to determine if beef carcass quality, color, and yield measurements could be used to predict tenderness of beef strip loin steaks. This project included 919 head of grain finished cattle, both steers and heifers, of various breed types (*Bos taurus* and *Bos indicus*) that were fed to a target endpoint of 1 cm of backfat. Cattle were slaughtered at the same commercial slaughter facility. Low voltage electrical stimulation was applied at the slaughter floor and the carcasses were chilled for 48 hours. Carcass data were collected for quality, color, and yield factors following chilling. Hunter CIE L, a*, and b* scores explained 14% of the variation of WBS and initial tenderness on steaks at 3 d postmortem ($P < .01$). Lean color scores explained 17% of the variation in WBS and 6% of the variation in sensory tenderness scores ($P < .01$). Marbling score explained 7% of the variation of WBS and 8% of the variation of sensory panel tenderness, respectively ($P < .01$). Hump score explained 5% of variation in sensory panel tenderness and muscle score explained 6% of variation in WBS ($P < .01$). Marbling ($r = -0.24$), fat thickness ($r = -0.25$), and muscle score ($r = -0.27$) correlations were good indicators of WBS. Correlations of color measurements with WBS values were -0.20, -0.12, and –0.04 for L, a*, and b* scores, respectively ($P < .01$). Hunter CIE L score was the best objective color indicator of WBS ($r = -0.19$) and sensory panel tenderness ($r = .22$). There seems to be a meaningful relationship between objective and subjective color measurements and beef top loin tenderness.

Effects of Seaweed Extract and Endophyte Infected-Tall Fescue Grazing Prior to the Finishing Period on Carcass Characteristics, Beef Display Color and Shelf Life

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A total of 96 steers, 48 from Mississippi and 48 from Virginia were grazed on tall fescue that was either endophyte infected (E+) or endophyte free (E-) and had been treated or untreated with seaweed (Ascophyllum nodosum) extract. At the end of the grazing season steers from both locations were transported to the Texas Tech Feedlot and finished on the same finishing diet. After slaughter, 48 strip loins were captured and delivered to the Texas Tech Meat Laboratory for color and shelf life determination. The endophyte within tall fescue resulted in lower hot carcass weights and smaller ribeye areas, and seaweed extract improved marbling scores ($P < .05$). Steaks were removed from the strip loin at d 7, 14, 21, and 28 postmortem and placed in a display case for color determination. Color determinations were made by a beef sensory visual panel and a Minolta Colorimeter for 3 to 5 consecutive d for each of the four aging treatments. In addition, cooked sensory determinations were made. Seaweed extract treatment improved color uniformity, reduced discoloration, and the amount of browning ($P < .05$). Seaweed treatment extended the color, and reduced discoloration and browning during the display time by one full day ($P < .05$). Seaweed treatment on E+ fescue improved visual color, percentage browning, and percentage discoloration measurements during d 2,3,4, and 5 of retail display by a ½ to one full score ($P < .05$). The extension of shelf life in the retail case by treating fescue would result in fewer economic losses for the beef retailer. The mechanism through which seaweed increases the shelf life of beef is unknown and requires further investigation, but may be related to observed changes in antioxidant activities in the plant and animal.

Evaluation of Microbial Safety and Shelf Stability of Country-Cured Ham

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Country style ham has long been considered a shelf stable product. However, based on the increase concern over the safety of the meat supply and the latest outbreaks associated with cured products, this study attempts to validate the safety of country-ham processing procedures and corresponding reductions of *Listeria monocytogenes*, *Salmonella, Staphylococcus aureus* and *Echerichia coli* O157:H7 to safe levels following USDA guidelines. MPR, a_w, and pH are measured to determine shelf stability over six months. Four groups of 116, 24 pound hams were surface inoculated with at least 10^8 CFU/cm^2 of a cocktail of one of the above microorganisms. Hams were then cured with salt or salt and nitrite for approximately 45 days at 4^0C, then equalized for 3 weeks at ^{0}C and 62%RH after which the hams were divided in two treatments, smoked and non-smoked. The cold smoked process lasted 6 hours and subsequently hams were located in the aging room at 28^0C and 65%RH. Three different hams per treatment were analyzed following inoculation, after curing, after salt equalization, after smoking, and monthly for up to 6 months during the aging process to evaluate the residual microbial popu-

lation on the hams. Levels of *Listeria monocytogenes* on the smoked hams decreased from $3.0x10^8$ CFU/cm^2 in salt treatment and $2.6x10^8$ CFU/cm^2 in salt and nitrite treatment to $4.0x10^3$ and $1.0x10^3$ respectively after 1 month of aging. Populations of *Listeria monocytogenes* also decreased on non-smoked hams resulting in $4.5x10^5$ and $4.0x10^5$ CFU/cm^2 in salt and salt with nitrite treatment respectively. Reductions in *Salmonella* populations were greater than those of *Listeria* spp.after 42 d., decreasing from $2.0x10^7$ CFU/cm^2 in salt and salt with nitrite treatment to $4.0x10^3$ and $1.0x10^4$ CFU/cm^2 respectively after 42 days.

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Consumer Impressions of "Tender Select" Beef

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With the recent development of technology to classify beef for tenderness, it is now possible for packers and retailers to market brands of beef known to be consistently tender. The present experiment was conducted to determine consumer impressions of "Tender Select", a model beef brand comprised of cuts from "Tender" U.S. Select carcasses. A telephone survey was conducted in metropolitan Denver, CO to recruit consumers (n = 1,036) for this study. Those consumers who met minimal limits for household income, age, and beef consumption, were invited to participate in a "beef shopping and usage study" in a local supermarket. Point-of-purchase material was developed that described "Tender Select" as "the only steak guaranteed tender and lean." When shown a copy of the concept card, 88% of participating consumers (n = 759) indicated that they would definitely or probably buy that product. Of those consumers that said they would buy the product, 35% indicated that their purchases of "Tender Select" would be in addition to their current fresh meat purchases. Of those consumers that indicated that "Tender Select" would be a replacement for current fresh meat purchases, 94% indicated that "Tender Select" would replace other beef cuts. Most consumers (54.1%) indicated that if "Tender Select" was available at their grocery store, 1 or 2 of their next 10 purchases of beef cuts would be "Tender Select." Only 5% of consumers indicated that if "Tender Select" was available at their grocery store, none of their next 10 purchases of beef cuts would be "Tender Select." Sixty-five percent of consumers indicated that if a grocery store carried a line of beef cuts guaranteed to be tender, they would buy all of their beef at that store. These data provide evidence of the potential impact of tenderness-based beef marketing on consumer purchase behavior.

Color, pH, Water Holding Capacity, and Emulsion Capacity of Muscles from the Chuck and Round

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Selection of muscles for alternative processing and/or merchandising strategies requires knowledge of the various physical, chemical, and processing characteristics of each muscle. The objective of this study was to characterize muscles from the chuck and round and to determine the inter-relationships among these characteristics. Chucks and rounds (96 each) were obtained from beef carcasses varying in carcass weight (250-430 kg), yield grade (1-5), and quality grade (Choice + to Select -). Ultimate pH, emulsion capacity, color, and water holding capacity were determined on 12 round muscles and 27 chuck muscles. Wide ranges in ultimate pH (5.2 to 6.7), water holding capacity (30 to 42% weight loss on centrifugation), emulsion capacity (158 to 194 mL oil emulsified/2.5 g of lean), and color (L-values from 29 to 45; a-values from 17 to 29; b-values from 5.6 to 8.0) were observed among muscles. Carcass weight, quality grade, and yield grade had little influence on these characteristics. Ultimate pH and water holding capacity were strongly related ($r = -.75$, $P < .01$) to each other, but their relationships to emulsion capacity were low ($r < .20$, $P > .05$). Redness (a-value) and blueness (b-value) were significantly related to water holding capacity ($r > .59$, $P<.01$). Darker muscles (lower L-values) had higher emulsion capacities ($r = -.49$, $p < .05$). Muscles were categorized on the basis of ultimate pH: low pH muscles (pH < 5.5), intermediate pH muscles (pH 5.5 to 5.8), and high pH (> 5.8) muscles. These groups differed ($P < .05$) in water holding capacity (high pH muscles were significantly higher) and color (low pH muscles were lighter and less blue than others). These data reveal substantial variation in characteristics of the muscles of the beef chuck and round and suggest it may be possible to capitalize on these intrinsic properties to define optimal usage to enhance value.

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The Effects of Ribeye Steak Tenderness Classification on Tenderness of Top Sirloin, Top Round, and Bottom Round Steaks

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The objective of this study was to determine the effect of longissimus tenderness classification of beef carcasses on tenderness of three other major muscles. Ninety-eight crossbred steers and heifers (14 to 17 mo of age) were humanely slaugh-

tered over 10 weeks and the carcasses were chilled 48 h at 0°C. At 48 h postmortem, carcasses were assigned to one of three tenderness classes (tender = < 26 kg, intermediate = 26 to 42 kg, tough = > 42 kg) using slice shear force from the MARC Beef Classification System. The longissimus thoracis, gluteus medius, semimembranosus, and biceps femoris were removed, aged at 3°C, and frozen at –30°C at 14 d postmortem. Two, 2.54-cm thick steaks were obtained from each muscle, thawed to 5°C, cooked with a belt grill to 71°C, and served warm to an eight-member trained descriptive attribute panel. Panelists evaluated each sample for tenderness, juiciness, and beef flavor intensity on eight-point scales (8 = extremely tender, extremely juicy, intense; 1 = extremely tough, extremely dry, and bland). The mean slice shear force values were 20.7, 34.4, and 46.3 kg, respectively for "tender", "intermediate", and "tough". Tenderness ratings were highest ($P < .05$) for "tender" and lowest for "tough" for all muscles except gluteus medius in which "tender" and "intermediate" were not ($P > .05$) different (longissimus 7.7, 7.1, and 6.3; semimembranosus 6.4, 5.8, and 5.1; biceps femoris 5.9, 5.4, and 4.8; gluteus medius 6.8, 6.5, 5.8, respectively for "tender", "intermediate", and "tough"). The magnitude of the difference in tenderness rating between "tender" and "intermediate" and between "intermediate" and "tough" was similar for all muscles. Tenderness ratings of the "tender" class were significantly different among muscles. The percentages of tenderness ratings greater than 5.0 for "tender" and "commodity" (all samples), respectively, were longissimus, 100 and 95%, semimembranosus, 95 and 85%, gluteus medius, 100 and 94%, and biceps femoris, 95 and 81%. The simple correlations between longissimus and the other muscles for tenderness were semimembranosus, .58, biceps femoris, .43, and gluteus medius, .68. Juiciness and beef flavor intensity ratings were not affected ($P > .05$) by tenderness class in any muscle. These data indicate that longissimus slice shear force could be used to classify top sirloin, top round, and bottom round cuts for tenderness.

Quality Characteristics and Storage Stability of Restructured Beef Steaks from Grass- and Grain-Fed Cattle

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The goal of this study was to improve palatability and extend shelf-life of beef from grass-fed cattle with or without grain supplements by the combination of restructuring and product formulation. Meat trimmings from the plates, chucks, and briskets of grass (alfalfa)-fed or grain (corn)-finished steer carcasses were processed into steaks with three formulation treatments: 1) control (0.25% tripolyphosphate, 1.5% NaCl); 2) with antioxidant (0.25% tripolyphosphate, 1.5% NaCl and 0.015% propyl gallate on a fat basis); and 3) with antioxidant and beef flavor agents (0.25% tripolyphosphate, 1.5% NaCl, 0.015% propyl gallate, and 0.75% beefy flavoring). Steaks were stored frozen (-29°C) and analyzed after 0, 1, 3, and 6 months for color (Hunter L, a, and b), lipid oxidation (TBARS), microbial population (total colony-forming units, *Staphylococcus* bacteria, coliforms), cooking yield, Instron binding strength, and sensory attributes. The results showed a marked increase in lipid oxidation in grass-fed beef steaks but only little change in grain-finished steaks after 6 months storage, which corresponded well with rancidity scores assigned by the taste panel. Antioxidant treatments effectively retarded ($P < 0.05$) lipid oxidation during storage of all steaks and improved their flavor scores. The beefy flavoring agent significantly intensified beef flavor characteristics and masked the grassy off-flavor, and hence, enhanced ($P < .05$) consumer acceptance of grass-fed beef. Microbial populations decreased ($P < .05$) during storage while color scores, cooking yield, and binding strength of steaks from both dietary regimes remained unchanged or changed only slightly, regardless of formulation treatments. Overall, through the use of meat restructuring technology and proper antioxidant and flavor agents, beef from grass-fed cattle, which is undesirable to most domestic consumers, can be processed into palatable and shelf-stable, value-added products.