Effects of increasing lysine levels on carcass composition, cutting yields, and further processed product characteristics of immunologically castrated male pigs


The objective of this study was to determine if increasing lysine levels in the diets of immunologically castrated male pigs will increase percent fat free lean and carcass cutting yields as well as to determine if the further processed products made from these raw materials are different from those made from physical castrates or entire males. The anti-gonadotropin releasing factor (GnRF) immunological (Improvac, Pfizer Animal Health) is used worldwide to immunologically castrate entire male pigs to control boar taint and take advantage of their inherent ability to grow leaner and more efficiently than physically castrated males. The immunization process controls boar odor problems and makes the likelihood for adoption into U.S. swine production systems far more likely. Reported lean meat advantages will also provide potential economic benefits to the domestic meat industry. Approximately 1200 male pigs (physical castrates, immunologically castrated males (IC), and entire males) were assigned to 1 of 4 diet programs with increasing lysine levels: physical castrate — low lysine (0.7% in the late finishing diet), IC — low lysine (0.7%), IC — low/medium lysine (0.8%), IC — high/medium lysine (0.9%), IC — high lysine (1.0%), and entire — high lysine (1.0%). At 5 weeks post-second injection, pigs were individually weighed and the two pigs (n = 96) in each pen closest to the median pig weight were selected and humanely slaughtered. Right sides of the carcasses were dissected into soft tissue, skin, and bone. Proximate composition was determined on the soft tissue to determine percent fat-free lean. Left sides were weighed and initially fabricated into ham, loin, belly, and whole shoulder. Each primal piece was weighed again and further fabricated into respective subprimal pieces. Further processed ham and bacon were made from the left sides of the carcasses. Immunological castration did not change (P > 0.05) shear force values or ultimate pH. Marbling appeared to decrease as dietary lysine was increased among IC males. As expected IC males had a higher (P < 0.05) percent fat-free lean than physical castrates but were lower (P < 0.05) than entire males. High lysine and high/medium lysine level IC males had higher (P < 0.05) lean cutting yields and carcass cutting yields than physical castrates. Lean cutting yield and carcass cutting yields appeared to increase as dietary lysine was increased among IC males. There were no differences (P > 0.05) in cooked yield or protein fat free values of further processed hams between physical castrates and IC males. Fresh bellies from IC males were thinner and had narrower flop distances (P < 0.05) than physical castrates but were thicker and had wider flop distances (P < 0.05) than entire males. Bacon cooked yields were not different (P > 0.05) between any lysine levels of IC males and physical castrates but were higher (P < 0.05) than entire males. Overall, immunological castration improved carcass cutability, increased percent fat free lean, and had no effect on further processed products when compared to physical castrates.

Keywords: Cutting yield, Immunological castration, Lysine

Fresh meat and further processing characteristics of ham muscles from finishing pigs fed ractopamine hydrochloride, paylean


Ractopamine hydrochloride (RAC; Elanco Animal Health, Greenfield, IN) has been commonly shown to improve hot carcass weight, dressing percentage and loin eye area of finisher pigs. However, the effects of RAC on further processed product characteristics, ham muscles profiles, and ultimate pH of ham muscles are less understood. Some studies have reported that RAC increases ultimate pH values for longissimus muscle, but recent meta-analysis concluded that RAC does not affect ultimate pH. Interestingly, 6 of the 7 experiments evaluated reported a numerical increase in ultimate pH when RAC was included in the diet. Higher ultimate pH values in hams could affect further processing characteristics by improving protein to water interactions and water retention. Therefore, the objective of this experiment was to determine the effects of feeding RAC on ultimate pH of 6 fresh ham muscles and to determine if RAC affects water retention and protein binding properties of cured hams made from these raw materials. Two hundred fresh hams were selected based on hot carcass weight from barrows and gilts originating from the same finishing facility. The fresh hams were utilized in a randomized complete block design with a 2 × 2 factorial arrangement of the following treatments: 1) Gender (barrows vs. gilts); and 2) RAC dose fed for 27 days prior to harvest (0 vs. 7.4 mg/kg). Hams were fabricated into 5 pieces (inside, outside, knuckle, shank portion, and light butt), trimmed, and weighed. Ultimate pH value was measured on the semimembranosus, adductor, semitendinosus, biceps femoris, rectus femoris, and vastus lateralis. A balanced subset of hams (n = 100) were pumped with a cure solution to a target of 130% of original green weight, processed, and cooked to 66 °C. Cooked hams were analyzed for moisture retention, protein binding strength, and cholesterol. The remaining 100 fresh hams were homogenized and analyzed for proximate composition and salt.
soluble protein determination. Data were analyzed by using Proc GLM of SAS. RAC increased (P<0.05) inside, outside, knuckle, light butt, and Shank meat weights, resulting in trimmed ham weights being improved by 0.74 kg or 0.22% on a percentage of HCW basis. RAC did not affect the percent moisture of fresh ham muscles, but increased (P<0.01) percent protein values by 0.36% and decreased fat values by 0.42%. Ultimate pH was increased (P<0.05) by RAC feeding in the rectus femoris, vastus lateralis, semitendinosus, and biceps femoris by an average of 0.05 units. However, RAC did not affect cooked ham characteristics. Cooked yield, evaporative chill loss and protein fat free values were not different (P>0.05) between RAC and control further processed hams. RAC also did not affect the percentage of salt soluble proteins in fresh hams or the break strength of further processed hams. In summary, RAC can be fed to pigs to achieve the desired ham cutting yields that have been reported by other researchers without positively or negatively affecting further processed ham characteristics.

Keywords: Pigs, Paylean, Hams

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**Influence of feeding different levels of fat from dried distillers grains with solubles and restaurant grease on bacon cooking characteristics and belly fatty acid profiles of market pigs**

S. Arnold*, J. Zhu, A. Schinckel, B. Richert, M. Latour, Purdue University, West Lafayette, IN, United States

Crossbred gilts (119; avg. initial BW = 33.5 kg) were randomly assigned to 3 dietary treatments. The 3 dietary treatments were corn-soybean meal based diets differing in concentrations of distillers grains with solubles (DDGS) and supplemental restaurant grease (RG) to alter carcass fat and attain target carcass iodine values (IV) of 65, 75, and 85. Dietary treatments were: 1) Control, 0% DDGS, 1% RG; 2) 25% DDGS, 1% RG; and 3) 25% DDGS, 5.3% RG. At Week 15, gilts (avg. final BW = 123.9 kg) were harvested and bellies processed at commercial facilities into sliced bacon. Pigs were individually identified throughout the entire process. A fat sample was collected from the belly of each pig to determine fatty acid (FA) composition. Bacon was stored frozen at −23.3 °C and removed from cold storage at 28 d and stored at 4 °C prior to cooking at 35 and 63 d post-processing. Within these storage durations, cooking characteristics were measured at 0 and 7 d post-opening the package. The open package was returned to the same storage room until cooking at 7 d. Four bacon slices per package were cooked at 0 and 7 d within each storage duration. Bacon slices were cooked by pan frying the 4 slices from a single package together at 260 °C for 2 min per side. Individual bacon slices were weighed and measured pre and post-cooking and distortion scored (15, least to most) post-cooking to document changes in bacon characteristics. Individual pig was the experimental unit for statistical analysis; with the FA profiles utilizing treatment and replicate, while bacon cooking was analyzed as a factorial of treatment, storage duration and days the package was open and replicate as a blocking factor. The saturated FA 14:0, 16:0 (24.2, 21.9, 18.6%), and 18:0 (11.1, 9.6, 8.3%) and the unsaturated FA 18:1n9 (39.3, 36.8, 35.1%) all were reduced (P<0.001), while the unsaturated FA 18:2n6 (13.4, 19.8, 25.9%) increased as dietary IV increased (P<0.001) from treatment 1 to 3, respectively. Belly FA IV (62.5, 71.2, 79.6) and N6:n3 ratio (29.4, 44.9, 50.3) increased as dietary IV increased (P<0.001), while saturated:unsaturated FA ratio (0.61, 0.52, 0.42) declined (P<0.001) from treatment 1 to 3, respectively. Raw bacon slice length (22.5, 23.2, 24.2 cm), package purge, and purge as a percent of package weight increased (P<0.0001) and slice weight (23.6, 23.0, 22.5 g) decreased as dietary IV increased (P<0.0001) from treatment 1 to 3, respectively. Cooked bacon slice weight (73.8, 70.0; P<0.02) and percent of raw length (63.3, 62.6, 59.4%; P<0.0004) decreased while cooking loss increased (86.4, 65.5, 68.7%; P<0.0007) as dietary IV increased from treatment 1 to 3, respectively. There was no effect of dietary IV on cooked bacon visual scores (P>0.12). Storage from 35 to 63 d reduced raw bacon slice length (P<0.05), shatter (P<0.004), and cook loss (P<0.04). Storing the open package for 7 d increased raw slice weight (P<0.05) and cooked slice length (P<0.02) while reducing raw bacon shatter (P<0.0001).

The increased dietary IV negatively affected bacon from these gilts by increasing bacon package purge and bacon slice length while reducing cooked bacon weights and yields.

Keywords: Dietary iodine value, Fatty acids, Bacon

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**Effects of dried distiller grains with solubles (DDGS) and ractopamine on fatty acid concentrations of pigs**

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One hundred sixty pigs (88 barrows and 72 gilts) were allocated by initial BW, sex, and litter to a factorial arrangement of treatments consisting of four dietary DDGS treatments and two ractopamine (RAC) treatments. The four DDGS treatments were: (T1) standard corn-soybean meal + 3.0% choice white grease (CWG) diets fed from 34 to 127 kg BW, (T2) diets containing 25% DDGS fed from 34 to 127 kg BW, (T3) diets containing 25% DDGS fed from 34 kg BW to 4 wk prior to market and fed T1 for the last four weeks to market BW, and (T4) diets containing 25% DDGS fed up to 8 wk prior to market and fed T1 diets to market BW. The two RAC treatments are either a control (0 ppm) or 2 wk of diets supplemented with 5 ppm followed by 2 wk of 10 ppm RAC. There were 5 pigs/pen and 4 pens/treatment. Three pigs/pen were transported to the Purdue Meats Laboratory for carcass data and tissue harvesting. Separation of backfat tissue from the loin at the 10th rib was evaluated. The fat samples from the backfat, belly, jowl and clear plate were analyzed for fatty acid (FA) concentrations. The DDGS treatments affected (P<0.05) the FA concentrations of 16:1n7, 18:0, 18:1n9, 18:2n6, 18:3n3, 18:2n9, 11, 18:2n10, 12 and 20:1n9 in the backfat tissue. The concentrations of 18:2n6 and IV values of the all fat tissue samples were related to the duration in which DDGS was fed. The concentrations of 18:2n6 in the backfat samples were 14.9, 17.3, 19.5 and 23.2 for control, 8-wk withdrawal, 4-wk withdrawal and continuous DDGS treatments (P<0.001), respectively. The IV values of the backfat samples were 67.7, 70.7, 73.1, and 77.1 for the control, 8-wk withdrawal, 4-wk withdrawal and DDGS treatments, respectively (P<0.001). Following a similar pattern, the IV values for the belly (66.6, 69.6, 69.5, and 74.0: P<0.0001), jowl (71.0, 74.1, 76.3, 78.5: P<0.001) and clear plate (70.6, 74.1, 75.5, 78.5: P<0.004) for the control, 8-wk withdrawal, 4-wk withdrawal and DDGS treatments, respectively, all increased with DDGS feeding duration. Concentrations of 18:0, 18:1n9, 18:1n7 and saturated:unsaturated fatty acid ratio decreased in all fat tissue samples as the duration of DDGS feeding increased (P<0.005). Ractopamine had little impact of the fatty acid profiles of the any fat tissue sample. Barrows had greater concentrations of 18:0 (P=0.002), lesser concentrations of 18:2n6 (17.7 versus 19.7, P<0.001), lower mean iodine values (70.7 versus 73.6, P=0.001) than gilts in the backfat samples. Similar sex differences were found in the other fat samples. The incidence of backfat separation from the loin muscle was increased in gilts (P=0.001, 29.2 vs 64.6%). Control pigs tended (P=0.11) to have lower incidence of backfat separation than pigs of the continuous DDGS, 4-wk withdrawal and 8-wk withdrawal treatments (29.2, 62.5, 41.7 and 54.2%, respectively). There were few significant two variable interactions for the fatty acids concentrations of the fat tissue samples. Feeding of DDGS increased unsaturated fatty acid concentrations and iodine values in belly, jowl, backfat and clear plate. These parameters incrementally
improved with increased time of the withdrawal of DDGS from the diet.

Keywords: Fatty acids, Dried distillers grains with solubles, Ractopamine

Zilpaterol improves feeding performance and fabrication yield of concentrate finished culled cows

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The objective of this study was to determine the effects that zilpaterol hydrochloride had on feeding performance, carcass grading performance, and fabrication yield of concentrate finished culled cows. Three hundred and twenty commercial beef cattle were obtained from ranches in Missouri and South Dakota. Cows were assigned to one of two treatments: 1) a control diet containing no zilpaterol hydrochloride (ZIL) and 2) a diet that contained ZIL. Cows were fed for 75, 88, or 110 days and all received the control ration until ZIL treatments were initiated. Twenty-four days prior to slaughter, ZIL feeding began for the designated treatment pens. The cows were fed ZIL (8.33 mg/kg (100% DM basis)) for 20 days with a 4-day withdrawal period prior to slaughter. No differences (P>0.05) were detected between the two treatment groups for Initial BW or DMI. Final BW (621.1 vs. 639.6 kg), ADG (2.17 vs. 2.75 kg), and G:F (0.120 vs. 0.156) were greater (P<0.01) in cows fed ZIL than the non ZIL cows. No differences (P=0.05) were found for lean maturity score, skeletal maturity score, fat thickness, LMA/HCW, or USDA calculated yield grade among the two treatment groups. Feeding ZIL increased skeletal maturity score, fat thickness, LMA/HCW, or USDA calculated yield grade among the two treatment groups. Feeding ZIL increased post mortem pH and Warner-Bratzler shear force determinations (P<0.05) amongst treatments for the BB, BV, and TB. The natural position (cranially to the point of the shoulder) resulted in the lower Warner–Bratzler shear force values for the BB, BV, and TB. Results also indicate for the in-home sensory evaluation indicated that the PP, SS, and SV were more tender (P<0.05) when the foreshank was repositioned to be perpendicular to the floor. Repositioning the foreshank to be parallel to the floor exhibited the least improvement in tenderness. Repositioning the foreshank perpendicular to the floor improved tenderness overall in sarcrome length, Warner–Bratzler shear force values, and was the manipulation that was chosen to be most tender by the consumers in the in-home sensory survey. We recommend that the beef industry consider this technology and the possibility of further improving value of cuts from the chuck.

Keywords: Beef, Chuck, Tenderness

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Comparison of USDA beef quality and yield grading characteristics of steer and heifer carcasses evaluated by subjective and objective methods

T. J. McEvers\textsuperscript{a,b}, J. P. Hutcheson\textsuperscript{a}, T. E. Lawrence\textsuperscript{a}, \textsuperscript{a}West Texas A&M University, Canyon, United States, \textsuperscript{b}Inter vet/Schering-Plough Animal Health, Desoto, KS, United States

Five large-scale investigations involving beef steers (n=2,565) and heifers (n=2,445) were compiled for the evaluation of zilpaterol hydrochloride (ZIL) use and its effect on predicted carcass value. Grading parameters used for value prediction were collected in large beef processing facilities from USDA graders and video image analysis (VIA) technology. Parameters for quality and yield assessed were collected for each evaluation point, compiled and compared. Using the values assigned by USDA graders and VIA technology, each carcass was assigned a value

Pre-rigor foreshank manipulation to improve beef chuck tenderness

A. Grayson\textsuperscript{a}, T. Lawrence, West Texas A&M University, Canyon, United States

Thirty beef carcasses were harvested to determine the effects of pre-rigor foreshank manipulation on sarcrome length and tenderness of seven chuck muscles. One of four shank manipulation treatments (cranially to the point of the shoulder – A, caudally at greater than 30° angle to the floor – B, cranially perpendicular to the floor – C, or parallel to the floor – D) was randomly assigned to each side of the carcass using an incomplete block design. Foreshanks were manipulated approximately 1 hour post-mortem and were held in place until the completion of rigor. The biceps brachii (BB), infraspinatus (IS), pectoralis profundus (PP), serratus ventralis (SV), supraspinatus (SS), teres major (TM), and triceps brachii (TB) were excised from the chuck 7 days post-mortem. Four steaks were taken from each muscle for sarcrome length measurements, Warner–Bratzler shear force determination, and an in-home sensory evaluation. Result indicate that the sarcrome length was altered (P<0.05) for the BB, IS, PP, SV, TM, and TB. Positioning the foreshank perpendicular to the floor most positively impacted the sarcrome length of all muscles. Warner–Bratzler shear force determinations differed (P<0.05) amongst treatments for the BB, SV, and TB. The natural position (cranially to the point of the shoulder) resulted in the lower Warner–Bratzler shear force values for the BB, SV, and TB. Results also indicate for the in-home sensory evaluation indicated that the PP, SS, and SV were more tender (P<0.05) when the foreshank was repositioned to be perpendicular to the floor. Repositioning the foreshank to be parallel to the floor exhibited the least improvement in tenderness. Repositioning the foreshank perpendicular to the floor improved tenderness overall in sarcrome length, Warner–Bratzler shear force values, and was the manipulation that was chosen to be most tender by the consumers in the in-home sensory survey. We recommend that the beef industry consider this technology and the possibility of further improving value of cuts from the chuck.

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Oxidative stress may affect meat quality by interfering with collagen turnover in intramuscular connective tissue fibroblasts

A. C. Archie-Contreras1,2, P. P. Purslow3,4

1University of Guelph, Guelph, ON, Canada, 2University of Zulia, Maracaibo, Venezuela

Vitamins E and C may increase collagen turnover. Stress during handling of cattle might reduce vitamin concentrations in muscles, which may increase reactive oxygen species (ROS) dramatically in the animals. Any imbalance between production of ROS and their safe disposal may culminate in a situation known as oxidative stress. Fibroblasts synthesize collagen and regulate its turnover by the production of matrix metalloproteinases (MMPs) responsible for collagen degradation. The objectives of this work were first, to investigate the ability of ROS to influence collagen turnover in primary intramuscular fibroblasts derived from two muscles of beef animals and second, to study the effect that ROS may have on counteracting vitamin E and vitamin C in the regulation of collagen remodelling. Fibroblasts were isolated from longissimus dorsi (LD) and semitendinosus (ST) muscles of a yearling animal and grown in DMEM, 10% serum, 5% CO2. Fibroblasts were treated for 24 h with 1) the superoxide generating system xanthine/xanthine oxidase (X/XO, 0.1 or 0.5 μM of vitamin E, ii) 50 μM vitamin E, iv) 50 μM vitamin C and then exposed to X/XO showed a decrease (P<0.01) in MMP-2 activity in both cell lines. Total collagen synthesis was also lowered due to the presence of ROS in LD cells (P<0.001); however, although this trend was also shown in ST cells, only those cells previously treated with 100 μM of vitamin E alone (P=0.0001) and together with 50 μM of vitamin C (P<0.05) showed a significant decrease. Oxidative stress may decrease net collagen turnover in intramuscular fibroblasts, and may also interfere in the up-regulation of collagen turnover exerted by vitamins C and E, which could lead to decreased collagen solubility in some muscles. Thus, oxidative stress is an environmental/dietary factor that might affect meat quality.

Keywords: Video image analysis, Zipatrol hydorchloride, Beef

Inhibiting pink discoloration in cooked turkey produced from presalted stored ground turkey breast trim

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The objective of this experiment was to determine the ability to eliminate pink discoloration, associated with the storage of presalted ground turkey, in cooked ground turkey using pink inhibiting ligands. Ground turkey breast trim (1 d PM) was mixed with 2% NaCl vacuum packaged, and stored (6 d, 2–3 °C). Each batch (1530 g salted meat) received 0.5% STP (meat weight basis, MWB) in water (10% MWB) or only added water (10% MWB). Each batch received a different level of a pink inhibiting ingredient (PII) delivered in a water solution (10% MWB). Ten treatments tested were: none (control), citric acid (CA; 0.1, 0.2, 0.3%), calcium chloride (CC; 250, 500 ppm), EDTA (50, 100 ppm), and sodium citrate (SC; 0.5, 1%). Batches were mixed for 5 min (CC treatments: CC solution mixed in before STP), stuffed (50 g) into tubes, and centrifuged. Treatments were fast (preheated 90 °C water bath) or slow (initially a 50 °C water bath) cooked (internal endpoint, 76.7 °C) and stored (2–3 °C) before being analyzed (1, 14 days). Results (4 replications) were separately analyzed by presence of STP. Data were analyzed as a randomized split-split plot design (PII treatments, whole plot; cooking rate, split plot; storage, split plot), Controls had pink discoloration, particularly in absence of STP (CIE a*, 6.24). Consistently greater percentage myoglobin denaturation (PMD) as a result of PII addition was not found in absence of STP. However, addition of PII in the presence of STP resulted in greater (P<0.05) PMD than the control. All samples had less than 0.6 ppm nitrosyl hemochrome suggesting limited, if any, contamination of the treatment mix with nitrite. Reflectance estimator of nitrosyl hemochrome (rNIT; % reflectance at 650 nm divided by % reflectance at 570 nm; lower ratio, less rNIT) indicated less (P<0.05) rNIT for all PII treatments than the control except for turkey containing both EDTA (100 ppm) and STP. All PII reduced (P<0.05) reflectance estimator of nitricitamide hemochrome (rNIC; % reflectance at 537 nm divided by % reflectance at 553 nm; lower ratio, less rNIC) at least at one level of PII addition in absence of STP, except for SC which was not different (P>0.05) than the control. CA reduced (P<0.05) rNIC in presence of STP. Overall cooking yield was reduced (P<0.05) by CA (78.8%) compared to the control (89.2%). PII tested, at all levels were effective at lowering pink color in cooked ground turkey, thereby reducing (P<0.05) redness (CIE a*) compared to the control (22.3%, 11.4%, 9.4%, and 15.5% reduction; CA, CC, EDTA, and SC, respectively). CIE a* generally decreased as the level of PII was increased with or without STP. CIE a* was lower (P<0.05) with a slow cooking rate in absence of STP compared to a fast cooking rate. However the opposite was found in the presence of STP. Storage of presalted ground turkey did produce pink discoloration in uncured, cooked turkey. This pink discoloration can be reduced by incorporation of citric acid, calcium chloride, EDTA or sodium citrate although incorporation of citric acid will increase cooking losses. Use of sodium citrate would offer some control with less of a negative impact on cooking losses.

Keywords: Turkey, Breast trim, Pink discoloration

Packaging developments for raw ready-to-cook meals

O. Serheim1, M. Høy, N. Veflen Olsen, Nofima Mat, Ås, Norway

A small segment of the ready meal market is called ready-to-cook (RTC) meals. These full dinner meals usually consist of raw meat or fish, which may affect meat quality.
Effect of pressure on quality and functional properties of beef semitendinosus muscles


The objective of this study was to determine the effects of hydrostatic pressure treatments on the pH, colour, drip loss, water binding capacity (WBC), protein solubility and tenderness (Warner–Bratzler shear force, WBSF) of beef eye of round (semitendinosus, ST) muscle steaks. Fresh post-rigor ST muscles from beef over thirty months of age were cut into 2.54 cm steaks, individually vacuum packaged in high pressure applicable bags and immediately subjected to high pressure processing (HPP) at 50, 100, 150, 200, 250, 300, and 400 MPa for 5 min at 8 ºC. A group of steaks not subjected to HPP served as a control. All treatments were applied to each muscle with the location within the muscle balanced to ensure that all treatments were assigned to all locations. Instrumental colour (L*, a*, b*) change, drip loss, and thiobarbituric acid reactive substance (TBARS) values were measured on fresh steaks after HPP treatment. Thaw loss, pH, water binding capacity (WBC), total protein and sarcoplasmic protein solubility, cooking loss and WBSF were measured on thawed steaks after frozen storage. The pH of HPP treated muscles increased significantly (P<0.05) with the increase of pressure from 5.42 for control steaks to 5.69 for samples pressurized at 400 MPa. The drip loss was the highest for 200 MPa samples with a value of 2.13% compared to the control, which had a drip loss value of 1.21%. The lightness (L*) values remained unchanged (P>0.05) when pressure was below 150 MPa, however, the L* value increased significantly when pressures of 200 MPa or higher were applied. The redness (a*) value was not affected up to 150 MPa but significantly decreased for the steaks treated with pressure higher than 200 MPa. The yellowness (b*) value of 50 MPa treated meat was lower when compared to the control, was not affected by pressure from 50 to 150 MPa, and was higher at pressures from 200 to 400 MPa. Based on visual observation and digital images taken before and after HPP treatment, the colour of the steaks changed from a natural reddish colour below 150 MPa, to a pinkish colour between 200 and 250 MPa, to a pale pink between 300 and 400 MPa. There was no significant differences (P>0.05) in WBC in beef treated with pressure below 100 MPa. Further increases in pressure resulted in a significant decrease in WBC from about 20% for samples treated with pressure below 100 MPa to ~3.42% for 400 MPa samples. Total protein solubility and sarcoplasmic protein solubility were not affected by pressure treatments below 200 MPa, but decreased significantly when treated at higher pressures. Overall, the colour of fresh ST muscle steaks was not affected when treated with high hydrostatic pressure below 150 MPa. There was no significant difference in protein functionality with pressure up to 100 MPa. Neither tenderness (Warner–Bratzler shear) nor oxidative stability (TBARS) was influenced by pressure treatment up to 400 MPa. HPP technology has received considerable attention as a method of processing meat. The information gathered in this study will be valuable in establishing HPP parameters that will optimize the effects of HPP on the colour, texture and functional properties of post-rigor beef.

Keywords: Beef, High pressure processing, Quality

Association of phenotypic characteristics with carcass grading performance and value

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The association of phenotypic characteristics with carcass performance and value was evaluated on data from 18,575 carcasses. Phenotype color frequencies were; black (50.0%), black-white face (10.6%), gray (4.9%), gray-white face (1.4%), Holstein (2.7%), red (10.6%), red-white face (5.8%), spotted (1.2%), striped (2.4%), white (3.5%), yellow (4.7%) and yellow-white face (2.2%). Cattle had sex frequencies of 83.5% steers and 16.5% heifers. Carcass data included HCW, KPH, LM area, 12th rib fat depth, and marbling score. Individual carcasses were assigned a base carcass value derived from the USDA AMS weekly beef carcass price equivalent index value report (NWLS410) and carcass premiums and discounts were derived from weekly slaughter cattle premium and discount reports (LMCT155). Weekly reports were used to capture seasonal changes in discounts, premiums and base prices; cattle were priced based upon the date of harvest. Hot carcass weight evaluation (P=0.05) indicated that Holsteins (415.3 kg) and black (381.3 kg) phenotypes had the greatest carcass weights. Yellow (372.8 kg) and spotted (366.3 kg) phenotypes had the lowest hot carcass weights. Steer carcasses (382.3 kg) had a greater hot carcass weight when compared to heifer carcasses (348.4 kg). Calculated yield grade evaluation (P=0.05)

Keywords: Ready to cook meals, Packaging, Shelf-life

Fresh cut vegetables, pre- or semi-cooked staple foods like rice, pasta or potatoes, and a pre-cooked sauce. Since RTC meals are cooked only once by the consumers, preferably in microwave ovens, they are likely to taste better than pre-cooked meals. RTC meals are currently marketed in the Netherlands and the UK, but sales are limited by a microbiological shelf life of only 5–6 days, and up to 20% of the meals are discarded as waste or sold at a reduced price. The EU a funded project, Double Fresh (STREP FR6 023182), aimed at increasing the quality and shelf life of RTC meals, reaching at least 10 days. In the technological development work, key success factors included selection of fresh raw materials of high quality, pretreatment of certain perishable ingredients and modified atmosphere packaging. Two meals with raw chicken breasts or salmon fillets were developed. The chicken fillets were marinated in a juice of red lingonberries (Vaccinium vitis-idaea) for 10 min. The salmon was filleted pre-rigor under high hygienic conditions. Respiring vegetables and non-respiring foods like meat and fish have different requirements for modified atmospheres. In general, vegetables need access to oxygen (O2) in levels of at least 2% and below 15% preferably should be stored in O2-free atmospheres with high concentrations of CO2. The meals were placed in one-compartment polypropylene trays of 1150 ml with laser-perforated top films. The packages were flushed with a gas mixture of 5% O2/5% CO2/90% N2 and stored at 4 ºC for up to 15 days. By monitoring the O2 levels of the packages during storage, changes in the quality and microbiological status of the meals could be predicted. Up to 9 days storage, the O2 concentrations of the meal packages were quite stable at 5–7%, slightly above the target of 3–5%. A drop in O2 values between 9 and 12 days storage indicated additional consumption of O2 by bacteria, faster in packages of non-marinated than marinated chicken meat (P<0.05). Concentrations of CO2 increased to ca. 20% at the end of storage. The microbiological shelf life of marinated chicken meals was 12 days, while it was only 7 days for non-marinated. Lingonberry juice marination reduced the total bacterial counts on chicken meat by 1 log after marination (P<0.05), and by 2–3 logs during modified atmosphere storage (P<0.05). The color of the marinated chicken meat was more red and stable during storage, as evaluated by instrumental and visual analyses. The drip loss was 5.8 and 2.4% from marinated and non-marinated meat, respectively (P<0.05). The salmon meals also had a microbiological shelf life of 12 days without major quality reductions. The new RTC meals with chicken and salmon both obtained a substantial extension of the microbiological shelf life, which will facilitate a wider distribution of the meals and reduce losses at the retail level.
indicated that white (2.37) and yellow (2.48) phenotypes had the lowest yield grades. Carcasses with the highest yield grade were black (3.11) and black-white face (3.16) phenotypes. Steer carcasses (3.02) had a lower calculated yield grade when compared to heifer carcasses (3.13). Marbling score evaluation (P<0.05) indicated that black (Small23) and black-white face (Small23) phenotypes had the greatest marbling scores. Yellow (Slight86) and yellow-white face (Slight86) phenotypes had the lowest marbling scores. Heifer carcasses (Small23) had a greater marbling score when compared to steer carcasses (Small23). Market price evaluation (P<0.05) indicated yellow ($130.51) and white ($130.49) phenotypes had the greatest values. Black-white face ($127.87) and Holstein ($118.44) phenotypes had the lowest values. Heifer carcasses ($131.99) had a greater market price when compared to steer carcasses ($128.65). Deviation from mean gross value evaluation indicated white ($13.85), black ($9.94) and gray ($9.28) phenotypes had the greatest deviation over the mean gross value and red-white face (-$13.36), striped (-$15.08) and spotted (-$19.39) had the greatest deviation under the mean gross value.

Keywords: Beef, Carcass, Value

Table 1
Carcass performance and value.

<table>
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<tr>
<th>Phenotype color</th>
<th>HCW, kg</th>
<th>Calculated yield grade</th>
<th>Marbling score</th>
<th>Market value</th>
<th>Deviation from mean gross value</th>
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<tr>
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Dial and digital food thermometer accuracy when measuring endpoint temperature in ground beef patties using common consumer cooking methods
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A social marketing campaign, “160 °F For Your Family,” was developed in Idaho and Washington to motivate consumer food thermometer use to ensure safely cooked ground beef patties. In preparation for the campaign, common consumer cooking methods for ground beef patties were identified, and the objective of this study was to assess the accuracy of dial and digital thermometers to determine the endpoint temperature of 160 °F (71.1 °C) in cooked ground beef patties using common consumer cooking methods. The availability of instant-read food thermometers in Idaho and Washington was surveyed in 168 grocery, department, kitchen specialty, hardware, and drug/variety stores. Six thermometers, representing commonly available dial and digital thermometer models from 3 price categories (low, medium and high cost), were selected for testing. Dial and digital thermometers were compared to thermocouples in ground beef patties cooked to 71 °C, using common consumer cooking methods (patties flipped once and containing chopped onions or topped with a slice of cheese during cooking in a preheated frying pan on a stovetop) as well as a laboratory cooking method (plain patties flipped every 30 s during cooking on a preheated electric griddle). The thermocouple and digital thermometers were inserted in the side of the patty to reach the geometric center, while the dial thermometers were inserted so that the sensing area straddled the geometric center of the patty. The study design was a randomized complete block design with 5 replications. Temperature variation within patties containing onion and plain patties was also examined when patties were flipped every 30 s or once during cooking. For the laboratory cooking method, two thermometers (digital-low cost and dial-medium cost) read within 1.5 °C of the thermocouple, the remainder varied by ± 3 °C. Using consumer cooking methods, where patties were flipped once and ingredients added, the accuracy of most thermometers was reduced. For patties containing chopped onions, one thermometer (dial-medium cost) read within 0.5 °C of the thermocouple, while the remainder ranged between 4.2 and 16.7 °C above the thermocouple reading. For patties that were sliced cheese added, thermometers ranged from 2.4 °C–11.6 °C above the thermocouple reading. Patties that were flipped once had a considerably larger temperature gradient from top to bottom than patties that were flipped every 30 s, making thermometer placement for accurate readings more difficult. Dial and digital thermometers were both utilized in promotional materials developed for a consumer campaign to encourage thermometer use.

Keywords: Ground beef, Safety, Thermometer

Ground beef patty cooking practices: An assessment of consumer purchasing, handling and cooking practices for comparison with laboratory cooking methods
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Foodborne pathogens can be present throughout ground beef patties, making internal endpoint temperature critical for product safety and leaving the most critical control point in the hands of the consumer; however, less than 15% of the US population uses a meat thermometer when cooking ground beef patties as indicated by previous studies. To perform an investigation of dial and digital thermometer accuracy using common consumer cooking methods, an assessment of consumer behaviors was performed. Initially, four consumer focus groups were conducted to guide development of a telephone survey. Consumers (n = 824) from Idaho and Washington responded to the telephone survey and topics included: purchasing practices, storage methods, types of added ingredients, patty size and thickness, cooking methods, and thermometer use. Respondents were primarily Caucasian and 67% were female. Participant ages ranged from 18 to 94 with most respondents over the age of 40. When cooking indoors, females prepared and cooked ground beef patties 70% of the time while when cooking outdoors, males cooked patties 65% of the time. Most consumers cooked ground beef patties indoors and outdoors less than 5 times per year. Consumers most commonly purchased fresh, ground beef. While 37% of consumers repackaged and froze ground beef, 34% refrigerated ground beef in its original packaging prior to preparation and cooking. Consumers most commonly reported using one quarter-pound of ground beef per patty and a patty thickness of one half-inch. Twenty-eight percent of consumers added chopped vegetables most of the time or always during preparation, and 29% added cheese to patties during cooking most of the time or always. The most common indoor cooking method was frying ground beef patties in a pan on a stovetop, and 75% of consumers used grilling for outdoor cooking. Laboratory methods typically involve cooking ground beef patties without ingredients and flipping patties frequently while cooking. In contrast to laboratory methods, 40% of consumers flipped ground beef patties only once, and
consumers most commonly flipped the ground beef patty for the first time after 5 min of cooking. Forty-five percent of consumers preferred well-done patties, and 10% preferred rare to medium-rare patties. Internal patty color was utilized by 70% of consumers to determine patty doneness and only 16% used a meat thermometer to check the endpoint temperature. The results of this study identified common consumer practices and guided method development for an examination of dial and digital thermometer accuracy in ground beef patties using consumer methods and comparison with laboratory methods.

Effect of pig diets supplemented by long-chain fatty acids on transport stress

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The objective of this work was to study the effect of docosahexaenoic, eicosapentaenoic acids (DHA/EPA, n-3) and conjugated linoleic acid (CLA) supplementation to pig diets on transport stress. Thirty-six 54-kg castrated males were randomly assigned to four supplementation groups: n-3; CLA; n-3 + CLA; blank. Animals were fed for 8 weeks with the following studied fatty acid concentrations: 2.7 g EPA, 1.8 DHA, 15 g CLA during the first 4 weeks; 3.6 g EPA, 2.4 g DHA, 20 g CLA for the rest of the study time. Once the feeding period was concluded, the animals were transported for 2 h at 45 km/h, 0.8m3/load density. The stress was measured at three sampling times (basal, post-long transport and post-slaughtering) by acid-base equilibrium, blood gasometry and blood metabolism. Animals fed with diets supplemented with n-3 and n-3 + CLA showed the higher resistance to stress as compared to animals supplemented with CLA, whereas animals fed with the blank had the lowest stress resistance. Significant differences were observed within supplemented diets in lactate (P < 0.0001, 0.0001, 0.0002, 0.0004) and K+ concentrations (P < 0.0001, 0.0001, 0.001, 0.0001) for n-3 + CLA, CLA, n-3 and blank, respectively among sampling times (basal, post-long transport and post-slaughtering). Conversely, no significant differences were observed within supplemented diets for HCO3- (P = 0.22, 0.05, 0.20, 0.04), Na+ (P = 0.33, 0.01, 0.69, 0.03) and Ca2+ concentrations (P = 0.36, 0.22, 0.39, 0.04 for n-3 + CLA, CLA, n-3, blank, respectively) among sampling times. Results suggested a better adaptation to stress in pigs fed with diets supplemented with n-3, n-3 + CLA and CLA.

Keywords: Docosahexaenoic acid (DHA), Eicosapentaenoic acids (EPA), Conjugated linoleic acid (CLA)

Survey on U.S. beef retailing practices in Mexico

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Surveys were conducted in retail chains (Chain) located at different Mexican cities (Mexico City, Guadalajara, Queretaro, Leon, and Monterrey) during January–April 2008 (N = 1004 retail trays) to learn about the predominant beef cut types, fabrication styles (Presentations) and degrees of leaneness. Sources of variation were Region (Central, Midwestern, Northern), City nested within Region, Chain (n = 8), and socioeconomic strata (Class) of the targeted clientele (high, middle, low). Levels of subcutaneous (SBCOVER), inter-muscular (SEAM) and intramuscular (MARBLING) fats were deemed as response variables. SBCOVER varied by Region (P = 0.01) whereas the three response variables varied by City and Chain (P = 0.05). Conversely, the effect of Class did not become significant (P = 0.07). The Region × Chain interaction affected (P < 0.01) MARBLING, Chain × Class influenced (P < 0.03) SBCOVER and MARBLING, whereas Region × Class affected (P < 0.01) all response variables. Retail outlets at Leon City trended to exhibit beef retail cuts with the thickest levels of SBCOVER and SEAM fats and the highest mean marbling scores. Nationwide, the five most commonly exhibited Presentations accounted for 82.1% of the total U.S beef surveyed; these Presentations [frequency, %] were: 1) Thinly sliced (ca. 4 mm-thick), not wider than 12 cm and not larger than 20 cm, milanesa-style steak [32.7%]; 2) Steak for grilling (carne para asar) [22.8%]; 3) Diced beef, locally called trozos, similar to beef for kabobs with a size of 5 cm approximately [10.2%]; 4) Fajita-style (ca.1.5 cm-thick) strips, not wider than 5–6 cm and not larger than 10–12 cm [10.0%]; and 5) Thinly sliced (ca.5 mm-thick), not wider than 8 cm and not larger than 30 cm, tampiqueña-style steak [6.4%]. The five most common, identifiable types of beef cuts accounted for 52.4% of the total beef merchandised. These types (frequency, %) were: 1) top round (17.2%), 2) bottom round (14.5%), 3) knuckle (10.6%), 4) eye of round (5.2%), and 5) neck + chuck roll (4.5%). The vast majority of the beef cuts (93.0%) were trimmed to less than 0.32 cm of SBCOVER for retailing (P < 0.05) while the average SEAM thickness was less than 0.32 cm in 94.4% of the surveyed cuts. Regarding prevalence of USDA grades, almost all (99.2%) of the exhibited US beef cuts with grade history derived from Select (74.6%) and Choice (24.6%) carcasses; 70.0% of the cuts exhibiting very low MARBLING levels (practically devoid, traces or slight amount). Overall, the findings indicate that with the current merchandising practices, Mexican retailers are trying to please the local preference for leaner, affordable and convenient beef items by fabricating and denuding U.S. beef retail cuts, mostly derived from rounds and chucks of the USDA Select grade.

Keywords: Leanness, Retail cuts, Fat cover

Venezuelan consumers’ preferences and perceptions of beef quality


A survey to examine beef quality perceptions, beef consumption preferences and habits of Venezuelan consumers was carried out between January 2007 and September 2009. Data was gathered by face-to-face interviews on the way out of fresh markets, butcher stores, supermarkets and, in some cases, at home. Participant’s selection was conditioned by two requirements: a) to be a beef consumer, and b) to be responsible for the food purchasing decisions in the family group. A total of 703 participants from three geographical regions [Zulian, n=181; Central, n=329 (Caracas, n=129; Valencia, n=100; Maracay, n=100); and Eastern, n=193] were surveyed. Forty-five questions were structured in five sections: (I) Demographic characteristics; (II) Beef consumption habits; (III and IV) Criteria for evaluating intrinsic and extrinsic quality attributes of beef; (V) motivations for the purchase and/or consumption of beef. Responses were subjected to principal component analysis to define the way consumers perceive beef quality. Women predominated (68.6%) as those who make the food-purchasing decisions. 76.6% of the respondents indicated a higher preference for beef than for other meat species. Most interviewees prepare (64.6%) and consume...
(60.4%) beef as the center of the plate, every two or three days. 63.2% of the respondents indicated that perceived food safety risks did not support changes in their beef consumption patterns. Intrinsic organoleptic attributes (tenderness, color, odor, freshness, taste and juiciness) of beef were highly regarded (97.3%) by respondents in each of the regions under study. However, it was readily evident that Venezuelan consumers prefer lean beef (90.1%), and disregard marbling as a quality indicator. In regard to the importance of extrinsic, retail cut characteristics, preference for imported beef, and safety. Marbling and willingness to pay for marbled separation was based on beef organoleptic traits, preference for distinct location for each region in the multivariate space. Such separation was based on beef organoleptic traits, preference for imported beef, and safety. Marbling and willingness to pay for marbled beef were disregarded and influenced negatively the purchase intent. Willingness to pay for hormone/antibiotic-free or natural/organic beef showed strong negative correlations. Perceived extrinsic and intrinsic quality attributes and the quality expected or desired depend on the consumers’ level of knowledge with beef quality matters or their eating experience. Healthiness, nutritive value and freshness were not easily evaluated by the consumers. Venezuelan consumers perceive that beef safety is a feature that retailers should guarantee. Meanwhile, branding and animal feeding conditions were disregarded as factors affecting the beef quality. These results show that Venezuelan beef consumers need to be informed and educated on quality and food safety matters, by means of trustworthy sources of information.

Keywords: Beef, Consumer preferences, Quality perception

North Dakota consumers’ sensory evaluation of the palatability characteristics of bottom round, top sirloin, chuckeye, and ribeye beef

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Consumer perceptions of palatability attributes of beef are often solicited at retail establishments via delivery of small meat samples on a toothpick. While this means of introduction distributes a product to the consumer, there is little or no feedback provided regarding consumer perception. The current project utilized a presentation method of meat kabobs, expanding the familiar meat on a toothpick distribution method by replacing the toothpick with a kabob stick and the small sample with four 50 g cubes of beef. This presentation allowed for convenient conveyance of four unique beef samples. The objective of this project was to evaluate consumer assessment of palatability traits of three traditional retail cuts: bottom round (BR-NAMPS 170), top sirloin butt (TS-NAMPS 184), and ribeye roll (RE-NAMPS 112A) versus one next generation beef value cut (CE-NAMPS 116D or 116G; designated Delmonico or Denver steaks). Kabob samples were lightly seasoned and grilled to an estimated degree of doneness of rare and moved to a 65°C oven until served (maximum holding time of 30 min). The settings for kabob sample assessment varied from a luncheon to an informal hamburger. Consumers voluntarily selected materials and were invited to complete a survey via telephone, internet or mail. The evaluation tools included a validated Stage of Change question to assess consumer intention and behaviors toward thermometer use. Additional questions about consumer perception of the materials, beliefs and attitudes towards thermometer use, potential barriers to thermometer use with hamburgers, and demographic information were also collected in the evaluation tool. Draft survey questions were pilot-tested and refined using feedback from food safety experts, focus groups, and cognitive interviews with consumers. A three month follow-up survey after initial survey administration assessed sustained thermometer use behavior changes among grocery store shoppers. Results indicated consumers from both audiences were in the pre-
action stages of change indicating progression towards thermometer use when cooking hamburgers. Grocery store shoppers were not equally distributed (P<0.01) among the stages of change with 4% in pre-contemplation, 51% in contemplation, 29% in preparation, 7% in action and 9% in maintenance. For the WIC audience, 22% were in pre-contemplation, 22% in contemplation, 39% in preparation, 8% in action and 10% in maintenance. A positive shift towards increased thermometer use was seen in the three month follow-up survey among grocery store shoppers; 30% of these respondents moved to a higher stage of change in the follow-up survey. Consumers also reported an increase in food thermometer use after viewing the educational materials in grocery stores (47% increase, kappa statistical value = 0.29) or in WIC offices (33% increase, kappa statistical value = 0.31). Thermometer sales were tracked during the thermometer campaign in grocery stores and a significant (P<0.01) increase in thermometer sales was seen among participating stores (218 units sold in participating stores, 81 units in control stores). The results of these campaigns indicate that educational materials developed using emotion based techniques can have a positive influence on thermometer use among consumers.

Keywords: Consumer, Ground beef, Thermometer

Marketing source-verified beef to restaurant patrons
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Consumers often rely on source-verification information to make beef purchasing decisions. The objectives of this research were to determine factors influencing consumer purchase decisions in nice restaurants and to see if consumers are interested in the origin of their beef. An on-line survey was conducted using patrons from three restaurants in Connecticut (n = 799). Following the survey, an in-restaurant taste-testing was conducted in two of the restaurants. Participants (n = 151) were asked to select one of four New York strip steaks. All descriptions stated that steaks were USDA Choice and had superior flavor and tenderness. The only difference between the descriptions was price ($30, $32, $34, and $36) and origin specification (country, region, state, or ranch). Price was randomly assigned to each steak and all steaks came from the same ranch in Nebraska. All strip loins were upper 2/3 Choice, aged for 28 days, cut into approximately 14 oz steaks, and shipped fresh (not frozen) to the restaurants. After the meal, participants were given a short questionnaire and asked to rate sensory attributes of their steak (overall appearance, aroma, flavor, juiciness, tenderness, and overall acceptability). All data were analyzed using Proc Freq of SAS. Regarding the online survey, 55% of the participants identified cut of beef as the primary factor determining their steak choice, while only 8% used USDA quality grade. About 51% said flavor and 23% said tenderness was the primary factor determining overall satisfaction when consuming beef in a restaurant. When origin information is not provided, 64% assume their meat was from the United States. About 39% want country-of-origin labeling, 37% want region-of-origin, and 36% desire state-of-origin. Only 19% want to know ranch-of-origin and 23% were indifferent. About 67% would be willing to pay a premium for a source-verified steak. For the in-restaurant taste-testing, 36% of the participants selected the steak that had ranch-of-origin specified and another 32% chose the steak with the state-of-origin specified. About 77% or more of the participants gave the steaks they would order the same steak again. Criteria for steak selection included quality grade (43%), a tenderness guarantee (42%), and origin information. The majority of the participants agreed that the best beef comes from the Midwest (90%), with 62% specifically naming Nebraska and 25% naming Texas as states that grow high quality beef. When participants were asked if they would be willing to pay more for beef that is source-verified, 61% said yes. These data suggest that there is consumer interest in a source-verified beef product.

Keywords: Beef traceability, Consumer preferences, Source-verification

Prevalence of various meat product label claims disseminated via social media technologies
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Food animal production has become increasingly questioned by consumers in recent years. Popular books and movies have spurred concerns about a variety of animal production practices, as well as the quality and safety of the meat produced from those animals. This discussion has transitioned from print media to the world wide web. Various social media (SM) tools enable any web user to rapidly and universally send and receive information about a variety of topics including meat science and muscle foods. However, the majority of the SM user accounts sending and receiving information about meat science and muscle foods may not be credible resources for such information. An uncontrolled observational study of various SM tools, including blogs, Twitter pages and Facebook pages that mention “meat” in their posts was conducted by conducting Google, Twitter, and Facebook searches on four separate weekdays over a 2 month period. The objective of this study was to evaluate the prevalence of meat product label claims presented using various SM tools. In total, 250 different pages or accounts were evaluated for a total of 948 observations (some accounts were deleted or temporarily unaccessible at the time of evaluation). Within each page, the following terms were searched and the presence or absence of each term was recorded: organic, natural, grassfed, local, and antibiotic. The proportion selected pages featuring meat that addressed the selected terms is presented. Eighty-three percent of pages presented information about organic and/or natural meats, and nearly 72% offered information about how to purchase such products. Eighty-nine percent of pages promoted grassfed meats. Though 88% of pages highlighted the benefits of local meats, 41% offered information for how to purchase them, and even fewer defined a distance associated with local. Nearly 80% had the term antibiotic posted to various pages, among which 86% discussed the perceived consequences of antibiotic use and encouraged raising livestock without antibiotics. Approximately 60% of online American adults are registered users of one or more SM services, and more than 90% of Gen-Y Americans are registered users of one or more SM services. The percentage of Americans that receive information via SM is projected to increase. It may be possible for the meat science industries to follow SM information to assess trends in consumer demands. Through targeted SM communications, the meat science industries may be able to provide meat consumers with realtime product information.

Keywords: Label, Production claim, Social media

Effect of weaning program and backgrounding method on meat quality of steers fed a common finishing diet
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This study sought to evaluate the meat quality of steers fed a common finishing diet following four different weaning management and backgrounding programs. Steers (n = 37) were assigned to one of four treatments including 1) cow calf pairs maintained and grazed together and placed on a finishing diet (CC), 2) weaned calves grazed ahead of
cows and then placed on a finishing diet (WNF), 3) weaned calves supplemented with (Corn, DDGS, bypass protein, monesin) grazed ahead of cows and then placed on a finishing diet (WF), 4) stocker calves grazed in a managed grazing system prior to being placed on a finishing diet (STK). Following grazing, steers were commingled and fed a common receiving, growing, and finishing diet. Steers were humanely slaughtered at the University of Missouri under USDA-FSIS inspection after reaching a minimum live weight of 498 kg or having an estimated 12th rib fat thickness of 1.016 cm. Carcass measures for HCW, REA, 12th rib fat and KPH were made. Yield grade was calculated according to USDA equations. A 3-rib section (ribs 10–12) was removed from each carcass following an 18 d aging period at 4°C, deboned, sliced into 2.54 cm steaks, and evaluated for Warner-Bratzler shear force (WBSF), cooking loss %, total fatty acid profile and fat and moisture (CEM) analysis. Day 18 aging was assigned as d 0 for retail display. Cut steaks were allowed to blossom 15 min and Minolta color (L*, a*, b*) was measured on one steak from each rib section. Steaks were then packaged individually and placed under simulated retail display for 7 d at 4°C. Additional Minolta color measures were taken on d 1 and 7. Linear contrast analysis of the data yielded the following results. Treatment CC exhibited greater final weights than the average of all other treatments (P = 0.02). Treatment STK calves had increased total days on feed when compared to WNF and WF calves (P = 0.03), whereas supplemented weaned calves (WF) required fewer total days on feed than those that were not supplemented (WNF) (P = 0.01). No differences were found between CC and the average of all other treatments for carcass measurements, cooking loss %, WBSF, and fat %. When compared against the combination of WNF and WF groups, the STK group was not different in carcass measurements or meat quality parameters. Kidney, pelvic, and heart fat % was lower for the WF group than the WNF group (4.16% vs. 3.55%) (P = 0.03). Supplementing weaned calves (WF) tended to decrease yield grade when compared to non-supplemented, weaned calves (WNF) (3.27 vs. 2.89) (P = 0.07). WNF calves had higher marbling scores (5.44) than WF calves (5.02) (P = 0.02), and supplementing tended to increase cooking loss % (14.04 vs. 17.94) in WF calves compared to WNF (P = 0.07). Additionally, CEM fat % decreased with feed supplementation during grazing (WNF vs. WF) (P = 0.04). Percentage of total polyunsaturated fatty acids was lowest in the STK group compared to the average of the other treatments (P = 0.03). No differences were shown for Minolta color based on day and grazing treatment. Overall, these data indicate that these pre-feedlot management methods do not significantly alter carcass performance or compromise meat quality parameters.

Keywords: Backgrounding, Beef, Meat quality

Effects of long-term feeding of two corn byproducts on composition, tenderness and shelf-life stability of beef strip steaks


The objective of this study was to evaluate carcass composition, tenderness, and shelf-life stability of steaks from steers using distillers dried grains with solubles (DDGS) or corn gluten feed (CGF) compared to soybean meal/corn (SBM) as a protein supplement from weaning to slaughter at 25% DM. Beef steers (n = 81, BW = 306 kg) were randomly assigned to pens (n = 9) and stockerized using corn silage and DDGS, CGF or SBM. After a 90 d stockerizing period, 12 steers (BW = 396 kg) were randomly selected from each treatment for individual feeding using the same protein supplement. Steers were fed for 100 d and slaughtered at 1.27 cm of backfat. Carcass data were collected 24 h post-mortem and strip loin steaks were removed and fabricated into steaks at 48 h. Strip loin steaks were used for Warner-Bratzler shear force (aged 7, 14, or 21 d), objective/subjective color and lipid oxidation in simulated retail display (aged 1, 3, 6, or 9 d), and proximate analysis. Carcass characteristics were similar among treatments (P = 0.10), except for lean maturity, which was greatest (P = 0.01) in SBM. Moisture tended to be greater (P = 0.07) in DDGS compared to CGF. Protein and lipid content were similar (P = 0.10) among treatment groups. An interaction was detected for shear force. At d 7, SBM steaks were less (P = 0.01) tender than DDGS or CGF. By d 14 SBM and CGF steaks were not different (P = 0.30); however, SBM was still less tender (P = 0.05) than DDGS. By d 21, tenderness was not different (P = 0.05) among treatment groups. For retail display L* was highest for CGF (P = 0.04) and all treatments became darker (P = 0.01) at d 9. Objective redness (a*) declined (P = 0.01) over time across treatments. Also, CGF tended (P = 0.08) to have increased a* values at d 9 than those from DDGS. A time effect was observed for b* where values tended (P = 0.06) to differ between d 1 and d 6. There was no treatment effect for overall acceptance (P = 0.17), but acceptance did decline (P = 0.01) after d 3. A treatment x day interaction (P = 0.04) occurred for subjective redness where SBM steaks tended (P = 0.07) to have higher redness scores at d 6 than CGF. At d 9 SBM steaks were redder (P = 0.01) than DDGS and CGF were intermediate. Steaks from steers fed DDGS tended (P = 0.06) to have lower redness scores at d 9 compared to CGF. A treatment x day interaction (P = 0.01) occurred for subjective discoloration. At d 3 and 6, CGF had more discoloration (P = 0.04) than SBM or DDGS. However, at d 9 SBM and CGF were not different (P = 0.10). Steaks from DDGS were more (P = 0.01) discolored than both alternative treatment groups. Lipid oxidation increased (P = 0.001) over time until d 6 for all treatments; however, differences (P = 0.05) were not found among treatments. These data indicate that using DDGS and CGF as a protein supplement for beef steers from weaning until slaughter is not detrimental to meat quality, and yields a comparable product to SBM supplemented steers.

Keywords: Corn byproducts, Shelf life, Meat quality

Factors affecting carcass, quality and instrumental color characteristics of serially harvested, forage-finished steers


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Fall-born steers (n = 60, 316.75 ± 29.2 kg) were serial harvested to examine the effects days of grazing (DOG) on carcass, quality and instrumental color characteristics of steers grazing cool- and warm-season forages. Steers were placed on fescue in fall and allowed to graze until the beginning of the trial (Dec. 9, 2008). On the trial start date, steers were stratified by weight and the first group of steers (Group 1; 0 d, about 12 mo of age) were harvested to serve as a baseline for the remaining groups (n = 5; 2, 56 d; 3, 112 d; 4, 168 d; 5, 224 d; 6, 280 d) and were placed on ryegrass. Groups were serial harvested every 56 d for a total of 6 harvest groups. After group 4 (June 23, 2009), steers were moved to a bermudagrass and fescue pasture for 28 d. Steers were then moved to a crabgrass pasture for the duration of the grazing period and were allowed to graze in the same pasture to eliminate variation among forages. Steers were humanely harvested at a small commercial processing plant in Bluffton, GA. Twenty-four h postmortem, hot carcass weight (HCW), backfat at the 12th rib, marbling, ribeye area, kidney, pelvic and heart fat (KPH), pH, lean a*, b*, and L*, fat a*, b*, and L* at the 12th rib, and yield grade were measured on each carcass. Strip loins were removed from the left side of carcasses 24 h postmortem, vacuum packaged and aged 13 d in dark storage at 2°C. Strip loins were then removed from their vacuum packages, cut into steaks and assigned to one of three treatments: 14 d aging, 21 d aging or display (DIS; 14 d vacuum packaged, 7 d display in...
overwrapped package) for seven d in a retail coffin case. Color measurements taken were L*, a*, b*, hue angle, saturation index, and 630/580 nm ratio on days 0 and 6 of display. Thiobarbituric acid reactive substances (TBARS) were determined on d 6 DIS steaks. Correlations were generated using the Proc Corr procedure of SAS. Regression analyses were generated using Proc Reg Stepwise of SAS and were checked for model adequacy. Values for TBARS had moderate positive correlations with d 0 b* and Hue angle values and a low positive relationship with Saturation index and 630/580 nm ratio. Values for TBARS had moderate positive relationships with d 6 L*, b*, hue angle, and Saturation index and a moderate negative relationship with 630/580 nm ratio. Days of grazing had positive (P<0.05) low correlations with d 0 L*, saturation index, 630/580 nm ratio, and d 6 L* values. Ribeeye area, DOG and HCW all had high negative relationships with d 0 hue angle indicating that the larger heavier animals had truer red color on d 0. However, d 6 hue angle values had a low negative (P>0.05) relationship with only ribeye area. As expected, DOG, live weight, HCW and ribeye area all had high positive (P<0.05) correlations with each other. Regression analyses showed that marbling (P=0.05) was the best predictor for both 14 d and DIS shear force. Results indicate that increased DOG allow for increased marbling, HCW, ribeye areas, and backfat. Moreover, hue angle may be a good predictor of lipid stability in the muscle.

Keywords: Beef heifers, Serial slaughter, Zilpaterol-HCl

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**Modification of steer growth, age at slaughter and meat quality through nutrition and exogenous bio-stimulants**

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Exogenous growth promotants such as hormonal growth implants and β-agonist feed supplements are options producers can use to increase growth of beef cattle that may interact with breed and age at slaughter to affect beef quality. One hundred and twelve crossbred Hereford-Aberdeen Angus (HA) or Charolais-Red Angus (CRA) calves were assigned in a 2×2×2 factorial arrangement to finish either on grain at 12–13 months (calf-fed) or on forage at 1820 months (yearling-fed), receive hormonal growth implants (IMP) or not (NOIMP), and be supplemented with ractopamine hydrochloride (Optaflexx 45) (RAC) or not (NORAC). The m. semitendinosus (ST) and m. glutaeus medius (GM) were assessed at 1 or 7 days post mortem for individual muscle weight, color, muscle pH and temperature, sarcomere length, fibre type and areas, purge loss, cooking loss, shear force, and proximate analysis. Data were analyzed using PROC MIXED (P<0.05) (SAS Version 9.2, SAS institute Inc., Cary, North Carolina) and included finish time, implant, β-agonist, breed and their interactions as sources of variation. IMP ST had a greater mean shear force than NOIMP ST (7.87 and 6.92 &; 0.26 standard error of the mean) kg respectively, (P=0.0307) and was associated with an increase in red, intermediate, and white muscle fibre areas. Yearling-fed ST and GM had greater mean shear force values than calf-fed ST (8.31 and 6.47 &; 0.26 kg respectively, (P=0.001) and GM (6.37 and 5.29 &; 0.28 kg respectively, (P=0.0259), an increase that was accompanied by an increase in connective tissue shear force most likely associated with increased collagen insolubility due to advancing animal age. The percentage of white muscle fibres increased by 7.2% in ST with animal age (P=0.0007) while intermediate fibre percentage decreased by 6.6% (P=0.002), but both muscles from yearling-fed steers had greater red and intermediate muscle fibre areas than calf-fed steers. This flux of fibre types and areas in the ST with animal age was associated with an increase in myofibrillar shear force of 1.2 kg (P=0.0097), so connective tissue may not have been the only factor responsible for increased ST toughness in yearling-fed steers. Shear force in GM muscles was greater for CRA than HAA steers (6.01 and 5.64 &; 0.22 kg respectively, (P=0.044). IMP increased the percentage of red muscle fibres by 3.1% (P=0.044) and decreased the percentage of intermediate fibres by 3.2% (P=0.0394) in the GM. RAC, however, reduced the percentage of red muscle fibres by 3.8% (P=0.0182) and increased the percentage of white muscle fibres by 6.1% (P=0.0346) in the GM. IMP also was associated with a shift from white to intermediate fibres in HAA ST. Yearling-fed CRA GM had a greater percentage of white muscle fibres than yearling-fed HAA GM (39.9 and 36.6 &; 1.8%, P=0.0434). Overall, increased age at slaughter and IMP increased cooked ST toughness suggesting both collagen and myofibrillar protein proteolysis contributed to ST eating quality. Toughness of the GM was affected by breed and age at slaughter, implying that GM toughness was primarily affected by connective tissue. RAC had little effect on meat quality, indicating that it can be used in modern beef production systems without compromising GM and ST quality.
Quantification of red meat yield using objective measurements captured by video image analysis technology

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Video image analysis (VIA) images from beef steer and heifer (n=211) carcasses were analyzed for indicators of lean and fat to develop improved methodology to predict red meat yield. Carcasses were fabricated into industry standard cuts. Images taken by VIA technology were evaluated using computer image analysis software to quantify parameters used in multiple-linear regression models to predict percentage red meat yield, fat trim, and bone for each carcass. Prediction models included several variables currently quantified by VIA technology such as longissimus muscle area (LMA), cm2, subcutaneous fat area around the 75% length of the longissimus (SFA75), cm2, and SFA, from 25 to 100% the length of the longissimus (SFA), cm2, subcutaneous fat area as HCW, kg, longissimus depth (LD), cm, subcutaneous fat thickness at intramuscular fat content (IMF). Other variables used in calculation such as HCW, cm2, HCW, kg, SFA75, LD, SFA, and SFA, HCW, was used. The use of these equations in beef processing facilities will enable carcasses to be further evaluated using computer image analysis software to evaluate three types of nozzles (3.175 mm three-hole nozzle, 3.175 mm fan nozzle used in combination with 5.10 atm of pressure, three-hole nozzles. The optimum nozzle×pressure treatment was a five variable equation (Adj. R2 = 0.65, root MSE = 0.021) consisting of HCW, longissimus depth (LD), and subcutaneous fat thickness at 100% the length of the longissimus (SFT100). For cattle fed zilpaterol hydrochloride (ZIL), a five variable equation (Adj. R2 = 0.65, root MSE = 0.021) consisting of HCW, SFA75, LD, SFA, and SFA, HCW, was used. The use of these equations in beef processing facilities will enable carcasses to be further sorted into finite groups and valued based on predicted red meat yield from objective measures.

Keywords: Video image analysis, Red meat yield, Beef

Quality indicators and effects of aging and calcium chloride in tenderness of forequarter muscles from Bos indicus, Bos taurus and Mexican commercial crossbred cattle


Diversity of production systems in Mexico leads to the use of different breed types, Bos taurus (Bt), Bos indicus (Bi) and Mexican Commercial Crosses (MCC) for meat production. Recent research has proven high tenderness in certain muscles of the forequarter, which has resulted in targeting specific muscles to marketing niches, as in the case of the Infraspinatus and Teres major muscles. The objective of this study was to determine quality characteristics and the effects of aging and calcium chloride in tenderness of beef muscles from the forequarter and relate them to their genetic origin. Thirty 18–24 month old bulls treated with zilpaterol and fed similar diets during 80 to 110 days were selected for this study. Bt and Bi groups received electrical stimulation, therefore in the statistical analysis, initial shear force of MCC group was analyzed separately. Infraspinatus, Supraspinatus, Subscapularis, Brachialis, Complexus, Splenius, Triceps brachii long head and lateral head, Biceps brachii, Teres major and Rhomboideus muscles were obtained. Each muscle was cut into five 2-inch thick steaks, one for initial shear force, three for aging treatments (7, 14 and 21 days) and one for calcium chloride treatment. Response variables included shear force, cooking loss, moisture and fat percentage for each muscle. Results showed Bi muscles to be less tender than those from Bt animals. Infraspinatus is the most tender (P<0.05) of all muscles in both Bt and Bi (3.39±0.15 and 4.20±0.13 kg, respectively). Within the MCC group, Infraspinatus also proved to be the most tender muscle. Unexpectedly, Rhomboideus muscle from Bt was tougher (P<0.05) than that of the Bi ones, 5.92±0.17 kg vs 5.05±0.13 kg, respectively. Average WBSF decreased significantly at 7 days of aging, Bt muscles showed the lowest values (3.8) when compared to Bi and MCC (4.3 and 4.4, respectively). Tenderness did not change significantly after 7 days. Calcium chloride had no significant effect on the initial WBSF values of MCC muscles (5.9 vs 5.6) and Bt (4.8 vs 4.2); however, it had a significant effect on Bi WBSF values (5.5 vs 4.4). At 7 aging days, Brachialis and Triceps (lateral head) were classified as tough muscles (SF >4.6 kg), Biceps and Supraspinatus as intermediate muscles (SF <4.6 kg) and Complexus, Splenius, Teres major, Subscapularis, Rhomboideus and Triceps (long head) as tender muscles (SF <3.9 kg). Finally, Infraspinatus was found to be very tender (SF <3.2 kg). Tenderness of Mexican beef can be improved by aging muscles from Bi and MCC for 7 days. A longer aging time is not recommended because no further improvement will be obtained.

Keywords: Aging, Forequarter muscles, Mexican beef

An objective method to quantify beef head cleanliness utilizing the mechanical head wash as a means of water conservation

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The objective of this research was to evaluate methods to modify existing mechanical head wash cabinets in an effort to conserve water used during harvest. Water conservation is of high importance in the Texas high plains region. Recession of the Ogallala Aquifer has caused beef processors to explore use of deeper aquifers with lower water quality resulting in increased cost for treatment and pumping. This study evaluated three types of nozzles (3.175 mm three-hole nozzle, 3.175 mm fan nozzle, and 3.175 mm venturi nozzle) and three different water pressures (34.0, 5.10 and 6.80 atm) in a two-way treatment structure. The optimum nozzle × pressure combination was used to evaluate the effect of water temperature (15.5 °C, 37.8 °C, and 57.2 °C) in a one-way treatment structure. Pre-wash and post-wash images of beef heads were captured with a digital camera. Images were analyzed via image analysis software to quantify the percentage change in red saturation. An interaction (P=0.09) was detected between water pressure and nozzle type. These data indicated a decrease in change of red saturation as pressure increased for venturi nozzles. In contrast, an increase in change of red saturation was experience as pressure decreased when using fan or three-hole nozzles. The optimum nozzle × pressure treatment was a 3.175 mm fan nozzle used in combination with 5.10 atm of pressure, which used 26 L of water per head washed. Water temperature did not impact (P=0.21) change in red saturation. Reducing water use and minimizing energy inputs to heat water could result in economic benefits to the beef processor, while conserving the fresh water supply.

Keywords: Image analysis, Mechanical head wash, Water conservation

Effect of exercising gilts during gestation on neonate development and offspring growth

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In livestock species, including the pig, decreased blood flow during gestation can contribute to poor postnatal performance. To determine the
effect of increased umbilical blood flow on fetal, neonatal, and postnatal growth, gestating Yorkshire gilts (n = 8) bred to a common boar, were assigned as control (CON; to remain in the gestation stall for the duration of gestation) or to exercise (EX) where they were housed in the gestation stall but allowed 30 min to exercise 3 times per week from d 40 to d 105 of gestation. We have previously reported an increase in umbilical blood flow in EX gilts compared to CON gilts. All piglets were weighed immediately after birth. Within 12 h of the completion of parturition, piglets were measured for crown-rump length (CRL), biparietal distance, and abdominal girth. The lightest (LWT) and heaviest (HWT) male and female piglet in each litter were selected for necropsy, excluding piglets weighing <800 g. Livers, semimembranosus (SM), and semitendinosus (ST) muscles were dissected and weighed. Tissue weights (g) and tissue weight/live BW (g/g) were analyzed. Offspring were followed throughout growth and weighed weekly throughout the nursery phase (4 weeks post-weaning), the last two weeks of the grower phase, and every two weeks during the finishing phase beginning at 56.35 ± 2.15 kg. Weight at birth of offspring was not different (P = 0.40; 1367 CON vs. 1465 EX ± 84.33 g). There were no treatment differences for CRL, biparietal distance, or abdominal girth. Liver weight was greater in EX piglets compared to CON piglets (P = 0.003). When liver weight was calculated as a proportion of BW (g/g), a treatment by weight interaction occurred. Light weight EX piglets had heavier liver weight (g/g) compared to LWT CON piglets (P = 0.001), but were not different from either HWT EX or HWT CON piglets. Light weight piglet’s CON livers were also smaller than HWT EX (P = 0.01) but not different than HWT CON livers. There were no treatment differences for SM (g) or ST (g) and (g/g) weights. There was a tendency (P = 0.08) for CON piglets to have a larger proportion of SM (g/g) compared to EX piglets. At weaning there was a tendency (P = 0.10) for CON piglets to be heavier compared to EX piglets. There were no treatment differences in offspring weight during the first four weeks post weaning, during the grower phase, and in the finishing phase. Organ composition of offspring born to gilts that exercised during gestation was changed however this did not influence postnatal growth.

Keywords: Exercise, Neonate development, Offspring growth

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Carcass characteristics and composition of intact male Boer and Kiko goats harvested at four timepoints

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This study evaluated the effect of breed and feeding duration on carcass characteristics and composition of male goats. Intact male goats (n = 48) were allotted in a 2 × 4 factorial arrangement, with 2 breeds (Boer and Kiko) and four feeding periods (0, 4, 8, and 12 weeks post weaning). Animals were housed in individual pens at Tuskegee University and fed a 16% crude protein concentrate diet at no more than 3.2% of body weight, with ad libitum access to hay. After each feeding period, animals were harvested at Mississippi State University. Final live weight, hot carcass weight (HCW), and cold carcass weight (CCW; 24 h post mortem) were recorded and used to calculate dressing percent and cooler shrink. Longissimus temperature and pH were recorded at 0.5, 1, 3, 5, 8, 12, and 24 h post mortem. At 24 h post mortem, carcasses were fabricated and left sides were cut into shoulder, foreshank, breast, rack, loin, sirloin, hind leg, hindshank, and trim primals. Soft tissue (muscle and fat) for all primals was combined for the entire side, ground, and frozen for subsequent moisture, fat, and protein analysis. Right sides were dissected, and the longissimus dorsi, semimembranosus, gluteus medius, biceps femoris, infraspinatus, supraspinatus, semitendinosus, psoas major, and adductor muscles were excised and weighed. There were no interactions between breed and feeding period for any of the parameters measured (P > 0.05). Final live weight (P < 0.0001), HCW (P < 0.0001), dressing percent (P = 0.0038), and CCW (P < 0.0001) increased, and cooler shrink decreased (P = 0.0005) as feeding duration increased. Boer goats had a heavier final live weight than Kiko goats (P = 0.0328), but HCW, dressing percent, CCW, and cooler shrink were not affected by breed. Longissimus temperature at 0.5, 1, 3, 5, and 8 h post mortem increased (P < 0.05) after longer feeding durations, but temperatures at 12 and 24 h post mortem decreased (P < 0.05) after longer feeding durations. Longissimus pH at 0.5, 1, 3, 5, and 24 h was increased after longer feeding durations (P < 0.05). Breed did not affect (P > 0.05) Longissimus temperature or pH change. All primals were heavier (P < 0.05) as feeding duration increased. Boer goats had heavier breast (P = 0.0016) and leg (P = 0.0097) primals than Kiko goats, but weights of all other primals were not affected (P > 0.05) by breed. Weight of the longissimus dorsi, semimembranosus, biceps femoris, infraspinatus, supraspinatus, psoas major, and adductor muscles increased (P < 0.05) as feeding duration increased. Boer goats had heavier (P < 0.05) semimembranosus and biceps femoris muscles than Kiko goats. Results indicate that intact male Boer and Kiko goats showed similar patterns of growth over 0, 4, 8, and 12 weeks of feeding. Further research should evaluate the impact of breed and feeding duration, particularly the post mortem temperature and pH changes, on meat quality characteristics.

Keywords: Goat, Composition, Feeding duration

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Incidence and severity of Arcanobacterium pyogenes injection site abscesses with needle or needle-free injection methods

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Nursery age pigs (n = 198) were used to evaluate the difference in the occurrence of injection site abscesses between needle-free jet injection and conventional needle-and-syringe injection systems. Pigs were fed for 21 d prior to treatment administration to acclimate the pigs to the environment of the Kansas State University Segregated Early Weaning (SEW) unit. On d 21 each pig was injected with aluminum hydroxide adjuvant in the neck and ham with needle-free jet injection (Pulse Needle-Free Systems, Lenexa, KS) and conventional needle-and-syringe injection. Needle-free and conventional needle-and-syringe injections were randomly assigned to pig side yielding a total of 396 injections per treatment with a total of 792 injections sites. Immediately prior to injection, the external surface of the injection sites were contaminated with an inoculum of Arcanobacterium pyogenes, a bacterium commonly associated with livestock abscesses. The pigs were then fed for a period of 27 and 28 d. On d 27 and 28 the pigs were humanely euthanized and sent to the Kansas State Veterinary Diagnostics Laboratory where necropsies were performed and the injection sites underwent histopathological evaluation. The needle-free jet injection system was associated with more injection site abscesses than the conventional needle-and-syringe injection method for both neck (P = 0.0625) and ham (P = 0.0313) injection sites. Twelve abscesses were found at injection sites administered via needle-free jet injection method while only 1 abscess was found where a conventional needle-and-syringe injection method was used. At the neck injection sites, 5 abscesses were found while at the ham injection sites, 8 abscesses were observed. Of the 13 abscesses that were found, 10 developed on the left side of the animal and only 3 were seen on the right side. In summary, the implementation of needle-free jet injection systems in market hog production will be beneficial to eliminate needles and needle fragments in meat products but, when in the presence of Arcanobacterium pyogenes, it may increase the occurrence of injection...
site abscesses in pork carcasses that will need to be trimmed in pork processing plants. Although more abscesses were associated with needle-free jet injection, their occurrence was still observed at a very low rate given that injection sites were intentionally contaminated prior to injection. This project was funded by the National Pork Board.

Keywords: Abscess, Arcanobacterium pyogenes, Needle-free injection

**A survey of realized weights and percentages of lean tissue for various upland and migratory game bird species at progressive stages of processing**

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The public is largely unaware of the significance of protein derived through hunting. Specimens from fourteen game bird species were processed and weights at each stage were recorded to provide data for estimating lean. Process weights were: whole body WB, field dressed FD, skinned carcass SC, boneless lean LN, and breast weight BR. Hunters were provided with means to preserve entrails, thus gut weight plus field dressed weight was taken as WB weight. Feathers, skin, head and foot removal left SC weight. Separable lean (LN) was removed from the skeleton and the pectoral muscles (BR) were weighed separately as many hunters only save the breast muscle. Species were divided into: UPLAND SPECIES: pheasant (Phasianus colchicus torquatus), sharp-tail grouse (Tympanuchus phasianellus), grey partridge (Perdix perdix), mourning dove (Zenaïdura macroura), ruffed grouse (Bonasa umbellus) and sage grouse (Centrocercus urophasianus)); MIGRATORY SPECIES: (snow/blue goose (Chen Hyperborea), canada goose (Branta canadensis), sandhill crane (Grus canadensis tabida) mallard (Anas platyrhynchos), gadwall dove (Zenaïdura macroura), ruffed grouse (Bonasa umbellus) and blue-wing teal (Anas discors)). For each of the species, successive processed weight was expressed as both an average weight for that species and as an average percentage using the lesser processed weight as the denominator through various stages of processing. Considerable size differences among the various species precluded comparison of yield edible tissue directly. Percentage of LN and breast BR using WB weight as the denominator were summarized for upland birds and migratory birds were divided into large (geese and crane) and small (ducks). Ducks averaged 28.9% LN (SE ± 0.63) of WB and 18.6% BR (± 0.36). Large migratory birds averaged 33.2% (± 0.45) LN and 16.4% (± 0.20) BR. Upland species had larger LN and BR percentage (41.5±0.50 LN and 25.6%±0.24 BR). The most popular game bird in ND is the pheasant. Harvest estimate for 2008 was 776,000 birds. Based on our data of 0.51 kg lean per bird, nearly 400,000 kg edible lean was made available for consumption. U.S. Fish and Wildlife Service estimated 13,635, 700 ducks and 3,792,600 geese were harvested in the USA in 2008. Based on our data of 0.24 kg LN per duck, some 3,335 million kg of LN and 3,835 million kg LN from geese (LN mean 0.75) were harvested in 2008.

Keywords: Game birds, Lean yield

**Substituting distillers dried grains for cottonseed meal in lamb finishing diets: Carcass characteristics, meat fatty acid profiles, and sensory panel traits**

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Effects of replacing cottonseed meal (CSM) with corn distillers dried grains (DDG) on carcass characteristics, meat fatty acid profiles, and sensory panel traits were investigated in Rambouillet wether lambs (n = 44, initial BW = 28.8 ± 3.5 kg). Lambs were individually fed ad libitum diets for 84 d containing DDG that replaced 0% (0DDG), 33% (33DDG), 66% (66DDG), or 100% (100DDG) of the CSM in a completely randomized design. Carcass characteristics, fatty acid profiles, and sensory panel traits from the LM were determined on 8 randomly-selected wethers’ diet-1. Carcass characteristics and meat moisture percentage were not affected (P>0.14) by diet. As DDG increased in the diet, extracted fat increased linearly (P=0.004) and meat samples from lambs fed 100DDG diet had greater (P=0.006) extracted fat than meat samples from lambs fed ODDG diet. Oleic (trans-9, 10, 11) and cisvaccenic acids linearly increased (P<0.09), and CLA (other than cis-9, trans-11 isomers) and Arachidonic acid linearly decreased (P<0.02) in meat as DDG increased in the diet. The CLA cis-9, trans-11 isomer quadratically increased (P=0.07) as percentage of DDG increased in the diet. Meat samples from lambs fed 100DDG diet had greater (P<0.10) oleic and cis-vaccenic acids and less (P<0.08) palmitic acid, CLA (other than cis-9, trans-11 isomers), and arachidonic acid than meat samples from lambs fed ODDG diet. Increasing DDG in the diets affected cook loss, initial and sustained juiciness, sustained tenderness, and flavor intensity. Meat samples from lambs fed 100DDG had less (P=0.01) cook loss and greater (P<0.04) initial and sustained juiciness and than meat samples from lambs fed ODDG diet. Substituting DDG for CSM in lamb finishing diets

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had no negative effect on the evaluated carcass, sensory traits or longissimus fatty acid profile. Supplemental or replacement DDG in lamb diets can be used as an alternative protein source without detrimental effect on meat quality characteristics.

Funded in part by the U.S. Department of Transportation, Office of the Secretary, Grant No. DTO59-07-G-00053.

Keywords: Carcass characteristics, Distillers dried grains, Feedlot

Effect of breed-type on performance, carcass traits, fatty acid content, cholesterol content, and consumer sensory evaluation of crossbred hair sheep


Hair sheep breeds offer the benefit of reduced shearing, parasite resistance, enhanced performance in feedlot trials, and red meat yield. To evaluate the effect of four hair sheep breed types on feeding performance, carcass characteristics, lipid characteristics and consumer acceptability; four crossbred hair sheep groups were evaluated: 50% Rambouillet × 25% St. Croix × 25% Dorper (RR; n = 20); 25% Rambouillet × 37.5% St. Croix × 37.5% Dorper (SD; n = 19); 50% Barbados Blackbelly × 25% St. Croix × 25% Dorper (BB; n = 20); 7/8 Dorper × 1/8 Barbados Blackbelly (DD; n = 16) were used. Animals were fed a concentrate diet ad libitum to a final weight endpoint and harvested at the GW Davis Meat Laboratory at Texas Tech University. Carcass characteristics were recorded on ribbed carcasses before each was fabricated into subprimal cuts using industry fabrication specifications. Loins were then portioned into steaks for shear force, free fatty acid, and consumer sensory analysis. In addition to the four crossbreeds, steaks from 100% Rambouillet sheep were also fed to consumers. Results showed the BB group gained the least per day (P<0.05) and had the poorest feed efficiency (P<0.05). The DD group had more (P=0.01) 12th rib fat than BB and SD, with the RR breed group being intermediate. The DD group also had the greatest (P<0.02) body wall thickness while being heaviest muscled; exhibiting the largest (P<0.05) LMA, leg circumference, and carcass and leg conformation scores. High levels of saturated fatty acids (SFA) and monounsaturated fatty acids and low levels of odd-chained and polyunsaturated fatty acids (PUFA) were observed among all breed types. RR and DD samples had higher (P<0.05) concentrations of SFA than SD and BB. RR and SD samples had the greatest (P<0.05) concentrations of PUFA. There were no detectable differences (P=0.5) in shear force measurements. Consumers preferred (P<0.05) steaks from 100% Rambouillet to the four crossbred treatments. The steaks from 100% Rambouillet sheep were rated most tender (P<0.05) and, along with DD and RR, rated juicier (P<0.05) than SD and BB. Flavor was rated similar (P=0.05) for 100% Rambouillet, RR, and DD; with each being preferred to SD and BB. These results indicate differences in performance, carcass characteristics, fatty acid composition and palatability existed between crossbred hair sheep and selection must be based on specific needs of each producer.

Keywords: Carcass traits, Hair sheep, Meat quality

Principal component analysis of physicochemical and sensory attributes of refrigerated ovine meat

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Physicochemical and sensory analysis are needed to fully describe meat quality, as each type of analysis gives specific information to provide a global knowledge of meat quality. However, it is essential the use of a trained sensory panel in order to correlate the sensory attributes with other quantitative data, by using a multivariate statistical method such as principal component analysis (PCA). Recently, ovine meat consumption and trading is growing all over the world, but there are few reports that describe their quality attributes. The main objective of this work was to analyze and correlate the instrumental evaluation of color and texture with sensorial evaluation of color, appearance and texture, as well as, the variation in pH and protein solubility in ovine meat during refrigeration. Twenty-two one-year-old Pelibuey lambs were slaughtered in a commercial abattoir. Longissimus-lumborum muscles were dissected, vacuum-packaged and stored at 2 °C; samples were taken for analysis at 3, 5, 7 and 14 days of storage. Color and texture were evaluated by means of a Minolta colorimeter (L, a*, b*) and a TA-TXT2 plus texturometer (WB-shear force & TPA), respectively. Thirteen-member trained panel evaluated changes in sensory attributes in raw meat using a 9-point scale for the greasy and homogenous appearance, color, brightness, fibrous appearance, firmness, and manual adhesive-ness. In addition, pH, sarcoplasmic and myofibrillar protein solubility were measured. PCA score plot showed clear separation according to the days of storage but none between samples. First and second PCA (PC1 and PC2) components accounted for 55% and 36.6% of variance, respectively. PC1 was defined by brightness, fibrous appearance, firmness, manual adhesiveness, as well as, total and myofibrillar protein solubility, a*, b* and TPA (hardness, chewiness, springiness, cohesiveness and adhesiveness). The PC2 was defined by sensory color, greasy and homogenous appearance, as well as, pH, L* and WB-shear force. Instrumental color values increased during storage from to 108 up to 12.15 for a*, and 9.9 up to 10.9 for b* (P<0.005), but no difference was detected for the sensory color evaluation. Myofibrillar protein solubility increased from 88.6 up to 106.4 mg/g meat (P<0.0001); pH increased from 5.71 up to 6.62 (P<0.0008). Brightness had the highest value (6.23) at days 7 and 14, showing a high positive correlation with a* (r=0.985). Furthermore, fibrous appearance declined from 5.45 to 4.44 after five days of refrigeration, data was correlated with TPA hardness (r=0.93) and TPA chewiness (r=0.908); but a negative correlation was obtained with firmness (r=-0.963). Positive correlation was observed for firmness with myofibrillar solubility (r=0.854) and TPA adhesiveness (r=0.827). Data obtained from the chemical, physical and sensory analysis explain completely the quality characteristics of ovine meat. Storage time has a significant effect on the ovine meat quality, as the principal component analysis makes possible to give a synthesized judgment of meat characteristics variability during refrigeration.

Keywords: Ovine meat, Sensory analysis, Principal component analysis

Effects of wet aging and temperature on Warner–Bratzler shear force values and cooking loss of pork loins

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Twelve paired bone-in pork loins with normal inherent muscle quality were used to investigate the effects of wet aging and temperature on Warner-Bratzler shear force (WBS) and cooking loss. During three separate replications, each of four paired bone-in full loins was fabricated into ten 2.54 cm chops from the center-loin. Chops were assigned randomly to one of two temperature controlled aging treatments (Group A 0 °C and Group B 2.22 °C) and wet aged for 3, 6, 9, 12, and 15 days. WBS evaluation indicated observed values decreasing with increasing aging periods. Day 15 WBS values were significantly more tender than WBS values at Days 3, 6, and 9 (P<0.05). Separate temperature controlled groups influenced
decreasing WBS values; Group A resulted in a WBS value of 3.2 kg and Group B had a WBS value of 3.0 kg (P ≤ 0.05). Days of age and temperature did not significantly influence cooking loss. Cooking loss was variable to replication, days of age, and temperature. Within this study, results indicate that over varying days and temperature differences, increased time of aging and temperature can affect overall tenderness of a pork product. Results of this trial suggest aging pork products can provide a more tender product for the consumer.

**Keywords:** Pork, Warner–Batzler shear force, Wet aging

### Evaluation of the ability to predict belly fatty acid concentrations from fatty acid concentrations of the clear plate, jowl and backfat of pigs
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A trial was conducted to evaluate; (1) the relationships of fatty acid (FA) concentrations from values obtained from clear plate, jowl, backfat and belly, and (2) the accuracy of predicting belly FA concentrations from the fatty acid concentrations of the other depots. The barrows and gilts had been allocated to a factorial arrangement of treatments consisting of four dietary DDGS treatments and two ractopamine (RAC) treatments. The four DDGS treatments were: (T1) standard corn-soybean meal ~3.0% choice white grease diets fed from 34 to 127 kg BW, (T2) diets containing 25% DDGS fed from 34 to 127 kg BW, (T3) diets containing 25% DDGS fed from 34 kg BW to 4 wk prior to market and fed T1 for the last four weeks to market BW, and (T4) diets containing 25% DDGS fed up to 8 wk prior to market and fed T1 diets to market BW. The two RAC treatments are either a control (0 ppm) or 2 wk of diets supplemented with 5 ppm followed by 2 wk of 10 ppm RAC. The correlations amongst the four fat depots ranged from 0.07 to 0.46 for FA 18:0, 0.52 to 0.72 for FA 18:1n9 and 0.81 to 0.89 for FA 18:2n6 concentrations. Correlations amongst the iodine values (IV) of the four tissue depots ranged from 0.31 to 0.71. The concentrations of saturated FA of the belly were best predicted (P < 0.01) by the clear plate (RSD = 1.46 and 1.41% for 16.0 and 18.0), Belly, 18:1n9 concentration was predicted from backfat, jowl and clear plate 18:1n9 concentrations with RSD’s of 2.66, 2.39 and 2.73%, respectively, Belly, 18:2n6 concentration was predicted with R² values of 0.66 to 0.71 and RSD values of 1.85 to 2.03% from the other three tissues. Belly IV concentrations were predicted with R² values of 0.703 to 0.879 with RSD’s of 1.29 to 2.03 units from the IV values of the other three tissues. Belly N-6/N-3 ratios were values of 1.85 to 2.03% from the other three tissues. Belly IV were correlated (R = 0.85) between the true and predicted DDGS treatment means. However, 18 or the 27 equations accounted for less than 50% of the true DDGS treatment variation in the belly FA concentrations. The equations predicted less variation between the DDGS treatments than the actual DDGS treatment means. The predictions of belly fatty acid concentrations from other tissue samples were inconsistent in their ability to predict dietary DDGS treatment and sex differences.

**Keywords:** Belly, Fatty acids, Prediction

### The impact of a diet high in unsaturated fat on loin fat separation in market gilts
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The purpose of this study was to investigate how a diet enriched with Distillers Dried Grains with Solubles (DDGS), influences fat separation in market gilts. In this study, (n = 60) market gilts were assigned to three dietary treatments. The diets were primarily corn-soybean meal based containing different levels of DDGS to result in targeted iodine values (IV) of (65, 75 and 85) in the carcass. All market gilts were sampled after 16 weeks in a commercial processing facility. Boneless loins (n = 119) were harvested and trimmed specifically for an export market. After trimming, the relative amount of fat separation from the lean was quantified by measuring the defected area. It was determined that 61.5%, 95%, and 97.5% of the loins examined had fat separation in the three groups of targeted IV market gilts, 65, 75, and 85, respectively. There was a significant (P < 0.05) increment increase in fat separation size per loin as targeted carcass IV increased, 57.16 cm², 63.16 cm², 103.55 cm² with 65, 75, and 85, IV carcasses respectively. A strong relationship was observed in fat separation size per loin as IV increased. These data would estimate that every IV point added, the level of fat separation increases by 29.65 cm² with (R² = 0.958). In summary, this study demonstrates that a diet high in unsaturation, specifically high levels of DDGS will increase the relative amount of fat separation on boneless loins.

**Keywords:** Loin fat separation, Unsaturated fat

### The impact of a diet high in unsaturated fat on loin fat separation in market gilts
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A study was conducted to evaluate the influence of feeding dried distillers grains with solubles (DDGS) and restaurant grease (RG) on fat separation in boneless final trim export loins. Crossbred gilts were blocked by body weight and randomly assigned to 3 dietary treatments. The three dietary treatments were corn-soybean meal based diets differing in concentrations of DDGS and supplemental RG to alter carcass fat and attain target carcass iodine values (IV) of 65, 75, and 85. Dietary treatments were: 1) Control, 0% DDGS, 1% RG; 2) 25% DDGS, 1% RG, and 3) 25% DDGS, 5.3% RG. Market gilts (n = 60) were sampled after 15 wk (av. final BW = 123.9 kg) in a commercial processing facility. Boneless loins (n = 119) were harvested, trimmed specifically for an export market and Cyrovac sealed. After trimming, loins were evaluated for color acceptability for export and the relative amount of fat separation from the lean was quantified by measuring the defected area. It was determined that 61.5%, 95%, and 97.5% of the boneless loins examined had fat separation defects in the three groups of targeted IV market gilts, 65, 75, and 85, respectively. The average size of each individual defect area increased with the highest IV being significantly greater than treatment 1 and 2 (25.3, 18.7 and 44.9 cm²; P < 0.006; treatments 1 to 3, respectively). There was a significant (P < 0.05) incremental increase in fat separation size per loin as targeted carcass IV increased, 44.25 cm², 63.16 cm², 103.55 cm² with 65, 75, and 85, IV carcasses, respectively. A strong (R² = 0.958) relationship was observed in fat separation size per loin as IV increased. These data would estimate that every carcass IV point added between 65 and 85 IV, the level of fat separation increases by 2.965 cm². In summary, this study demonstrates that a diet high in unsaturated fatty acids, specifically high levels of DDGS and RG, will increase the relative amount of fat separation in boneless loins and may affect export acceptability of the loins.

**Keywords:** Dietary iodine value, Fat separation, Loin
Effects of distillers dried grains with solubles on pork longissimus and sausage quality

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The objective of this study was to evaluate sausage and loin quality of pigs fed different levels of distillers dried grains with solubles (DDGS). Crossbred barrows and gilts (n = 60) averaging 34 kg body weight were randomly allotted from outcome groups of weight and gender to one of four treatment groups (3 replications, 5 pigs/pen) and fed corn-soybean meal diets with 0, 15, 30, or 45% DDGS. When the mean pen weight reached 120 kg, pigs were humanely harvested at the University of Kentucky Meats Laboratory. After a 24-h chill (4 °C), shoulder butts (IMPS 406) and picnics (IMPS 405) were removed, deboned, ground separately through a 6.35 mm grinder plate, and sampled for fat percentage by microwave analysis. Bratwurst-style sausage was produced by combining ground Boston butts and picnics to target 30% fat in the final product, blended with commercial seasonings, then stuffed into a natural casing. Loose sausage was placed on Styrofoam trays, wrapped with polyvinyl chloride (PVC) wrap and stored under cool white fluorescent lighting (1300 lx) at 4 °C. Objective color values (L*, a*, b*) were also taken on loose packaged sausage at 6 locations at the same time daily for 7 days with a HunterLab Mini-scan XE Plus standardized to black and white tiles overwrapped in PVC and then averaged. Sausage was also sampled for thiobarbituric acid reactive substances (TBARS) at the same time daily on days 0, 3, 5, and 7. Bratwurst-style sausages were steeped in water until an internal temperature of 71 °C was reached. Loins (IMPS 412) were deboned, then cut into 2.54 cm chops for sensory analysis. Loin chops were cooked in a clam shell cooker until an internal temperature of 70 °C was reached. An 8-member trained taste panel of University of Kentucky faculty and staff evaluated the sausages for juiciness, texture, and off-flavors, and loin chops for juiciness, tenderness, and off-flavors under red lighting on a 15 cm unstructured line scale. The addition of 30% and 45% DDGS to the diet increased juiciness (linear, P = 0.04) and created a more chewy (less mushy) texture (linear, P = 0.004) in the Bratwurst-style sausages. These high levels of DDGS in the diet did not affect the tenderness, juiciness, or off-flavors of the loin chops (P > 0.10). With the addition of 30% and 45% DDGS in the diet, TBARS increased linearly with increased storage time (day 7: linear, P = 0.02). Decreasing b* values (b* = degree of yellowness with positive values = yellow; day 5: linear, P = 0.002) and chroma scores (day 5: linear, P = 0.001) were noticed with higher levels of DDGS in the diet (30% and 45%). These results indicate that feeding high levels of DDGS in the diet (30% and 45%) do not negatively affect the eating quality of Bratwurst-style sausage or loin chops.

Keywords: DDGS, Loin, Pork quality

Influence of dietary dried distillers grains and glycerol on bacon quality


The objective of this study was to determine the impact of 0 and 20% dried distillers grains with solubles (DDGS) and increasing levels of glycerol (0, 2.5 and 5.0%) in grow-finish rations on bacon quality. A total of 84 barrows (PIC, initially 31.03 kg) were fed corn–soybean meal-based diets organized in a 2 × 3 factorial with primary effects of DDGS (0 or 20%) and glycerol (0, 2.5, or 5%). Belt length was measured from flank end to blade end. Belly thickness was measured at 8 locations evenly spaced around the perimeter of the belly. Belly firmness was measured by centering bellies perpendicularly (skin side up and skin side down) over a stainless steel smokestick and measuring the flex between the edges on the ventral and dorsal edges of the belly. Bellies were injected at 12% of the skinned belly weight.

Keywords: Bacon, Consumer panel, Iodine value
resulting in a final concentration of 1.74% salt, 0.5% sugar, 0.3% sodium phosphate, 120 ppm sodium nitrite, and 500 ppm sodium erythorbate in the bellies. Bellies were cooked to an internal temperature of 53 °C, chilled, pressed and sliced for evaluation. Belly slice yield was calculated by determining the yield of #1 type bacon slices. Proximate analysis and fatty acid analysis were evaluated by taking every 10th bacon slice beginning from the caudal end to make a composite sample for each belly. Iodine value was calculated using the resulting fatty acid content results. Twenty bacon slices were removed from the belly one-third the length of the belly from the cranial end for sensory analysis and cooking yields. Sensory characteristics were evaluated on an 8-point scale for brittleness, bacon flavor intensity, saltiness and off-flavor. There were no significant DDCS x glycerol interactions on any parameters measured (P > 0.08). Inclusion of 20% DDGS in pig diets decreased belly firmness (P < 0.04) as measured by the belly flop fat side down method. Twenty percent DDGS decreased myristic acid, palmitic acid, palmitoleic acid, stearic acid, oleic acid, vaccenic acid, total saturated fatty acids, and total monounsaturated fatty acids (P < 0.01). In contrast, 20% DDGS increased linoleic acid, α-linolenic acid, eicosadienoic acid, total polyunsaturated fatty acids, unsaturated: saturated fatty acid ratios, polyunsaturated: saturated fatty acid ratios, and iodine values (P < 0.01). The inclusion of 0, 2.5 and 5% glycerol in swine diets did not affect any measured parameters in this study. In conclusion, feeding DDGS at a level of 20% decreased belly firmness and changed the fatty acid profile; however, it did not affect belly processing or sensory characteristics. Glycerol fed at 2.5 or 5.0% did not affect belly quality, fatty acid profile, or sensory characteristics of bacon.

This research was funded by the National Pork Board.

Keywords: Belly quality, Dried distillers grains, Glycerol

Effect of ractopamine hydrochloride on growth and carcass characteristics of lightweight swine

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Phenethanolamines and other repartitioning agents effect the development and performance of finishing swine according to weight and length of feeding time. Previous research regarding ractopamine hydrochloride (RAC) has involved finishing swine from 91–122 kg. While the majority of swine in the United States are fed to final weights of 113–122 kg, domestic Asian consumers prefer smaller, trimmer pork carcasses (86–95 kg). The objective of this research is to evaluate the effects of ractopamine hydrochloride on growth and carcass traits of lightweight swine (68–92 kg). Three trials involving 65 pigs were conducted. All trials utilized a randomized complete block design. Beginning weights averaged 68.23 kg and pigs had ad libitum access to water and a 16% crude protein corn-soybean meal based pelleted ration. RAC was included in the diet at 0, 5, and 10 ppm for an average of 25 days until a weight of approximately 92 kg. Weights were obtained in all phases of the trial in order to calculate feed efficiency, average daily gain (ADG), drift and dressing percentage. Loin eye area, trimness (backfat measurements), and pork muscle quality factors of carcasses were evaluated 24th post harvest at a commercial processing facility by trained personnel. No differences (P > 0.05) were found between treatments groups for ADG or feed to gain ratio. Groups fed 5 ppm RAC had lower weight loss from drift (P < 0.05). No differences (P > 0.05) between treatment groups were found for dressing percent, carcass length, first rib fat thickness, tenth rib fat thickness, or loin eye area. Last rib fat thickness and last lumbar fat thickness were significantly lower (P < 0.05) for the two groups fed RAC. Firmness, color, and marbling were not affected by treatment group (P > 0.05). These results suggest that feeding ractopamine hydrochloride in lightweight swine diets can reduce last rib and last lumbar vertebral fat thickness and drift weight loss while not having a negative impact on feed to gain ratio, loin eye area, or pork muscle quality.

Keywords: Carcass traits, Ractopamine, Pork

Characterization of loin shape in Duroc and Duroc composite finishing gilts

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Gilts (n = 45) were utilized in this study to characterize the effect of genotype on loin characteristics and quality over the length of the loin. Three diverse genotypes included a high quality Duroc line (A), a Duroc based composite line selected for lean growth (B), and an F1 cross of the two (C). Pigs were selected based on live weight and harvested at the University of Illinois Meat Science Lab. Twenty-four hours postmortem, bone-in loins were removed from the left sides of carcasses. Skin-on loin primal were cut perpendicular to the backbone at the 5th/6th rib, 7th/8th rib, 10th/11th rib, last rib, mid-lumbar, and the loin/sirloin junction. Quality measurements (subjective and objective color, marbling, firmness, and ultimate pH) were collected at each location. Digital images were taken of each surface and analyzed using digital imaging software (Adobe Photoshop, Adobe Systems Inc, US) for LEA, loin width, loin depth, and fat depth. Loin depths were measured at the center of the long axis along the loin face (Depth 1), ¼ of the way across the long axis of the loin face (Depth 2), and ¾ of the way across the long axis of the loin face (Depth 3). An average loin depth was calculated for each image and used to calculate loin depth:width ratio as an indication of shape. Ratios of Depth2:Depth1 and Depth3:Depth1 were calculated as indication of depth relationships. Data were analyzed using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) and means separation was done with the PDIFF option. Image measurements were analyzed as repeated measures with main effects of genetic line, location, and their interaction. There was a genetic line effect for marbling (P < 0.01), firmness (P < 0.01), subjective color (P < 0.01), and b* color values (P = 0.01). Line A had more (P < 0.05) marbling and was more firm than line B and C. Line A was lighter (P < 0.05) for subjective color when compared to lines B and C. There was a location effect for marbling (P < 0.01), firmness (P < 0.01), subjective color (P = 0.01), a* color values (P < 0.01), and b* color values (P < 0.01). The 5th/6th rib loin face had lower (P < 0.05) values for marbling and firmness when compared to the 10th/11th rib loin face and the loin/sirloin loin face. The 5th/6th rib loin face had greater (P < 0.05) values for subjective color score when compared to the other two locations. Furthermore, the 10th/11th rib loin face had lower (P < 0.05) values for a* and b* color values than the other two locations. There was a genetic line x location interaction for marbling (P = 0.03). There was a genetic line effect (P < 0.05) for LEA, width, fat depth, all three depths, and depth ratios. Genetic line A had the smallest (P < 0.01) LEA, loin width, depth 2, and depth 3 measurements and also had the greatest (P < 0.01) values for fat depth. The most posterior portions of the loin had the largest (P < 0.01) LEA, loin width, fat depth, and muscle depth 1. However, the more anterior portions of the loin had greater (P < 0.01) values for depth: width ratio and muscle depth:depth ratios. There was a genetic line x location effect (P < 0.01) on fat depth, but not on any of the other measurements obtained. In conclusion,
Effects of zilpaterol hydrochloride supplementation on market dairy cow carcass characteristics, cutability, and meat tenderness


Market dairy cows (n = 34) were utilized in this study to evaluate the effects of zilpaterol hydrochloride (ZH) supplementation in addition to concentrate feeding on carcass characteristics, carcass yields, and tenderness of selected beef steaks. Cows were stratified by weight and randomly assigned to a 42-d concentrate feeding trial, with 0 ppm (CT) or 7.5 ppm added ZH from days 19–39 followed by a 3-d withdrawal. Ultrasonic measurements for ribeye area (UREA), backfat thickness (bUBF), intramuscular fat % (UIMF), and ribeye ratio (depth:length) were taken at day 0, 19, and 42 of the study. At the end of the trial cows were harvested and USDA YG and QC data were collected on the right side of the carcass. Twenty-four hours postmortem, left sides of carcasses were fabricated into primal, subprimals, and boneless closely-trimmed cuts according to the guidelines of the North American Meat Processors (NAMP, 2007). Carcass yields were analyzed on a weight basis as well as a percent of chilled side weight (CSW). For tenderness, m. infraspinatus (IF), m. longissimus dorsi (LD), m. gluteus medius (GM), and m. rectus femoris (RF) were excised and aged. Aging times were 3, 7, 14, 21, and 28 d. Carcass yields were analyzed on a weight basis as well as a percent of chilled side weight (CSW). For tenderness, m. infraspinatus (IF), m. longissimus dorsi (LD), m. gluteus medius (GM), and m. rectus femoris (RF) were excised and aged. Aging times were 3, 7, 14, 21, and 28 d for LD steaks; 3, 14, 21, and 28 d for GM steaks; and 14 and 21 d for both IF and RF steaks. Data were analyzed using PROC MIXED (SAS Inst. Inc., Cary, NC) and means separation was done with the PDIFF option. For ultrasound measurements, ZH increased (P<0.01) UREA and ribeye ratio, but had no effect (P>0.05) on UBF or UIMF. Feeding ZH resulted in heavier (P<0.01) carcasses with greater (P=0.02) DP, larger (P=0.01) REA, and improved (P=0.02) YG compared to feeding concentrate alone. In contrast, carcass BF, quality grade, and IMF% were not affected (P=0.15) by ZH feeding. Subprimal yields from the chuck, rib, loin, and round, on a weight basis as well as on a percentage of CSW basis, were greater (P<0.05) in carcasses from ZH-fed cows compared to those from CT cows. For Warner-Bratzler shear force determination, LD steaks from ZH-treated cows were less tender (P<0.01) when compared to controls. Additionally, steaks from CT cows became more (P=0.05) tender after 14 d of aging while steaks from ZH cows required 21 d for significant tenderization to occur. Longissimus steaks from ZH cows also tended (P=0.06) to have higher slice shear force (SSF) values when compared to CT, for LD steaks, SSF from CT cows decreased (P=0.05) after 7 d of aging, whereas steaks from ZH cows only decreased (P=0.05) after 21 d. For GM steaks, ZH caused an increase (P<0.01) in SSF; and steaks from both treatments became more tender (P=0.05) after 14 d of aging. For FI steaks, no ZH effect (P=0.97) was found and, although, ZH steaks became more (P=0.05) tender after aging there was no difference (P=0.05) in SSF of CT steaks after aging. There were no treatment or aging effects (P>0.05) on SSF in RF steaks. In conclusion, feeding ZH to market dairy cows caused significant increases in carcass yields while having no adverse effects on carcass quality attributes, suggesting that ZH inclusion in a pre-slaughter feeding regimen would increase the value of market dairy cows. While ZH feeding caused a decrease in meat tenderness, this could be overcome with extended aging times.

Keywords: Beef quality, Shelf-life, Zilpaterol hydrochloride
ZH fed 10 d withdrawal cattle (P<0.01) when compared to control. There was no significant difference in REA between ZH fed 3 and 10 d withdrawal periods (P>0.05). A trend was observed for ZH fed 10 d withdrawal cattle to have an increased HCW when compared to control (P=0.0589), while there was no significant difference for cattle fed ZH with a 3 d withdrawal (P=0.3763) comparatively. There was no difference in ZH fed cattle when compared to control; kidney pelvic and heart fat %, adjusted preliminary yield grade, calculated yield grade, marbling score, or lean and bone maturity (P>0.05). There was an increase in WBS for ZH fed cattle when compared to control for Choice 7 d and 14 d aged steaks for both withdrawal periods. Choice ZH steaks aged 21 d from the 10 d withdrawal showed an increase in WBS while the 3 d withdrawal had no effect. Select ZH fed 7 d aged 3 d withdrawal steaks had higher WBS when compared to control while 10 d withdrawal had no effect. Oppositely the Select ZH fed 14 d aged 10 d withdrawal steaks had increased WBS while the 3 d withdrawal had no effect. There was no difference in Select ZH fed 21 d aged steaks for either withdrawal period when compared to the control. There was no difference in WBS between the 3 d and 10 d withdrawal period for any of the aging periods. Feeding Zilpaterol hydrochloride for 20 d improved carcass cutability while having little effect on fat composition of calf-fed Holstein steers. There was no difference observed between 3 d and 10 d withdrawal period. Zilpaterol hydrochloride treatment decreased steak tenderness, although as aging progressed there was a decrease in the difference between ZH and control steaks.

Keywords: Carcass characteristics, Holstein steer, Zilpaterol

Determining the influence of ractopamine-HCI (Optaflexx) on tenderness attributes of feedlot steers
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Ractopamine-HCl (Optaflexx) is a β-adrenergic agonist that has been reported to improve average daily gain and feed efficiency of feedlot steers and heifers. However reports investigating the influence of ractopamine-HCI on beef tenderness are mixed. Given that tenderness variability is among the most critical issues facing the beef industry it is necessary to more fully understand the effects of feeding Zilpaterol on beef quality. The objective of this study was to compare meat quality traits of crossbred beef steers fed one of 4 finishing diets. The control diet was a standard barley-based finishing diet comprised of 87.8% barley, 6.5% barley silage and 5.7% supplement (DM basis). The 3 other diets included substitution of 40% wheat (WDDGS), corn (CDDGS), or a 50:50 blend of corn and wheat (BDQDS) based DDGS for barley grain (DM basis). Six-bone rib sections (7th to 12th ribs) from 80 steers (20 per diet) were aged for 14 d and Longissimus steaks were obtained for proximate analysis, drip and cook loss, Warner-Bratzler shear force determination, objective and subjective colour analysis, and oxidative stability analysis (thiobarbituric acid reactive substances- TBARS). Steaks used for colour analysis were wrapped in an oxygen-permeable film and displayed for 7 d under simulated retail conditions (1200 lx, 4 °C). Ground meat for TBARS was cooked in a water bath to 71 °C and stored in the dark for 7 d (4 °C). Repeated measures analysis using Proc Mixed was used to determine differences between diets for colour and TBARS, while ANOVAs were used for analysis of the remaining parameters. No differences (P>0.05) were observed in meat composition, pH, drip loss or shear values due to dietary regime but a trend (P=0.07) was observed for cook loss, with the steaks from animals fed the control diet having the lowest and those from the WDDGS diet having the highest percentage cook loss. Diet had an effect on colour attributes. Steaks from the WDDGS group were lighter (higher L* value) than steaks from all other treatments, while control and CDDGS steaks had similar, intermediate L* values that were higher (P<0.001) than BDQDS steaks. Retail display panel results showed WDDGS steaks to have a lighter (P<0.001) lean colour score than the other diets. It was also observed that steaks from animals fed any of the DDGS diets lost redness faster over time (lower a* values) and had a less desirable retail appearance than control steaks (P<0.001); however, BDDQS and CDDGS steaks lost redness at a more rapid rate than WDDGS. Cooked ground beef from animals fed any of the DDGS diets had lower (P<0.005) TBARS values than ground beef from animals fed the control diet, with WDDGS and CDDGS ground beef having the lowest values. Overall, feeding 40% WDDGS, 40% CDDGS or their blend did not significantly affect meat quality; however, WDDGS did offer better protection against oxidation than the control, along with enhanced colour stability over CDDGS. In contrast, feeding BDDQS resulted in the poorest colour stability and intermediate protection against oxidation.

Keywords: Beef, Distillers grains, Oxidation

A comparison of wheat and corn-based distiller's grains plus solubles and their combination on the quality of beef longissimus
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Western Canada is experiencing a significant increase in wheat-based ethanol production. This has resulted in the generation of large volumes of dried distiller's grains plus solubles (DDGS) that can be used as a feedstock for livestock. Depending on market conditions, wheat and/or corn DDGS may be available. Considerable research has been conducted on the impact of feeding corn DDGS on beef quality, however little is known about the effects of feeding wheat DDGS on beef quality. The objective of this study was to compare meat quality traits of crossbred beef steers fed one of 4 finishing diets. The control diet was a standard barley-based finishing diet comprised of 87.8% barley, 6.5% barley silage and 5.7% supplement (DM basis). The 3 other diets included substitution of 40% wheat (WDDGS), corn (CDDGS), or a 50:50 blend of corn and wheat (BDQDS) based DDGS for barley grain (DM basis). Six-bone rib sections (7th to 12th ribs) from 80 steers (20 per diet) were aged for 14 d and Longissimus steaks were obtained for proximate analysis, drip and cook loss, Warner-Bratzler shear force determination, objective and subjective colour analysis, and oxidative stability analysis (thiobarbituric acid reactive substances- TBARS). Steaks used for colour analysis were wrapped in an oxygen-permeable film and displayed for 7 d under simulated retail conditions (1200 lx, 4 °C). Ground meat for TBARS was cooked in a water bath to 71 °C and stored in the dark for 7 d (4 °C). Repeated measures analysis using Proc Mixed was used to determine differences between diets for colour and TBARS, while ANOVAs were used for analysis of the remaining parameters. No differences (P>0.05) were observed in meat composition, pH, drip loss or shear values due to dietary regime but a trend (P=0.07) was observed for cook loss, with the steaks from animals fed the control diet having the lowest and those from the WDDGS diet having the highest percentage cook loss. Diet had an effect on colour attributes. Steaks from the WDDGS group were lighter (higher L* value) than steaks from all other treatments, while control and CDDGS steaks had similar, intermediate L* values that were higher (P<0.001) than BDQDS steaks. Retail display panel results showed WDDGS steaks to have a lighter (P<0.001) lean colour score than the other diets. It was also observed that steaks from animals fed any of the DDGS diets lost redness faster over time (lower a* values) and had a less desirable retail appearance than control steaks (P<0.001); however, BDDGS and CDDGS steaks lost redness at a more rapid rate than WDDGS. Cooked ground beef from animals fed any of the DDGS diets had lower (P<0.005) TBARS values than ground beef from animals fed the control diet, with WDDGS and CDDGS ground beef having the lowest values. Overall, feeding 40% WDDGS, 40% CDDGS or their blend did not significantly affect meat quality; however, WDDGS did offer better protection against oxidation than the control, along with enhanced colour stability over CDDGS. In contrast, feeding BDDGS resulted in the poorest colour stability and intermediate protection against oxidation.

Keywords: Collagen, Ractopamine-HCI, Tenderness
Feeding high levels of wet distillers grains and straw increases polysaturated fatty acids and decreases oxidative stability of beef

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This research was carried out to measure the effect of feeding high levels of wet distillers grains (DG) and straw on shelf life of beef. Cattle (n = 336; 270 ± 9 kg) were fed one of 6 diets (corn; 40% DG/0% straw; 70% DG; 8% straw; 77.5% DG/9% straw; 77.5% DG/17% straw, and 85% DG/10% straw -DM basis). Steers on corn, 40/0, 70/8, and 77.5/9 diets were fed up to 183 d and the remaining 77.5/17 and 85/10 diets were fed 225 d so as to attain similar final BW. Straw was added to treatments containing high levels of DG to help remove excess sulfur. Straw helps to maintain the rumen buffer system by increasing rumen pH. USDA Choice strip loins (m. Longissimus lumborum), 9–15 per treatment, (IMS # 180 PSO2; NAMP, 2007) were cut into 3 steaks (2.54 cm-thick) each after 20 d of postmortem aging. One steak from each loin was vacuum packaged for laboratory analysis of fatty acids, thiobarbituric acid reactive substances (TBARS) and proximate composition. One steak was overwrapped with oxygen-permeable, polyvinyl chloride film and placed in a retail display case maintained at 2 °C for 7 days for daily objective color evaluation, subjective (trained panel) assessment of discoloration and TBARS analysis on day 7. One half steak from each loin (to optimize sample size) was overwrapped with oxygen-permeable film and placed in 4 of retail display for TBARS analysis. The statistical analysis was carried out by GLIMMIX procedure of SAS with a split plot design. Steaks from cattle fed corn as a control diet had more monounsaturated fatty acids (P < 0.05) than steaks from cattle fed high levels of DG and straw. Trans-fatty acids (18:1 Δ11, 18:1 Δ13r, 18:1 Δ14r and 18:2 Δ9t, 12t, CLA c9, t11, and CLA c12, r10) significantly increased (P < 0.05) in the strips of cattle fed high level of DG and straw compared to the amount of corn-fed steers. The amount of PUFA, (n-3), (n-6), and (n-6)/(n-3) fatty acids increased significantly (P < 0.05) in the strips of cattle fed high level of DG and straw in comparison with corn-fed cattle. Levels of DG increased the amount of TBARS, an indication of more polysaturated fatty acids in steaks. Fat content was significantly (P < 0.05) greater in the strips of cattle fed 77.5% DG/17% straw compared to corn-fed steers. There was a probable significant effect (P = 0.06) on fat content of non-straw versus straw-fed cattle where straw-fed cattle tended to have high fat percentage. There was significantly lower (P < 0.05) moisture level in strip steaks from cattle fed high levels of DG in comparison to control and steaks from cattle fed low levels of DG. These data indicate that precautions against oxidation and discoloration are needed when cattle are fed high levels of DG, the meat is aged, and subjected to retail display in oxygen-permeable packaging.

Keywords: Beef, Fatty acid, Proximate analysis

Effects of feeding wet distillers grains plus solubles supplemented with synthetic antioxidant, ethoxyquin, on discoloration and lipid oxidation in beef Psoas major and Triceps brachii muscles

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Feedlot studies with synthetic antioxidant, ethoxyquin (AGRADO PLUS), have shown improvements in average daily gain and decreases in morbidity and mortality of cattle by improving the antioxidant capacity at the ruminal and postruminal stages of digestion. This study was conducted to evaluate the antioxidant effects of feeding ethoxyquin with wet distillers grain plus solubles (WDGS) diets on color and lipid stability of beef tenderloin (m. psoas major) and clod heart (m. triceps brachii) steaks (aged for 8 and 29 d postmortem) during retail display. Crossbred (British × Continental) steers (n = 467) were fed dry-rolled corn-based finishing diets containing 0 (corn) or 30% WDGS supplemented with ethoxyquin (0 or 150 ppm for the last 145–160 d). After 48 h of postmortem, 80 USDA Choice beef short loins and shoulder clods (n = 20 per dietary treatment) were collected and aged for 8 and 29 d at 0 to 2 °C. Tenderloins (IMS # 1190A; NAMP, 2007) from short loin and clod hearts (IMS # 1114E; NAMP, 2007) from shoulder clods were removed. From each muscle, three steaks were removed. One steak (for 0 d lipid oxidation) was vacuumed packaged and stored at −20 °C. Two additional steaks were aerobically packaged on Styrofoam trays and displayed for 4 and 7 d, respectively, under simulated retail display conditions. Percentage surface discoloration on each tenderloin and clod heart steak was visually evaluated daily by a trained 6-person panel.

Lipid oxidation status of steaks displayed for 0, 4, and 7 d were tested by measuring accumulation of thiobarbituric acid reactive substances (TBARS). No significant discoloration differences (P > 0.05) were detected among dietary treatments for 8 and 29 d aged steaks until 3-d of retail display. After that, steaks from cattle fed 30% WDGS plus no ethoxyquin had the highest discoloration and steaks from cattle fed corn with ethoxyquin supplementation had the lowest discoloration for both aging periods (P < 0.05). In addition, steaks from WDGS-fed cattle had significantly (P < 0.05) higher surface discolorations compared to steaks from corn-fed cattle. Lipid oxidation of tenderloin and clod heart steaks from both aging periods also gradually increased during retail display (P < 0.0001). Steaks from cattle fed ethoxyquin had significantly (P < 0.05) lower TBARS and surface discoloration values compared to steaks from cattle fed no antioxidant supplementation. Similar to discoloration results, the highest lipid oxidation was observed for steaks from cattle fed 30% WDGS diets with no ethoxyquin whereas the lowest oxidation rates were detected for steaks from corn plus ethoxyquin-fed cattle during retail display (P < 0.05). However, the effectiveness of ethoxyquin in reducing lipid oxidation and surface discoloration of tenderloin and clod heart steaks was reduced with feeding of WDGS.

Ethoxyquin feed supplementation appears to be a viable means to increase lipid and color stability of beef during retail display.

Keywords: Beef, Ethoxyquin, Wet distillers grains solubles

The effects of dietary selenium on the shelf-life stability of beef Longissimus lumborum steaks from maturing heifers


The objective of this study was to evaluate the effect of form of dietary selenium supplementation on quality of Longissimus lumborum (LL) steaks from slow-growing (0.5 kg/d) mature beef heifers as part of a larger study. Angus-cross heifers (n = 40) were assigned (n = 10; stratified by live Se levels) to 4 Se treatments for 226 d and throughout an 8-week harvest period. The basal diet contained 0.08 mg Se/d, whereas the mineral supplements provided no (control, C), or 3 mg Se/d as inorganic (sodium selenite, SS), organic (Sel-Plex, SP), or 50/50 SS/SP (Mix). Heifers were humanely harvested at the University of Kentucky Meats Laboratory with treatments equally distributed over d of kill. After a 24-h chill (4 °C) 3, 1.3-cm steaks were removed from the anterior portion of the left LL from each carcass for shelf-life evaluation, drip loss analysis, and fat and moisture percentage. Shelf-life steaks were placed on styrofoam trays,
overwrapped with polyvinyl chloride (PVC) film, and stored under constant, cool white fluorescent lighting (1300lx) at 4°C. Objective color values (CIE L*, a*, and b*) were taken at approximately the same time daily for 14 d with a Hunterlab Mini Scan XE (D65/10ÀÂ) standardized to black and white tiles overwrapped with PVC film. Objective color was determined at three locations on each steak then averaged. Drip loss steaks were weighed, enclosed in a plastic bag, and re-weighed after 48-h of suspension at 4°C. Drip loss was calculated as the percentage loss from the original weight. A 3-g sample was taken from each steak and the fat and moisture content was determined using a HFT 2000 fat and moisture analyzer. There were no treatment (P > 0.56) or treatment x day (P > 0.20) interactions for L*, a*, or b* values during 14-d of shelf-life evaluation. The L* values increased linearly (P < 0.03) whereas the a* and b* values decreased linearly (P < 0.04) as storage time increased from 0 to 14 d. Furthermore, Se supplementation did not affect drip loss (P > 0.88) and fat (P > 0.16) and moisture (P > 0.16) percentage. These data indicate that the form of dietary selenium supplementation to slow-growing beef heifers had no affect on shelf-life stability, drip loss, and fat and moisture percentage of Longissimus lumborum steaks.

Keywords: Beef, Color, Selenium

Effect of linseed and vitamin E on fatty acid and volatile compounds composition of beef from Pyrenean bullocks
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Recent research has demonstrated that feeding livestock with polyunsaturated fatty acid sources improves the n6/n3 ratio of meat, increasing the n3 fatty acids and decreasing the n6 fatty acids. Besides, vitamin E has been described as a natural antioxidant that prevents meat from oxidative processes thus avoiding the loss in nutritional and sensory quality. The present work is part of a research that aims to improve quality and nutritional value of bullock beef in order to make it more desirable to consumers. Twenty-four pure-bred Pyrenean bullocks were used. Male calves were weaned at 5 to 6 months of age and randomly allotted to three dietary regimes (8 animals per group): 1) A control regimen based on full concentrate (Control) diet (i.e., barley, corn, soya and cereal straw), 2) a dietary treatment consisting on the Control diet supplemented with 5% linseed (L), and 3) a dietary treatment which included linseed plus vitamin E (200 IU/kg DM) (LV). All experimental groups were fed ad libitum. Animals were slaughtered at 11 months of age. Samples from the longissimus dorsi muscle were excised 24 hours post-mortem, vacuum-packaged, aged during two days and frozen until further analyses of volatile compounds and fatty acid composition. Intramuscular fat for fatty acid analysis was extracted by solvents and the identification was carried out by gas chromatography (GC). Volatile compounds were extracted by purge and trap and identified by a GC-Mass spectrometer. Fifty-six fatty acids and 18 volatile compounds were identified. Regarding fatty acid composition, bullocks beef from L and LV groups showed higher values of n3 (P < 0.001), especially linolenic fatty acid (P < 0.001). Regarding volatile compounds, 2-propanone and 2-butanone were the predominant compounds which are usually related to liver-like flavour, the characteristic flavour of very lean beef derived from young bullocks. It should be stated that these beef samples did not undergo significant oxidation because Thiobarbituric acid values were relatively low (0.29 ppm) and those volatile compounds usually reported as oxidation markers (hexanal, 1-octen-3-ol, nonanal) did not show a significant presence. Thus, it can be stated that the diets under study increased the content of beneficial fatty acids of beef from Pyrenean bullocks without having a detrimental effect on its quality.

Keywords: Beef, Linseed, Quality

Quality characteristics of natural branded vs. conventionally-fed, commodity beef Longissimus steaks
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Beef ribeye rolls (IMPS#112A) were purchased to compare the fresh color, fatty acid composition, and cooked tenderness of longissimus steaks from natural-fed beef (all vegetarian diet, no hormone implants, and no dietary antibiotics) to that of conventionally-fed, commodity beef. Ribeye rolls were purchased from 5 natural-branded programs (designated N1, N2, N3, N4, and N5) and 2 beef packers (designated C1 and C2), and shipped to the University of Arkansas Red Meat Abattoir, where they were aged at 2°C for 10 d from the box date. Then, pH of each ribeye roll was recorded before being cut into 2.54-cm-thick steaks, and steaks from each ribeye roll were allowed to bloom for 30 min at 4°C before measuring instrumental color. One steak was cooked to 71°C on flat-top griddles to measure cooking loss and Warner-Bratzler shear force (WBFS), whereas another steak was trimmed free of all subcutaneous fat and connective tissue, freeze-dried for 72 h, and pulverized for moisture content and fatty acid analysis. Muscle pH of ribeye rolls from C1 and N3 were greater (P < 0.05) than the steaks from the other purchasing programs. Steaks from C2 were darker (lower L* values, P < 0.05) than steaks from N1 and N5, which had the lowest (P < 0.05) L* value. Steaks from N2 and N5 had greater (P < 0.05) a* values than steaks from N3 and C1; however, steaks from N3 and C1 had lower (P < 0.05) hue angles than steaks from C2 as well as N1, N2, N4 and N5. Cooking losses were greater (P < 0.05) in steaks from C1 and C2 than those from N2 and N5, and steaks from C1 had greater (P < 0.05) WBFS values than steaks from either C2, N1, N2 or N5. Steaks from N1 and N5 had greater (P < 0.05) moisture contents than steaks from N2, N3, and N4. Percentages of palmitic acid (16:0) and all SFA were greater (P < 0.05) in steaks from C1 than those from N1 or N3. Furthermore, steaks from C1 had greater (P < 0.05) percentages of linoleic acid (18:2n6) than N1 and N5, but steaks from N4 had greater (P < 0.05) proportions of linolenic acid (18:3n3) than steaks from N1 only. In addition, steaks from C1 and N3 had greater (P < 0.05) weight percentages of all PUFA than N1 steaks; however, there were no (P ≥ 0.12) differences in stearic acid (18:0), oleic acid (18:1n9), total or individual cis9-trans11, cis9-cis11, trans9-trans11, or trans 10-cis12) CLA, total n-6 fatty acids, total n-3 fatty acids, n-6:n-3 ratio, and PUFA:SFA. Although a number of differences were noted, results from this study indicated that there were as many, if not more, differences within natural brands or commodity beef than between natural and commodity beef.

Keywords: Commodity, Beef, Natural

Effects of sex and diet on beef quality sensory characteristics
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The evaluation of sensory characteristics for Bonsmara, Brangus, Charolais, Gelbvieh, Hereford and Romosinuano breeds derived from
Parameters were evaluated on samples collected from 7 longissimus dorsi variation in postmortem proteolysis. To alter sarcomere length, one and the q parameter refer to the geometrical shape of the pro

tively describe re

differences in samples. Although, BF was impacted both by sex and feedtype main effects(\(P<0.05\)). Lastly, OF was influenced by a

The objective of this study was to evaluate a novel optical imaging method to predict tenderness by identifying differences in the inherent factors which regulate tenderness. Two-dimensional optical reflectance in beef muscles was acquired by a point incident light. Five parameters were extracted from each reflectance image to quantify the reflectance profiles from 336 samples. The parameters quantitatively describe reflectance profiles from each sample. Parameters referred to as parallel gradient, perpendicular gradient, and scattering intensity are indicative of the intensity and distribution of light pixels imaged 5 to 10 mm from the point of origin. The bias parameter, B, and the q parameter refer to the geometrical shape of the profile. Parameters were evaluated on samples collected from 7 Bos indicus and 7 Bos taurus steers. Genetic differences were utilized to maximize variation in postmortem proteolysis. To alter sarcomere length, one side of each carcass was suspended from the Achilles’ tendon (NS) while the other was hip suspended (HS). Three muscles were sampled from each side to provide variation in connective tissue characteristics: longissimus dorsi (LD), semitendinosus (ST), and psoas major (PM). Samples were removed at 1 d postmortem, divided into 0.6 cm slices and 2.54 cm steaks, and allowed to age for 1, 4, 7, or 10 days at 4 °C. A time 0 reference sample was also collected from each muscle at harvest. SDS-PAGE and western blots were utilized to determine degradation of troponin-T (TnT) and desmin. Also, myofibrils were isolated to determine sarcomere length of each sample. Warner-Bratzler shear force was determined on 2.54 cm steaks aged 1 and 10 d to verify changes in tenderness. Animal breed, muscle, suspension method, protein degradation and aging time were expected to provide differences in tenderness. Each was investigated in relation to the five scattering parameters. With the exception of scattering intensity, all optical parameters were different \(P<0.05\) among the three muscles. In the PM, NS sides had higher \(P<0.001\) q values than HS sides which had shorter sarcomeres. The LD from NS sides revealed significantly lower \(P=0.01\) B values than those from HS sides. Scattering intensity was greater \(P<0.05\) in the LD and ST of Bos indicus compared with Bos taurus carcasses. The q parameter was higher \(P<0.05\) in the LD and ST from Bos indicus carcasses compared to Bos taurus, but the reverse \(P<0.05\) was noted for the PM. Also, Bos taurus samples had higher \(P<0.05\) values than Bos indicus carcasses for both spatial gradients. No parameters were correlated to degradation of TnT or desmin, but relationships between the parameters and aging time were visible. The q parameter increased \(P<0.05\) from 1 d to 10 d in all muscles, with the exception of the NS-ST. In addition, the scattering intensity increased \(P<0.05\) from 1 d to 7 d for the LD and ST. Also, results indicated that scattering intensity measured at 1 d was correlated \(R^2=0.50\) with 10 d WBSF in the LD and the q parameter measured at 1 d was correlated \(R^2=0.53\) with 10 d WBSF in the PM. These results suggest that reflectance images may provide valuable information for beef tenderness prediction; however, further detailed studies will aid in a more complete understanding of the mechanisms involved.

Keywords: Beef, Optical reflectance, Tenderness

Optical diffuse reflectance identifies differences in sarcomere length and aging in beef muscles

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The objective of this study was to evaluate a novel optical imaging method to predict tenderness by identifying differences in the inherent factors which regulate tenderness. Two-dimensional optical reflectance in beef muscles was acquired by a point incident light. Five parameters were extracted from each reflectance image to quantify the reflectance profiles from 336 samples. The parameters quantitatively describe reflectance profiles from each sample. Parameters referred to as parallel gradient, perpendicular gradient, and scattering intensity are indicative of the intensity and distribution of light pixels imaged 5 to 10 mm from the point of origin. The bias parameter, B, and the q parameter refer to the geometrical shape of the profile. Parameters were evaluated on samples collected from 7 Bos indicus and 7 Bos taurus steers. Genetic differences were utilized to maximize variation in postmortem proteolysis. To alter sarcomere length, one side of each carcass was suspended from the Achilles’ tendon (NS) while the other was hip suspended (HS). Three muscles were sampled from each side to provide variation in connective tissue characteristics: longissimus dorsi (LD), semitendinosus (ST), and psoas major (PM). Samples were removed at 1 d postmortem, divided into 0.6 cm slices and 2.54 cm steaks, and allowed to age for 1, 4, 7, or 10 days at 4 °C. A time 0 reference sample was also collected from each muscle at harvest. SDS-PAGE and western blots were utilized to determine degradation of troponin-T (TnT) and desmin. Also, myofibrils were isolated to determine sarcomere length of each sample. Warner-Bratzler shear force was determined on 2.54 cm steaks aged 1 and 10 d to verify changes in tenderness. Animal breed, muscle, suspension method, protein degradation and aging time were expected to provide differences in tenderness. Each was investigated in relation to the five scattering parameters. With the exception of scattering intensity, all optical parameters were different \(P<0.05\) among the three muscles. In the PM, NS sides had higher \(P<0.001\) q values than HS sides which had shorter sarcomeres. The LD from NS sides revealed significantly lower \(P=0.01\) B values than those from HS sides. Scattering intensity was greater \(P<0.05\) in the LD and ST of Bos indicus compared with Bos taurus carcasses. The q parameter was higher \(P<0.05\) in the LD and ST from Bos indicus carcasses compared to Bos taurus, but the reverse \(P<0.05\) was noted for the PM. Also, Bos taurus samples had higher \(P<0.05\) values than Bos indicus carcasses for both spatial gradients. No parameters were correlated to degradation of TnT or desmin, but relationships between the parameters and aging time were visible. The q parameter increased \(P<0.05\) from 1 d to 10 d in all muscles, with the exception of the NS-ST. In addition, the scattering intensity increased \(P<0.05\) from 1 d to 7 d for the LD and ST. Also, results indicated that scattering intensity measured at 1 d was correlated \(R^2=0.50\) with 10 d WBSF in the LD and the q parameter measured at 1 d was correlated \(R^2=0.53\) with 10 d WBSF in the PM. These results suggest that reflectance images may provide valuable information for beef tenderness prediction; however, further detailed studies will aid in a more complete understanding of the mechanisms involved.

Keywords: Beef, Optical reflectance, Tenderness

Quality attributes and color characteristics of three-piece boneless hams

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Management of pork quality continues to gain importance in today’s industry due to the increasing global demand for pork products. One of the quality defects receiving attention today is two-tone ham color, where a contrast in pigmentation is noted either within a muscle or between two adjacent muscles. Two-tone ham color can result in cured products that vary widely in appearance and fail to meet the consumer’s perceptions of quality. Thus, the objective of this study was to investigate the attributes of hams that varied in quality. Fresh whole hams were selected on three different days (\(n=50/day\)) from a large commercial pork plant. Hams were selected based on visual assessment of quality into normal (C) and two-tone (TT) groups. Following selection, CIELAB color and pH measurements were collected at the plant on the gluteus medius (GM) and gluteus profundus (GP) using a HunterLab Mini Scan Plus. Selected hams were then boxed and shipped to the University of Georgia. Approximately 36 h postmortem, CIELAB color and pH measurements were collected again on the GM, GP and rectus femoris (RF). Hams were then fabricated into the inside, outside, knuckle and light butt with 0 cm fat trim in order to determine lean cut yields. Following fabrication, CIELAB color measurements were collected on the semimembranosus (SM), biceps femoris (BF), semitendinosus (ST), and RF; and pH was measured in the RF. Color measurements were taken on the anterior (A) and posterior (P) regions of the SM, the dorsal (D) and ventral (V) regions of the BF, and the inside (I) and outside (O) regions of the RF. Drip loss (\(\%\)), moisture, and intramuscular fat were quantified in the SM muscle. The experiment was a completely randomized block design. Data were analyzed using GLM procedures of SAS and LSMEANS were generated. Correlations between color scores, \(pH\), fabrication yields and drip loss were calculated. Plant \(pH\) and fabrication \(pH\) were significantly lower \(P<0.01\); 5.73 vs. 5.61 and 5.75 vs. 5.57) in GM from TT hams compared to C. In addition, every muscle from TT hams was lighter \(P<0.01\) in color (lower \(L^\circ\) values) than corresponding muscles in C hams. The GM, SM, BF, ST, and RF from TT hams were also less red (significantly lower \(a^\circ\) values; \(P<0.05\)) than their C counterparts, while \(b^\circ\) values were significantly lower \(P<0.03\) in SM, BF, ST, and RF from TT hams compared to C hams. Although, the inside, outside, and light butt from C hams were significantly heavier \(P<0.04\) than those from TT hams; the knuckle from the TT hams was significantly heavier \(P<0.01\) than C hams.
However, there was no treatment difference (P>0.20) in ham muscle yield expressed as a percentage of trimmed ham weight. While the % fat and moisture from the SM were not significantly different between treatments, purge loss (P<0.01; 4.09 vs. 2.86) was greater in the SM of TT hams compared to C hams. When comparing across treatments, GM L* and GM pH values were correlated (P<0.05) with L* values for all other muscles and purge loss in the SM. These data show that GM color and pH are accurate predictors of pork quality attributes in the muscles of a three-piece boneless ham.

Keywords: Color, Ham quality, Muscle pH

Prediction of pork longissimus lean color stability using VIS/NIR spectroscopy
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Insufficient case-life is a costly problem facing pork processors. To assess Visible and Near-Infrared (VIS/NIR) spectroscopy as a technology to sort pork loins according to lean color stability, center-cut pork loins (n=1208) were selected from the boning lines of four large-scale pork processors. VIS/NIR spectra (350 to 1050 nm) were collected on each loin immediately after boning and approximately 1 h after boning on the ventral portion of the longissimus exposed by rib removal. At 14 d postmortem, a 2.5-cm chop from each loin was placed in simulated retail display. Instrumental color variables [CIE L*, a*, b*, and overall color change (ΔE)] were determined on days 0, 1, 7, 11, and 14 of display. Loins were blocked according to processing plant and observed d 14 ΔE into calibration and prediction data sets. Principal component analysis of color variables collected on days 0 and 14 identified a principal component (PC1) explaining 66% of the variance, which was strongly associated with color change. Partial-least squares regression was used on the calibration data set to develop models using VIS/NIR spectra to predict scores for PC1 which was validated on the prediction data set. The prediction model explained 45 and 40% of the variation in observed PC1 values in the calibration and prediction data sets, respectively. Within each data set, loins with predicted PC1 values less than 0 were classified as having stable lean color, while those with values greater than 0 were considered to have labile lean color. In the prediction data set, chops predicted to have labile lean color had higher (P<0.05) L* values, regardless of display day (60.6 vs. 57.1, respectively). Regardless of stability class, L* decreased (P<0.05) between days 0 and 7 (59.1 vs. 58.4) and then increased (P<0.05) between days 11 and 14 (58.5 and 59.6, respectively). Redness was similar (P>0.05) between chops classified as stable or those classified as labile on d 0 (18.3 and 18.4, respectively) and d1 (18.9 vs. 18.6) of display, but stable chops had higher (P<0.05) a* values on d 7 (17.4 vs. 15.8), 11 (16.8 vs. 14.3), and 14 (15.6 vs. 12.7) of display. Labile chops had higher (P<0.05) b* values than the labile chops on days 0 (21.7 vs. 20.1) and 1 (22.2 vs. 21.0), but the stability classifications did not differ on day 7 (21.4 vs. 21.0), 11 (21.2 vs. 21.0), and 14 (21.2 vs. 20.9). Overall color change increased (P<0.05) as display progressed, though this increase was much more extensive in chops predicted to be labile. Stability classes did not differ in ΔE on day 1 (P>0.05; 1.6 and 1.7 for labile and stable classes, respectively). However, day 7 ΔE was greater (P<0.05) in the labile chops (3.4) than in the stable chops (2.6). The differences in ΔE between chops predicted to be labile and those predicted to be stable had increased by days 11 (4.8 and 3.2, respectively; P<0.05) and 14 (6.2 and 3.8, respectively; P<0.05). Differences between color stability groups in the calibration data set were remarkably consistent with those reported for the prediction data set. These data indicate that VIS/NIR spectroscopy is an effective technology to segregate pork loins with regard to color stability.

Keywords: Color stability, Pork, Prediction

Use of VIS/NIR spectroscopy to predict beef lean color stability
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Technology to identify carcasses producing cuts with insufficient color-life for case-ready programs would be a benefit to beef processors and retailers. To evaluate visible and near-infrared (VIS/NIR) spectroscopy as a means for segregating carcasses based on beef longissimus color-life, spectra (350 to 1050 nm) were collected on the exposed ribeyes of carcasses (n=464) as they were presented for grading. Ribeye rolls were obtained from each carcass and aged until 18 d postmortem, when a 2.54-cm steak was removed and placed in simulated retail display. Instrumental color variables [CIE L*, a*, b*, hue angle, and overall color change (ΔE)] were determined on the longissimus muscle on d 0 and 6 of display. Partial least squares regression was used to develop models using VIS/NIR spectra to predict a principle component (PC1) explaining 48% of the variance of days 0 and 6 color variables, which was strongly associated with color change. The resulting model was applied to spectra collected on an independent sample of carcasses (n=100) as they were presented for grading. Carcasses were segregated into two color stability groups based on the predicted PC1 values. Strip loins were collected and aged for 14 d before a 2.54-cm steak was placed in simulated retail display. Color space values were collected on days 0, 1, 3, 6, and 9 of display. Steaks classified as stable had higher L* values on d 0 (43.4) than those classified as labile (42.6). In steaks classified as stable, L* values decreased (P<0.05) between days 0 and 1 (43.4 vs. 42.9) and between days 6 and 9 (42.4 vs. 40.3), whereas L* values of steaks classified as labile decreased (P<0.05) progressively between days 1 and 9 (42.0, 41.3, 40.5, and 39.3 on days 1, 3, 6, and 9, respectively). Values for a* were higher (P<0.05) for steaks classified as labile than steaks classified as stable on days 0 (34.1 vs. 31.5) and 1 (33.7 vs. 32.5), but also declined more rapidly so that on d 9 labile steaks had lower (P<0.05) a* values than steaks classified as stable (21.3 vs. 17.9). Yellowness (b*) values were higher (P<0.05) in steaks classified as labile than in steaks classified as stable on days 0 (27.6 vs. 25.3) and 1 (28.2 vs. 26.9). No differences in b* were detected between stability classifications on days 3, 6, or 9. Conversely, hue angle did not differ between stability classifications on days 0, 1, 3, or 6, but steaks classified as labile had higher (P<0.05) hue angle values on day 9 of display. Overall color change differed (P<0.05) between color stability classes such that steaks classified as labile had progressively greater ΔE values than steaks classified as stable on day 3 (4.7 vs. 3.6), 6 (9.5 vs. 6.9), and 9 (17.8 vs. 12.4) of display. These results indicate that VIS/NIR spectroscopy can be utilized to sort beef carcasses based on longissimus color stability.

Keywords: Beef, Color stability, Prediction

Relative contribution of animal and muscle effects to variation in beef lean color stability
D. A. King*, S. D. Shackelford, T. L. Wheeler, U.S. Meat Animal Research Center, Clay Center, NE, United States

Our objective was to determine the extent to which animal effects influence variation in beef lean color stability in comparison to muscle and quality grade effects. Carcasses (n=100) equally representing the U.S. Choice and Select grades were selected on five days from a commercial beef processing facility. At 14 d postmortem, steaks were
The relationship of colour readings in *longissimus lumbarum* muscle and intramuscular fat measured by image analysis with the acceptability of Spanish beef

M. J. Beriaint, G. Induraint, K. Insaustita, M. V. Sarritsa, T. R. Carrb,
"Universidad Pública de Navarra, Pamplona, Navarra, Spain," "University of Illinois, Urbana, United States"

This project was carried out as part of collaboration between the Universidad Pública de Navarra and the University of Illinois entitled "Beef quality attributes for consumers and its relation with beef carcass classification systems in Spain and the USA." The purpose of this research was to study the relationship of colour and the intramuscular fat measured by image analysis 4 h postmortem with the acceptability of beef. Twenty intact bulls of Pirenaica breed (Spain, Southern Europe) were fed concentrate and straw both ad libitum. Animals were slaughtered at 521 kg live weight and 351 days of age and yielded an average carcass weight of 323 kg (dressing percentage about 64%). Carcass grades for conformation and fatness according to the official European standards (European Commission) were assigned. Twenty-four hours post-mortem the *longissimus lumbarum* (LL) was removed and instrumental colour readings (CIE L*\(\text{a}\), \(\text{b}\), \(\text{C}\), \(\text{H}\)) were taken just after carcass cutting. Maximum shear force was assessed using a Warner-Bratzler (WBSF) shearing device on beef aged 7 days post-mortem with a TA-XTi texture analyzer (England). For the consumers' sensory study, steaks aged 7 days were cooked on a grill using AMSA (1978) guidelines to an internal temperature of 70 °C. A total of 13 evaluation sessions, each involving 20–25 consumers, were held. For sensory analysis, the consumer panel assessed aroma, juiciness, tenderness, flavour/taste, fattiness and overall acceptability of the samples on a 5-point scale: like very much, like moderately, neither dislike nor like, dislike moderately and dislike very much. Simple correlation coefficients were calculated to determine the relationship of meat colour and intramuscular fat measured by image analysis measurements with the acceptability of consumers. Longissimus lumbarum muscle colour readings (L*, \(\text{a}\), \(\text{C}\), \(\text{H}\)) showed a high correlation with the sensory characteristics for consumers, especially L*, \(\text{a}\) and \(\text{C}\) values (−0.643, \(\text{P}<0.01\); 0.687, \(\text{P}<0.01\); 0.570, \(\text{P}<0.01\), respectively). In contrast, it was not observed any relationship between marbling measured by image analysis and WBSF, with any of the sensory variables evaluated by the consumers panel, probably because steers of this work had low marbling (Practically devoid), and intramuscular fat hardly reached 1.3% muscle area. This fact could explain why muscle marbling measured visually or by image analysis did not predict the sensory quality variables. Some authors recommended L* value measured in the L dorsis muscle as a useful index in the carcass grading according to the muscle palatability. In general, darker colour meats show higher WBSF, a lower colour L*, \(\text{a}\) and \(\text{b}\) values. Previous research reported that the beef texture index, that included juiciness and hardness, can be predicted quite accurately by \(\text{C}\) measured on the RA muscle just 45 min after slaughter. In conclusion, colour measurements L*, \(\text{H}\) and \(\text{C}\) in the LL muscle would be quite useful to predict palatability meat for consumers.

Keywords: Color, Meat, Palatability

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</tr>
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</table>

The purpose of this work was to study the relationship of colour and the intramuscular fat measured by image analysis 24 h postmortem with the acceptability of beef. Twenty intact bulls of Pirenaica breed (Spain, Southern Europe) were fed concentrate and straw both ad libitum. Animals were slaughtered at 521 kg live weight and 351 days of age and yielded an average carcass weight of 323 kg (dressing percentage about 64%). Carcass grades for conformation and fatness according to the official European standards (European Commission) were assigned. Twenty-four hours post-mortem the *longissimus lumbarum* (LL) was removed and instrumental colour readings (CIE L*\(\text{a}\), \(\text{b}\), \(\text{C}\), \(\text{H}\)) were taken just after carcass cutting. Maximum shear force was assessed using a Warner-Bratzler (WBSF) shearing device on beef aged 7 days post-mortem with a TA-XTi texture analyzer (England). For the consumers' sensory study, steaks aged 7 days were cooked on a grill using AMSA (1978) guidelines to an internal temperature of 70 °C. A total of 13 evaluation sessions, each involving 20–25 consumers, were held. For sensory analysis, the consumer panel assessed aroma, juiciness, tenderness, flavour/taste, fattiness and overall acceptability of the samples on a 5-point scale: like very much, like moderately, neither dislike nor like, dislike moderately and dislike very much. Simple correlation coefficients were calculated to determine the relationship of meat colour and intramuscular fat measured by image analysis measurements with the acceptability of consumers. Longissimus lumbarum muscle colour readings (L*, \(\text{a}\), \(\text{C}\) and \(\text{H}\)) showed a high correlation with the sensory characteristics for consumers, especially L*, \(\text{a}\) and \(\text{C}\) values (−0.643, \(\text{P}<0.01\); 0.687, \(\text{P}<0.01\); 0.570, \(\text{P}<0.01\), respectively). In contrast, it was not observed any relationship between marbling measured by image analysis and WBSF, with any of the sensory variables evaluated by the consumers panel, probably because steers of this work had low marbling (Practically devoid), and intramuscular fat hardly reached 1.3% muscle area. This fact could explain why muscle marbling measured visually or by image analysis did not predict the sensory quality variables. Some authors recommended L* value measured in the L dorsis muscle as a useful index in the carcass grading according to the muscle palatability. In general, darker colour meats show higher WBSF, a lower colour L*, \(\text{a}\) and \(\text{b}\) values. Previous research reported that the beef texture index, that included juiciness and hardness, can be predicted quite accurately by \(\text{C}\) measured on the RA muscle just 45 min after slaughter. In conclusion, colour measurements L*, \(\text{H}\) and \(\text{C}\) in the LL muscle would be quite useful to predict palatability meat for consumers.

Keywords: Color, Meat, Palatability

**Effect of enhancement solution pH on the fresh and cooked color of dark cutting beef**


Dark-cutting (DC; n = 41) beef strip loins (IMPS #180) were used to test the effects of citric acid-marination pH on visual and instrumental color characteristics during a 5-d, simulated retail display period and cooked beef color. Both DC (mean pH = 6.65) and normal pH low choice (CH; mean pH = 5.48) strip loins were cut into 2 equal-length portions, and DC sections were injected to 111% of raw product weight with pH 3.5, 4.0, 4.5 or 5.0 solutions made by mixing citric acid (CA) in either a 0.5% phosphate solution (\(\text{P}\)) or tap water (\(\text{H}_{2}\text{O}\)). After injection and vacuum-tumbling, sections were cut into 2.5-cm-thick steaks destined for display in \(\text{O}_{2}\)-permeable packaging at 4 °C and 1600 lx of warm light.
white lighting, or cooked to 71 °C on a gas-fired open-hearth grill for cooked color analyses. Visual color of fresh steaks was evaluated by a 5-person trained panel on day 1, 3, and 5 of display. Cooked steaks were cut perpendicular to the steak surface, and one-half of each steak was evaluated for degree of doneness (1 = rare to 6 = very well done) and cooked color (1 = very red to 7 = brown) by a 10-person trained panel, whereas the instrumental color readings were measured on the other half of each steak. Post-enhancement muscle pH for enhanced DC steaks did not (P=0.09) differ from that of the non-enhanced DC steaks regardless of solution pH. Initial color scores of enhanced DC steaks were greater (P≤0.001) than untreated DC, but not CH (P≥0.001) on days 1 and 3 of display. Even though enhanced DC steaks received similar initial color scores to untreated DC (P≥0.34) on day 5 of display, DC steaks enhanced with H2O-based solutions received greater (P=0.01) color scores than steaks enhanced with PO4-based solutions. Discoloration scores were not (P≥0.055) affected by enhancement pH solution on any day of display, but, only on day 1, DC steaks enhanced with PO4-based solutions were more (P=0.03) discolored than DC steaks enhanced with H2O-based solutions. There was a quadratic effect (P=0.01) of enhancement solution pH on cooked color scores, with steaks enhanced with pH 4.0 and 4.5 solutions receiving lower scores than both CH and non-enhanced DC steaks. Degree of doneness scores increased linearly (P=0.03) as solution pH increased from 3.5 to 5.0, but none of the enhanced DC steaks had degree of doneness scores comparable to CH steaks. Only cooked steaks from pH 5.0-enhanced DC sections had greater (P=0.03) L* values than CH, but not (P=0.59) DC, and steaks from DC sections enhanced with the pH 3.5 solution had lower (P=0.2928) b* values than untreated DC steaks; however, there were no (P≥0.08) differences in cooked color redness (a*) values among CH, DC, or enhanced DC steaks. Results from this study indicate that pH values of the enhancement solutions, regardless of base solution, were insufficient to improve the fresh or cooked color of DC beef comparable to that of CH.

Keywords: Beef, Citric acid, Enhancement dark-cutters

Citic acid marination can improve the cooked color, but not fresh color, of dark-cutting beef
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Dark-cutting (DC; n = 41) beef strip loins (IMPS #180) were used to test the effects of citric acid-marination pH on visual and instrumental color characteristics during a 5-d, simulated retail display period and cooked beef color. Both DC (mean pH = 6.61) and normal pH low choice (CH; mean pH = 5.38) strip loins were cut into 2 equal-length portions, and DC sections were injected to 111% of raw product weight with pH 2.0, 2.5, 3.0, and 3.5 solutions made by mixing citric acid (CA) in either a 0.5% orthophosphate solution (PO4) or a 0.5% triphosphate solution (TSP). After injection and vacuum-tumbling, sections were cut into 2.5-cm-thick steaks destined for display in O2-permeable packaging at 4 °C and 1600 lx of warm white lighting, or cooked to 71 °C on a gas-fired open-hearth grill for cooked color analyses. Visual color of fresh steaks was evaluated by a 5-person trained panel on days 1, 3, and 5 of display. Cooked steaks were cut perpendicular to the steak surface, and one-half of each steak was evaluated for degree of doneness (1 = rare to 6 = very well done) and cooked color (1 = very red to 7 = brown) by a 10-person trained panel, whereas the instrumental color readings were measured on the other half of each steak. Post-enhancement muscle pH decreased linearly (P=0.001) as solution pH decreased from 3.5 to 2.0, with DC steaks enhanced with pH 2.5 solution comparable (P=0.14) to that of CH, but the pH of DC sections enhanced with pH 2.0 solution was lower (P<0.001) than CH. Enhanced steaks, regardless of solution pH, received lower (P<0.001) initial color scores than CH, and higher (P≤0.003) scores than non-enhanced DC steaks on days 1 and 3 of display. Discoloration scores for DC steaks enhanced with pH 2.0, 2.5, and 3.0 solutions were lower (P≤0.03) than DC steaks each day of display, whereas steaks enhanced with pH 3.5 solutions did not (P≥0.08) differ from DC on days 1 and 3. Cooked steaks enhanced with pH 2.5, 3.0, and 3.5 solutions had b* values that were comparable (P≥0.85) to that of CH steaks. Degree of doneness and cooked color scores increased linearly (P≤0.01) as solution pH decreased from 3.5 to 2.0, with degree of doneness and cooked color scores of pH 2.5 enhanced DC steaks similar (P=0.10) to CH steaks. Enhancing DC beef with citric acid, at a solution pH of 2.5 to 3.5, effectively reduced muscle pH and eliminated the persistent red cooked color typically associated with DC beef; however, citric acid enhancement of DC beef failed to improve the fresh color to that of CH beef.

Keywords: Beef, Dark-cutter, Citric acid enhancement

Sorghum bran, chestnut wood powder, and Chardonnay grape seed flour addition and their effects on lipid oxidation and color in ground beef patties
T. L. Roybal, L. Rooney, J. M. Awika, R. K. Miller, Texas A&M University, College Station, United States

Naturally occurring tannin antioxidants found in sorghum bran varieties as well as Chardonnay grape seed flour and chestnut wood powder were hypothesized to inhibit lipid oxidation of ground beef more effectively than the industry synthetic and natural standards BHA/BHT and rosemary extract respectively. Ground beef containing 81% lean was purchased via retail on three different processing days, each defining a replicate. The ground beef was weighed into portions and mixed with a randomly assigned treatment. Treatments were added based on meat weight and included a control (no added ingredient), 0.2% rosemary, 0.02% combined BHA/BHT, 0.5% Chardonnay grape seed flour, 0.1% and 0.25% chestnut wood powder, and 0.25% and 0.5% of the following sorghum bran: black, black with added tannin, white, and high tannin. Patties weighing 200 g were formed from the mixtures. Patties were randomly designated as cooked or raw and by storage length (0, 1, 3, 5 d). Two patties per treatment per storage length were cooked to an internal temperature of 73 °C. All patties were aerobically packaged and stored in a 4 °C cooler under fluorescent lighting. Cooked patties were analyzed for 2-thiobarbituric acid reactive substances (TBARS) to evaluate the effectiveness of the added tannin containing antioxidants. Subjective and objective color and pH were measured of two raw patties per treatment per storage length. Antioxidant addition reduced TBARS values over time compared to the control (P<0.0001); all treatments with the exception of 0.25% white sorghum reduced TBARS values over time compared to the current standard natural antioxidant additive in meat processing, rosemary extract. Four treatments (0.5% black tannin sorghum, 0.5% Chardonnay grape seed flour, 0.25% chestnut wood powder, and 0.1% chestnut wood powder) showed no significant increase in TBARS values over storage. As expected, sorghum treatments were more effective at inhibiting lipid oxidation at higher treatment levels. TBARS values were similar for ground beef containing 0.1% and 0.25% chestnut wood powder (0.56 vs. 0.55), indicating that the lower concentration was effective at inhibiting lipid oxidation. The black sorghum and black sorghum with added tannin ingredients yielded the lowest color space values (L*, a*, and b*; P<0.0001). Percent surface discoloration over time was highest in...
patties containing a sorghum treatment ($P < 0.0001$). Specks of visible ingredients were measured in random 2.54 cm² areas on the patty surfaces and were possible color measurement influences. Influence of specks may be reduced by further processing ingredients to smaller particle size. There is viable reason to consider the application of many of the natural plant-based treatments involved in this study, especially in the pre-cooked sector of the meat industry. Chardonnay grape seed flour, chestnut wood powder, and many sorghum bran varieties added at low levels effectively retarded lipid oxidation without negative color changes.

Keywords: Antioxidants, Lipid oxidation, Tannins

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**Effect of sequential dipping treatments of hydrochloric acid/citric acid together with cetylpyridinium chloride, and trisodium phosphate on microbial properties of inoculated beef**

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Microbial contamination of beef is a serious concern for the meat industry as microorganisms can be introduced to muscle surfaces from various sources. Studies have suggested efficacies of various decontamination treatments using single or multiple antimicrobial intervention for reducing microbial load in beef and beef products. However, the antimicrobial effects of hydrochloric acid and citric acid blend (Citrolow, Safe Food Inc., Little Rock, AR) alone or in combination with trisodium phosphate (TSP) and/or cetylpyridinium chloride (CPC) as a sequential antimicrobial application on beef are unknown. For the application of antimicrobial agents, *biceps femoris* muscles were used for treatment of individual steaks. *Biceps femoris* muscles ($n=3$) were cut into steaks and each steak was inoculated by dipping into a bacterial cocktail preparation containing $10^7$ CFU/mL of *Escherichia coli* (EC; ATCC # 11775) and *Salmonella typhimurium* (ST; ATCC # 1769NR). For antimicrobial application, steaks were dipped into treatments containing: (1) Inoculated control (no antimicrobial treatment); (2) Citrolow; (3) Citrolow followed by CPC; (4) Citrolow followed by CPC followed by TSP; and (5) Citrolow followed by CPC and TSP combinations. After treatment, each steak was placed on foam trays with absorbent pads and overwrapped with polyvinyl chloride film. Steaks from each treatment ($n=3$) were sampled for EC, ST, coliforms (CO), and aerobic plate count (APC) on day 1, 2, 3, 5, and 7 of display. Instrumental color properties for $L^*$, $a^*$, $b^*$, hue angle, and saturation index were evaluated on days 0, 1, 2, 3, 5, and 7. Coliform and APC counts for day 2 and day 3 were higher ($P < 0.05$) for the inoculated control, KL, TSP, and water, whereas NMS and CPC reduced ($P < 0.05$) CO and APC counts on days 2 and 3 of display. Coliform and APC counts on days 5 and 7 were different ($P < 0.05$) for CPC vs. the inoculated control, KL, NMS, TSP, and water. On day 2, EC counts were reduced ($P < 0.05$) by CPC and NMS vs. inoculated control, KL, TSP, and water ($2.72$ and $3.32$ vs. $4.67$, $4.67$, $4.19$, and $4.66$, respectively). A treatment by day effect by day effects were detected for $L^*$ values, or $b^*$ values, but individual treatment effects ($P < 0.05$) were detected. A significant ($P < 0.05$) treatment by day effect was observed for $a^*$ values, hue angle and saturation index. Steaks treated with CPC were less red ($P < 0.05$) than the uninoculated control, inoculated control, KL, NMS, TSP, and water on day 0 of display for $a^*$ values. On days 5 and 7 of display, steaks did not differ ($P > 0.05$) between treatments for vividness (saturation index). Therefore, spray treatment of beef *biceps femoris* muscles at the sub-primal level, and again at the individual steak level with the same allotted treatment may enhance shelf life and color initially, but these treatment effects may not persist through 7 days of display.

Keywords: Antimicrobial, *Biceps femoris*, Instrumental color

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**Quality and sensory characteristics of cubed beef steak dipped in edible solutions of thermized cheddar whey**

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The objective of this study was to investigate the efficacy of heat modified (thermized) Cheddar whey protein concentrate (WPC), with and without added enzymatically hydrolyzed whey (WH), as an

Keywords: Antimicrobial, *Biceps femoris*, Hydrochloric acid

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The effects of cetylpyridinium chloride, trisodium phosphate, potassium lactate, sodium metasilicate, or water as multiple antimicrobial interventions on microbiological and instrumental color characteristics of beef *biceps femoris* muscles

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The effects of antimicrobial agents on *biceps femoris* muscles treated at a sub-primal level and at individual steak levels were studied. *Biceps femoris* muscles ($n=12$) were cut into three subsections ($n=35$ subsections). Each subsection was brush inoculated with *Escherichia coli* (EC; ATCC # 11775) and *Salmonella typhimurium* (ST; ATCC # 1769NR) at $10^7$ CFU/mL, and spray treated with either: (1) water; (2) $3\%$ potassium lactate (KL); (3) $4\%$ sodium metasilicate (NMS); (4) $0.5\%$ cetylpyridinium chloride (CPC); (5) $10\%$ trisodium phosphate (TSP); (6) inoculated control; or (7) un inoculated control. Each subsection was cut into three individual steaks ($n=105$) allowing fifteen steaks per treatment per day. The individual steaks were spray treated again with the same treatments allotted at the sub-primal level for a multiple intervention application. Steaks were placed on foam trays with absorbent pads, overwrapped with polyvinyl chloride film, displayed under stimulated retail conditions, and sampled for microbiological and instrumental color characteristics. Steaks were sampled for EC, ST, coliforms (CO), and aerobic plate count (APC) on day 1, 2, 3, 5, and 7 of display. Instrumental color properties for $L^*$, $a^*$, $b^*$, hue angle, and saturation index were evaluated on days 0, 1, 2, 3, 5, and 7. Coliform and APC counts for day 2 and day 3 were higher ($P < 0.05$) for the inoculated control, KL, TSP, and water, whereas NMS and CPC reduced ($P < 0.05$) CO and APC counts on days 2 and 3 of display. Coliform and APC counts on days 5 and 7 were different ($P < 0.05$) for CPC vs. the inoculated control, KL, NMS, TSP, and water. On day 2, EC counts were reduced ($P < 0.05$) by CPC and NMS vs. inoculated control, KL, TSP, and water ($2.72$ and $3.32$ vs. $4.67$, $4.67$, $4.19$, and $4.66$, respectively). A treatment by day effect by day effects were detected for $L^*$ values, or $b^*$ values, but individual treatment effects ($P < 0.05$) were detected. A significant ($P < 0.05$) treatment by day effect was observed for $a^*$ values, hue angle and saturation index. Steaks treated with CPC were less red ($P < 0.05$) than the uninoculated control, inoculated control, KL, NMS, TSP, and water on day 0 of display for $a^*$ values. On days 5 and 7 of display, steaks did not differ ($P > 0.05$) between treatments for vividness (saturation index). Therefore, spray treatment of beef *biceps femoris* muscles at the sub-primal level, and again at the individual steak level with the same allotted treatment may enhance shelf life and color initially, but these treatment effects may not persist through 7 days of display.

Keywords: Antimicrobial, *Biceps femoris*, Instrumental color

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Quality and sensory characteristics of cubed beef steak dipped in edible solutions of thermized cheddar whey

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The objective of this study was to investigate the efficacy of heat modified (thermized) Cheddar whey protein concentrate (WPC), with and without added enzymatically hydrolyzed whey (WH), as an
antioxidative and antimicrobial agent to include its effects as an edible coating on sensory and other quality attributes of cubed beef steak (semimembranosus). Fresh Cheddar whey was skimmed, pasteurized and batch heated (thermized) at 70 °C for 0, 5, 10, and 15 min. Resulting batches were vacuum evaporated and spray dried. Coating dips containing 5% (w/v) WPC, 2.5% (w/v) sorbitol (plasticizer), and 0.125% (w/v) CaCl₂ were dispersed in distilled water (pH 6.5), with (+) and without 0.25% (w/v) whey hydrolyzates (WH). Fresh cubed (tenderized) beef steaks (3–4 oz) were coated with the dip. Styrofoam tray overwrap packaged and refrigerated (4 °C) until analyses. Controls were not dipped with any whey components. Microbial analyses involved duplicate plating of each refrigerated (4 °C) until analyses. Controls were not dipped with any whey components. Microbial analyses involved duplicate plating of each of the nine treatments for both total count (TPC) and E. coli initial and final screening with monitoring of the TPC every 48 h for eight days. Sensory analysis utilized a trained panel of experts to evaluate the effect of the edible coating on all treatments at days 0, 2, 4 and 7. Samples for detecting oxidative degradation were smaller in size and were handled separately from the microbial and sensory samples. Although not statistically significant compared to controls, thermized WPC treatments (5+, 5, 10 and 10+) numerically showed greater potential for microbial reduction and shelf-life enhancement of 1 to 2 days on cubed beef steak. Sensory results showed that treatments with thermized WPC maintained overall acceptability through 4 days of storage with the 5 min. thermization treatment showing the most positive effect on lowering off flavor sensory scores while 15 and 15+ treatments tended to have a slightly negative impact on flavor attribute scores. Beef flavor intensity was not altered (P > 0.05) by treatment or sample storage time (up to 7 days). The carbonyl content of all treatments was lower (P < 0.05) than those of controls and blank (coating solutions without WPC) after 72 and 96 h of storage. The lowest (P < 0.05) carbonyl content was recorded in samples with WH after 72 h of storage. The sulfhydryl content of all treatments was higher (P < 0.05) than those of controls after 72 and 96 hrs of storage, indicating oxidative protection provided by the coating. Thermization and/or addition of whey hydrolyzates reduced the TPC. Sensory analyses indicated no significant impact on general sensory characteristics or overall acceptability of the coated product for the first 4 days in the retail package. Thermization and/or the addition of WH was effective in protecting beef against protein oxidation and thermization significantly improved antioxidative properties of WPC based edible coatings when used on tenderized beef steak. Data showed that thermization of inexpensive and natural WPC enhanced antioxidative properties and had a positive impact upon the shelf life with no significantly negative influence on consumer acceptability of coated cubed beef steaks.

Keywords: Edible coating, Oxidation, Sensory, Thermization, Whey

Comparison of physical, chemical and sensorial characteristics between US Imported and northwestern Mexico retail beef


To compare beef from Northwestern Mexico (NMEX) and its counterpart imported from United States (US) in physical-chemical (PC) and sensory traits, samples of rib eye (m. Longissimus dorsi thoracis, LDT) and knuckle (m. Vastus lateralis, VL) of Mexican (n = 64 LDT; n = 51 VL) and US (n = 29 LDT; n = 25 VL) origins were randomly purchased from selected retail stores located at three cities of NMEX. PC evaluation included contents of moisture, fat and cholesterol, Warner-Bratzler shear force (WBSF), pH, CIE L*, a*, b*, and hue, cooking loss, and normalized fatty acid profile (FAP). Trained panelists evaluated raw and cooked samples for two visual (overall color and overall appearance) and six eating quality (odor, flavor, fat mouthfeelinig, tenderness, juiciness, and amount of connective tissue) traits. No differences (P > 0.05) found in beef PC or sensory traits between Mexican and US-imported LDT steaks while US-imported VL samples exhibited higher hue (32.91 vs. 28.68) and lower WBSF values (4.50 vs. 6.07 g), contained slightly more fat (2.89 vs. 2.40%) and were rated as more tender (6.21 vs. 5.38), than their NMEX counterparts (P < 0.05). FAPs varied significantly due to country of origin (COO). Mexican LDT had a higher (16.44 vs. 14.43%) content of C18:0. For VL no differences due to COO (P > 0.05) were found for any saturated fatty acid (SFA) or monounsaturated fatty acid (MUFA). However, differences (P < 0.05) were found in the amount of essential polyunsaturated fatty acid (PUFA). VL from US showed a higher concentration of linoleic acid (7.22 vs. 5.52%) and linolenic acid (0.42 vs. 0.32%), as well a higher (P < 0.05) FUPA:SFA ratio (0.23 vs. 0.18). The cholesterol content did not vary (P > 0.05) between samples of different COO, with values fluctuating between 38 and 40 mg/100 g tissue. Results indicate that domestic and US retail LDT steaks sold in the NMEX are similar in eating quality and PC, whereas differences observed in FAP deserve further attention from a nutritional standpoint.

Keywords: Meat quality, Mexican beef, U.S. beef

Prediction equations for Warner-Bratzler shear force using regression component analysis


The objective of this study was to develop predicted equations for Warner-Bratzler shear force (WBSF). A total of 644 observations were used, divided into two datasets: Dataset 1 comprised carcass and meat evaluation of 331 bovine (steers, heifers and bulls) of unknown farm history, processed in a slaughter plant. Dataset 2 was composed by 313 bovine (steers, heifers and bulls) coming from several diet-supplement experiments. Simple descriptive analysis, correlation analysis, principal components analysis (PCA) and regression component analysis (RCA) were performed in both datasets. A wide variation was detected in most of the variables. Equations were obtained for each sex condition within each dataset. In dataset 1, between 88.14% (for bulls) and 95.06% (for heifers) of the total variation observed in WBSF can be explained by its orthogonal regression. For dataset 2, the variation ranged between 76.43% (for bulls) and 82.49% (for steers). The best equation for steers (R² = 94.21) in dataset 1 was: 3.5659 + 0.0029 (carcass weight) − 0.0326 (subcutaneous fat) − 0.0147 (fat thickness) + 0.0004 (skeletal maturity). In dataset 2 (for steers), the best equation (R² = 84.49) was: 20.4914 − 0.0026 (live weight) − 1.068 (age) − 0.0061 (carcass weight) − 1.4868 (marbling) + 0.0112 (skeletal maturity) − 0.086 (loin eye area). An analysis of variance was used to compare carcasses that produced tenderer vs. those that produced tough meat. The analysis found that carcass from steers with tender meat resulted with less skeletal maturity scores, lower carcass weight and better subcutaneous fat (P < 0.05) than those that produced tough meat. However, carcass from heifers and bulls were not different (P > 0.05) when compared tender vs. tough categories. The prediction equations obtained in this study need to be validated before suggest its use in the carcass grading system. These results also are useful to formulate program to generate commercial brand to allow quality certification to those market niches.

Keywords: Prediction equation, Principal components regression, Tenderness
The objective was to determine the influence of beef lentinus muscle nutrient components on beef palatability traits and evaluate the impact of USDA quality grade on beef palatability. Angus cattle from related herds in California (n = 358), Colorado (n = 389), Iowa (n = 549), and Texas (n = 451) were utilized. Lentinus muscle samples were obtained and fabricated into steaks for trained sensory panel, Warner-Bratzler shear force (WBSF), thiobarbituric acid reactive substances (TBARS), fatty acid, and mineral composition analysis. Pearson phenotypic correlations were obtained by PROC CORR of SAS. Beef palatability data were analyzed by PROC GLM of SAS with USDA quality grade as the main effect. Specific mineral concentrations did not demonstrate strong correlations with WBSF or sensory traits (r = −0.14 to 0.16). However, all minerals evaluated except calcium were positively correlated (P < 0.05) with beef flavor. Every mineral except iron and zinc was negatively associated (P < 0.05) with WBSF, but only sodium, manganese, and potassium were related (P < 0.05) to overall sensory tenderness. Minerals demonstrated stronger correlations with TBARS than sensory traits. Every mineral was negatively associated with TBARS, with the strongest relationship between magnesium (r = −0.46). Searic acid (C18:0), C18:2, polyunsaturated fatty acids (PUFA), and the sum of n-6 fatty acids were negatively correlated (P < 0.05) with all three panelist tenderness traits (r = −0.09 to −0.20) and were positively correlated (P < 0.05) with WBSF (r = 0.09 to 0.15). Oleic acid (C18:1) and monounsaturated fatty acids (MUFA) were positively correlated (P < 0.05) with panelist tenderness ratings (r = 0.07 to 0.10) and negatively associated with (P < 0.05) with WBSF (r = −0.08 to −0.11). The strongest correlations with juiciness were negative relationships (P < 0.05) with C18:2, C18:3, PUFA, and the sum of n-6 fatty acids (r = −0.08 to −0.17). Correlations with beef flavor were weak, but the strongest was a positive relationship with MUFA (r = 0.14). Quality grade impacted (P < 0.05) WBSF, TBARS, and all trained sensory panel traits, except livery/metallic flavor. As quality grade increased, steaks were more tender (P < 0.05), as evidenced by both WBSF and sensory panel tenderness ratings. Prime steaks were rated juicier (P < 0.05) by panelists, while Select and Low Choice were similarly rated below Top Choice for sustained juiciness. Quality grade influenced (P < 0.05) beef flavor, but not in a linear fashion. Although there were significant correlations, these results indicate tenderness, juiciness, and flavor are not strongly influenced by the nutrient components in beef lentinus. Furthermore, the positive linear relationships between USDA quality grade and beef palatability traits suggest quality grade is still one of the most valuable tools available to predict beef tenderness.

Keywords: Beef, Nutrient composition, Palatability

The objective was to determine the influence of the SuspenTec system on the palatability traits of beef round cuts. In phase I, USDA select paired beef eye of round (ER, IMPS 171C; n = 17) and bottom round flat subprimals (BR, IMPS 171B; n = 17) were selected, aged for 14 d and cut into equal halves and randomly assigned to a 20% or 30% suspension of 50/50 beef trimmings incorporated in a brine solution containing salts, phosphates, and antioxidants or a control group. Each treatment was injected to a target weight of 118%. Subprimal halves were fabricated into 2.54 cm steaks for Warner-Bratzler shear force (WBS) and sensory analysis. Sensory and WBS data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) with subprimal identification as the random effect and suspension as the fixed effect. Suspensions containing 30% trimmings improved (P < 0.05) the WBS of BR steaks. No significant (P > 0.05) differences in tenderness in WBS values between treatments was evident in ER steaks; however, there were significant (P < 0.05) improvements in initial juiciness, sustained juiciness, initial tenderness and overall tenderness in both ER and BR when comparing the SuspenTec treatments to controls. This concluded that the 20 and 30% suspension treatments showed potential in increasing palatability traits of both subprimal cuts. Also, the 30% though not significant (P > 0.05) showed tendencies of being more effective than the 20% suspension treatment in terms of improving palatability traits of round cuts. Phase II was conducted using 14 d aged ER (n = 35) and BR (n = 32) subprimals that were either processed using the 30% SuspenTec suspension (30%), a traditional moisture enhanced (E), or blade tenderized (BT) which were compared to traditional wet aged 14 d controls (CON) cuts to determine their effects on WBS, sensory traits and lipid oxidation using thiobarbituric acid reactive substances (TBARS). No differences (P > 0.05) in WBS of BR or TBARS in either cut, however, consistent differences (P < 0.05) were evident among the various treatments on ER steaks, with E steaks exhibiting the most desirable WBS tenderness with BT and 30% being intermediate followed lastly by the CON steaks. From a sensory standpoint, 30% steaks showed higher levels (P < 0.05) of initial and sustained juiciness compared to CON and BT BF steaks. Even though no differences (P > 0.05) were evident in initial tenderness ratings of BF steaks, panelists rated overall tenderness of non-intact treatments as being more desirable when compared to CON counterparts. Additionally, BT reduced the amount of detectable connective tissue as compared to 30%, E and CON samples. Similarly, 30% and E affected (P < 0.05) the initial and sustained juiciness of ER steaks. Compared to CON ER steaks, all non-intact treatments (E, 30% and BT) improved (P < 0.05) the initial and overall tenderness ratings. These data support that traditionally tough round cuts can be subjected to several non-intact procedures, which ultimately improve overall palatability ratings when compared to traditionally used postmortem aging practices.

Keywords: Beef round, Palatability

The objective was to determine the influence of the SuspenTec system on the palatability traits of beef round cuts. In phase I, USDA select paired beef eye of round (ER, IMPS 171C; n = 17) and bottom round flat subprimals (BR, IMPS 171B; n = 17) were selected, aged for 14 d and cut into equal halves and randomly assigned to a 20% or 30% suspension of 50/50 beef trimmings incorporated in a brine solution containing salts, phosphates, and antioxidants or a control group. Each treatment was injected to a target weight of 118%. Subprimal halves were fabricated into 2.54 cm steaks for Warner-Bratzler shear force (WBS) and sensory analysis. Sensory and WBS data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) with subprimal identification as the random effect and suspension as the fixed effect. Suspensions containing 30% trimmings improved (P < 0.05) the WBS of BR steaks. No significant (P > 0.05) differences in tenderness in WBS values between treatments was evident in ER steaks; however, there were significant (P < 0.05) improvements in initial juiciness, sustained juiciness, initial tenderness and overall tenderness in both ER and BR when comparing the SuspenTec treatments to controls. This concluded that the 20 and 30% suspension treatments showed potential in increasing palatability traits of both subprimal cuts. Also, the 30% though not significant (P > 0.05) showed tendencies of being more effective than the 20% suspension treatment in terms of improving palatability traits of round cuts. Phase II was conducted using 14 d aged ER (n = 35) and BR (n = 32) subprimals that were either processed using the 30% SuspenTec suspension (30%), a traditional moisture enhanced (E), or blade tenderized (BT) which were compared to traditional wet aged 14 d controls (CON) cuts to determine their effects on WBS, sensory traits and lipid oxidation using thiobarbituric acid reactive substances (TBARS). No differences (P > 0.05) in WBS of BR or TBARS in either cut, however, consistent differences (P < 0.05) were evident among the various treatments on ER steaks, with E steaks exhibiting the most desirable WBS tenderness with BT and 30% being intermediate followed lastly by the CON steaks. From a sensory standpoint, 30% steaks showed higher levels (P < 0.05) of initial and sustained juiciness compared to CON and BT BF steaks. Even though no differences (P > 0.05) were evident in initial tenderness ratings of BF steaks, panelists rated overall tenderness of non-intact treatments as being more desirable when compared to CON counterparts. Additionally, BT reduced the amount of detectable connective tissue as compared to 30%, E and CON samples. Similarly, 30% and E affected (P < 0.05) the initial and sustained juiciness of ER steaks. Compared to CON ER steaks, all non-intact treatments (E, 30% and BT) improved (P < 0.05) the initial and overall tenderness ratings. These data support that traditionally tough round cuts can be subjected to several non-intact procedures, which ultimately improve overall palatability ratings when compared to traditionally used postmortem aging practices.

Keywords: Beef round, Palatability

Development of a lexicon for the description of beef aroma and flavor

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In an effort to increase beef demand, the beef industry has expanded beyond commodity beef merchandising into value-added cuts. As these beef cuts are developed it is critical that the industry be able to characterize the flavor attributes of these products. A trained sensory panel is typically utilized to determine flavor characteristics of food products including beef. Prior to product evaluation, a product lexicon or dictionary of terms is developed in order to anchor and orient panelists to the product. Once the lexicon is developed, it can be used by a descriptive panel to evaluate samples. Currently, the beef industry does not have a full beef flavor lexicon with defined references; therefore a comprehensive sensory lexicon for describing the aroma and flavor of beef was developed by a 6-member panel at Kansas State University with extensive experience in lexicon development and descriptive analysis. One hundred and eighty varying beef samples were selected and evaluated to represent
a wide range of possible flavor attributes. The samples included beef from various muscles, of different ages, sexes, grades, feed diets, packaging conditions and processing locations. Samples were prepared using different cooking methods (oven-broil, oven-roasted, stewing, grilled, and food-service gas-grilling) and to varying degrees of doneness (135, 145, 155, 165 or 175 °F). The panel identified, defined and referenced 41 aroma and flavor attributes for beef. Attributes defined were categorized into “Major Notes” and “Other Notes” depending on the frequency of presence in the samples. The “Major Notes”, the focus of this poster, include beef flavor, brown/roasted, bloody/serumy, fat-like, metallic, liver-like, green-haylike and all five fundamental tastes. Attributes, such as beef flavor, brown/roasted, bloody/serumy, fat-like, metallic, umami, overall sweet, sweet, sour aromatics, sour, salty and bitter were present in most samples, but the attributes liver-like and green-haylike were found in fewer samples. This lexicon provides accurate definitions and references that will allow the beef industry, beef processors and researchers to effectively characterize and differentiate the flavor attributes among different beef samples.

Keywords: Beef flavor, Descriptive analysis, Lexicon

Determination of fat percentage using CEM, Ether and Folch fat extraction methods within marbling scores on beef Longissimus muscle
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Fat percentage determination in raw meat products has changed with technological advances. The development of rapid fat analysis methods has allowed the meat industry to implement these methods into commercial packing plants to aid in ensuring quality. The objective of this study was to determine fat percentage within marbling scores and comparing three fat analysis procedures. Steaks (n = 119) were selected by USDA grading system using an E + V Vision Grading camera at a commercial beef plant during one day. Two samples per carcass were cut from the 13th rib, both sides, and transported to University of Missouri meat lab. The sample from the right side of the carcass was allotted to Warner-Bratzler shear force and the sample from the left side, which was graded by the camera, was allotted to fat extraction. Warner-Bratzler shear force samples were cut into 2.54 cm steaks and aged for 14 d. Steaks allotted to fat extraction were trimmed of all external fat and twice ground using 8 mm and 4 mm grinding plates. The allotted to fat extraction were trimmed of all external fat and twice ground using 8 mm and 4 mm grinding plates. The finely ground beef was then split into its allotted fat extraction methods. The three methods used in fat extraction were 2:1 chloroform/methanol (Folch), ether-extractable fat (Ether) and microwave drying and nuclear magnetic resonance (CEM). Warner-Bratzler shear force values were not different between marbling scores (P = 0.05). Regardless of fat extraction method, fat percentage increased as marbling score increased (P = 0.05). Regression equations for fat percentage using all extraction methods were linear. Prediction equation for CEM was fat percentage = −3.46 + 0.016(quantity of marbling score), R² of 0.824 (P = 0.0001). Prediction equation for Ether was fat percentage = −3.08 + 0.017(quantity of marbling score), R² of 0.859 (P = 0.0001). Folch prediction equation was fat percentage = −3.42 + 0.019(quantity of marbling score), R² of 0.816 (P = 0.0001). When CEM, Folch and Ether methods were compared, CEM and Folch regression lines had different slopes (P = 0.05). The slope of the regression line for Ether was not different (P = 0.05) from CEM or Folch. Overall, tenderness was not affected by marbling score, but as expected, as marbling score increased fat percentage also increased regardless of fat extraction method.

Keywords: Beef, Fat extraction, Marbling

Effect of brine enhancement and mechanical tenderization on shear force and moisture loss of cow semimembranosus steaks
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This study evaluated the effects of brine enhancement by means of mechanical tenderization on an under-utilized cut from cow carcasses on Warner-Bratzler shear force, vacuum purge, and drip loss. Comparison was made between enhanced and tenderized cow (CUL) and traditional fed beef (FED). Processing treatments included a control (CON) and a brine enhancement by means of mechanical tenderization (BRN) of the semimembranosus muscle. Beef semimembranosus from both CUL and FED beef carcasses were obtained from the University of Minnesota Meat Laboratory and cut into roasts (60 roasts, 5 per each of 3 replications, approximately 1 kg each). FED and CUL roasts were randomly assigned to CON and BRN treatments. BRN roasts were placed in a commercial meat tumbler with 15% (w/w) brine (water and sodium tripolyphosphate) to create an enhanced roast with 0.2% phosphate. Roasts and brine were tumbled for 30 min. BRN and CON roasts were individually vacuum packaged and allowed to equilibrate at 4 °C for 24 h before being cut into steaks (2.54 cm thick). Drip loss was evaluated for each steak by suspending steak samples for 24 h at 4 °C in a controlled atmosphere. Percent drip loss was calculated as the difference between the initial and final weight divided by the initial weight. Additional steaks were individually packed, and frozen (−20 °C) for 28 d. Steaks were thawed at 4 °C for 36 h. Purge loss was measured as the difference between the initial and final weight divided by the initial weight. Steaks were then cooked in an electric oven (180 °C) to an internal temperature of 71 °C and then allowed to cool for 24 h at 4 °C. Steak fiber cores were taken parallel to the muscle fiber orientation and sheared using a Warner-Bratzler shear force device. Tumbling and enhancement affected mean shear force values for CUL ENH (P = 0.001) and NENH (P = 0.009) with higher mean values for CUL NENH (3.65 kg) than CUL ENH (3.25 kg). Mean purge loss percentage was lower (11.18%) for NENH than ENH (13.28%) for FED steaks (P = 0.04). Additionally, mean purge loss percentage was higher for ENH (15.48%) than NENH (13.68%) for CUL steaks (P = 0.03). There was no affect on mean drip loss percentage between FED and CUL however, there was an effect within treatment for mean drip loss, with values lower for NENH (1.94%) than ENH (5.22%, P = 0.006). Results indicate that mechanical tenderization and brine enhancement may improve tenderness in cull cow beef to acceptable levels, but may also increase moisture loss.

Keywords: Cow beef, Enhance, Tumbling

Effect of brine enhancement and mechanical tenderization on shelf life characteristics of cow semimembranosus steaks
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The objective of this study was to evaluate the effects of brine enhancement by means of mechanical tenderization on an under-utilized cut from cow carcasses, on beef shelf life characteristics. Additionally considered was a comparison of enhanced and tenderized cow beef (CUL) to traditional fed beef (FED). Processing treatments included a control (CON) and a brine enhancement by means of mechanical tenderization (BRN) of the semimembranosus muscle. Beef semimembranosus from both CUL and FED beef carcasses were obtained from the University of Minnesota Meat Laboratory and cut into roasts (60 roasts, 5 per each of 3 replications, approximately 1 kg each). FED and CUL roasts were randomly assigned to CON and BRN treatments. BRN roasts were placed in a
commercial meat tumbler with 15% (w/w) brine (water and sodium tripolyphosphate) to create an enhanced roast with 0.2% phosphate. Roasts and brine were tumbled for 30 min. BRN and CON roasts were individually vacuum packaged and allowed to equilibrate at 4 °C for 24 h before being cut into steaks (2.54 cm thick), individually placed on retail polystyrene tray, covered with PVC film and stored at 4 °C under cool white fluorescent lighting. Surface L°, a°, b° colorimetric values were taken using a Hunter MiniScan XE Plus Spectrophotometer every 24 h for 14 d starting at day 0. Each day, 5 readings were taken per steak to ensure uniformity of sampling. Additionally subjective color evaluation was made by a trained panel every 24 h for 14 d starting at day 0. Parameters evaluated included steak lean color (8 point scale) surface discoloration (10 point scale) and overall acceptability (8 point scale). For objective analysis treatment and age did not affect mean L° or a° values (P=0.76 and 0.37 respectively) however; treatment and age did affect mean b° values (P=0.0001), with mean b° values higher in FED ENH than all other treatments. For subjective evaluation, there was no affect for CUL ENH or NENH for steak lean color, surface discoloration, and overall appearance (P=0.92, 0.66 and 0.69 respectively). There was also no affect for FED ENH or NENH for steak lean color, surface discoloration, and overall appearance (P=0.82, 0.94, and 0.86 respectively). However, FED did increase mean lean color (P=0.001), surface discoloration (P=0.009), and overall appearance (P=0.001) values. Results indicate that mechanical tenderization and brine enhancement may improve shelf life characteristics in traditional beef steaks, however cow beef steaks may not be affected with a desirable outcome.

Keywords: Cow beef, Enhance, Tumbling

Enhancement of beef semitendinosus with kiwi fruit juice increases tenderness and collagen solubility
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Variability in tenderness is a major problem for the beef industry partially because many muscles from the chuck and round are lean but may not be tender due to greater amounts of connective tissue. The addition of kiwi fruit juice and the enzyme abundant in kiwi fruit, actinidin, has been reported to increase tenderness of beef cuts when used as a marinade and when infused at slaughter in lambs. The mechanisms through which the tenderizing effect of kiwi fruit juice occurs are not clear. Beef semitendinosus muscles (n=10) were divided in half and enhanced with a kiwi solution (8.35% water, 1% kiwi fruit juice, 0.35% salt, and 0.3% phosphates) or a water solution (9.35% water, 0.35% salt, and 0.3% phosphates) to determine whether use of kiwi fruit juice can tenderize beef cuts which are high in connective tissue content. After enhancement with a multineedle injector each group of semitendinosus muscles was tumbled for 1 h under vacuum at 4 °C to better distribute the enhancement solution throughout the muscle. Upon completion of tumbling semitendinosus muscles were vacuum packaged in a high barrier bag and aged for 7 days at which time two steaks were fabricated from the medial portion of each semitendinosus muscle and used to determine Warner-Bratzler shear force, collagen solubility and collagen content. Data was analyzed as a paired t-test. Kiwi enhanced steaks had lower shear force values (P=0.0008), more soluble collagen (P<0.0001), and less insoluble collagen (P<0.0001) when compared to water enhanced controls. Cook yield was similar (P=0.05) between kiwi and water enhanced semitendinosus steaks. The results indicate that kiwi fruit juice could be a valuable enhancement ingredient to solubilize collagen and increase the tenderness of semitendinosus steaks.

Keywords: Collagen, Enhancement, Tenderness

Clarified Noni juice spray was not successful as an antioxidant in beef loin steaks

Products of the Morinda citrifolia plant (commonly called Noni) have been shown to have countless antioxidant, immune-stimulating, and tumor-suppressing properties in medicine and have been used, especially in Southeast Asia, to remedy a wide variety of ailments from muscle sprains and headaches to diabetes and heart disease. Recently, Noni pulp has been successfully added to ground beef patties as an antioxidant to improve shelf-life and color during retail display. Clarified Noni juice is derived by removing the solids from Noni pulp and, to date, has not been tested in meat products. Thus, the objective of the current study was to determine the effects of a clarified Noni juice spray applied as an antioxidant to fresh beef loin steaks on color stability during retail display. Four beef strip loins (IMPS #180) were cut into 10 steaks, and steaks were randomly assigned to 1 of 5 Noni spray treatments (0, 12.5, 25, 50 or 75% clarified Noni juice mixed (v/v) in distilled water) prepared in conventional, garden-style spray bottles. Steaks were weighed and both sides were sprayed with three full sprays from the designated treatment. After a 5 min equilibration period on racks, steaks were weighed to calculate uptake, packaged on foam trays with PVC overwrap, and placed in simulated retail display (4 °C and 1600lx warm-white lighting) for 5 d. Visual color evaluation was determined by 8 experienced panelists who scored total color and worst-point color on 7-point scales and percent discoloration on an 8-point scale, whereas instrumental color (L°, a°, and b°) was evaluated using a Hunter MiniScan XE Plus. The 50% Noni treatment had the greatest (P<0.05) antioxidant solution uptake, and the 75% treatment had greater (P<0.05) uptake than the 0% control. Panelist scores for total color, worst-point color, and percent discoloration increased (P<0.05) as display duration increased, indicating that the panelists observed the steaks becoming less red and more discolored with time. Steaks treated with 75% Noni had the greatest (P<0.05) total color and worst-point color scores, indicating that they were the least red when evaluating the entire steak and the worst point of the steak. Steaks treated with 75% Noni were also evaluated as more discolored (P<0.05) than those steaks treated with 0, 12.5 or 25% Noni. As display duration increased, instrumental color evaluation indicated that steaks became darker, less red, and less yellow (decreased L°, a°, and b°, respectively; P<0.05). Steaks treated with 75% Noni were darker (P<0.05) than those treated with 12.5, 25, or 50% Noni, but those treated with 0% Noni were intermediate (P<0.05). Furthermore, steaks treated with 75% Noni were the least red (P<0.05) and least yellow (P<0.05), whereas other treatments were similar (P>0.05). These results indicated that clarified Noni spray was not an effective antioxidant in fresh beef loin steaks, but perhaps different applications of this natural antioxidant will be successful in the meat industry.

Keywords: Beef steaks, Noni, Color
Impact of rosemary and green tea extract on the color stability, flavor, and oxidative properties of enhanced beef steaks

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Steaks cut from fresh beef shoulder clods were enhanced with solutions containing sodium tripolyphosphate (STPP), sodium chloride, potassium lactate, and sodium diacetate in order to increase their palatability and delay microbial spoilage during refrigerated (2 °C) storage. All enhancement solutions (10% extension) contained STPP (0.4%), sodium chloride (0.6%), potassium lactate (1.5%), and sodium diacetate (0.1%), calculated based on the total product weight. The enhancement solution alone (control), was compared to the enhancement solutions with added rosemary extract (RE; 0.05% and 0.075%) or a blend of rosemary and green tea extracts (RGT; 0.05% and 0.075%) to determine the impact of RE and RGT on color stability, flavor, and thiobarbituric acid reactive substances (TBARS) during storage. Steaks were packaged in polystyrene trays with oxygen permeable over-wrap. Two replicates of each treatment (n = 2) were prepared. Multiple regression analysis and analysis of variance revealed that steaks treated with RE and RGT exhibited the highest (P < 0.01) a* values (redness) throughout the storage study, with all treatments showing higher (P < 0.05) a* values than the control on d 5 and 10. RE and RGT also had a positive effect on flavor attributes, with the RGT 0.075% preferred (P < 0.05) over the control on d 6 and 9, and the 0.075% RE and 0.05% RGT preferred (P < 0.05) over the control on d 9. The sensory results were in agreement with the TBARS, as all RE and RGT treatments had lower (P < 0.05) TBARS than the control on d 5 and 9. This study demonstrated that using rosemary extract or a blend of rosemary and green tea extracts had a positive impact on the color, flavor, and oxidative properties of refrigerated, enhanced beef steaks.

Keywords: Enhanced steaks, Green tea extract, Rosemary extract

Plant-based tannins as antioxidants in pre-cooked ground beef patties

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Lipid oxidation in meat causes negative quality effects, including warmed over flavor, especially in further processed products, such as ground beef. Butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and rosemary extract (RM) are common antioxidants used to control oxidation. Studies have shown that many plant-based tannin compounds have high antioxidant properties. The objective was to evaluate oxidation, pH, color, and sensory effects of BHA/BHT, RM, Chardonnay grapeseed (CG), Norton grapeseed (NG), chestnut wood (CN), mimosa bark (M), and quebracho wood (Q) powder addition to raw and pre-cooked ground beef patties stored aerobically from 0 to 5 days. Over 3 replications, 81% ground beef was mixed with no treatment (control), BHA/BHT (0.02%), RM (0.2%), NG (0.5%), or 0.25% or 0.5% CG, CN, M, or Q powders on meat weight basis. Raw and cooked patties were aerobically stored for 0, 1, 3, and 5 days at 4 °C. In duplicate, cooked patties were analyzed for lipid oxidation over storage days using the thiobarbituric acid reactive substances (TBARS) method developed by Tarladgis et al. (1960) as modified by Rheo (1978). Raw patties were analyzed for pH, instrumental color, subjective color, and ingredient specs. At d0, TBARS values for cooked ground beef control patties were slightly higher than those for treated patties (P < 0.005); With increased storage time, patties containing either 0.25 or 0.5% CN, M, and Q or 0.5% CG did not increase in TBARS values. Control patties increased (P < 0.0001) in TBARS values from 1.29 mg malonaldehyde/kg sample at d0 to 7.33 mg malonaldehyde/kg sample at d5. Ground beef patties with RM or BHA/BHT addition also had increased (P < 0.0001) TBARS values with storage (0.73 to 3.62 and 0.78 to 1.70 mg malonaldehyde/kg sample, respectively), but increases were not as extensive as reported for control patties. As ground beef patties containing 0.25% CN, M and Q powders did not increase in TBARS value with storage, lower levels may be effective in retarding oxidation. All treated patties showed antioxidant abilities that were similar to or better than RM or BHA/BHT. CG and CN treated raw patties had slightly lower (P < 0.05) pH than control patties, although the difference was less than 0.1 units. Treated 0.25% CG and 0.25% Q patties were similar (P < 0.05) in lightness to control patties, and remaining tannin-treated patties were darker. Treated CN, 0.5% NG, and 0.5% M patties were less red (P < 0.005) and patties containing CG, NG, or M were less yellow (P < 0.02) than control patties. For subjective color, control patties had less discoloration (P < 0.0001) than 0.5% CN patties. Percent brown discoloration was highest (P < 0.0001) in CN treated patties. Percent green discoloration was highest in control patties and much lower (P < 0.005) in patties containing other treatments. Ingredient specs were significantly visible in CG and NG treated patties. CN, M, Q, and CG powders were effective antioxidants in aerobically stored, cooked ground beef patties. Further research to verify the lowest levels for addition of CN, M, and Q powders is needed. In raw ground beef, discoloration often seemed to be the result of ingredient addition. As lower levels of green discoloration were reported in patties containing tannin treatments, it is possible that these treatments had an antimicrobial effect that needs to be investigated.

Keywords: Antioxidants, Lipid oxidation, Tannins

Development of a method to manufacture uncured, no-nitrate/nitrite added whole muscle jerky

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Increasing demand for natural and organic foods has resulted in the consumer availability of a wide variety of uncured, no-nitrate/nitrite-added processed meat and poultry products. Because of the importance of nitrite for quality and safety, these products are commonly manufactured to simulate typical curing. This unique process commonly referred to as “natural curing” is accomplished by use of vegetable juice powder high in naturally occurring nitrates combined with a nitrate reducing starter culture to result in indirectly “cured” products. Since the starter culture used is not water soluble, making “naturally cured” whole muscle jerky with current manufacturing techniques has been found ineffective. The objective of this study was to identify a “natural curing” process for whole muscle beef jerky providing cured meat characteristics similar to those of a nitrite-added control. Three jerky treatments (TRT) (TRT 1: NO-VAC + 40.6C-2HR; TRT 2: VAC + 40.6C-2HR; TRT 3: VAC + 5C-48HR) and a sodium nitrite-added control (C) were used for this study. TRT 1 consisted of tumbling the whole muscle strips for 20 min, placing on smokehouse racks, and incubating for 120 min at 40.6 °C with 90% humidity prior to thermal processing. TRT 2 consisted of tumbling for 20 min, vacuum packaging, and incubating for 120 min at 40.6 °C before removing from packaging and placing on smokehouse racks for thermal processing. TRT 3 consisted of tumbling for 20 min, vacuum packaging, and incubating at 5 °C for 48 hr before removing from packaging and placing on smokehouse racks for thermal processing. The sodium nitrite-added control (C) was tumbled for 20 min before being placed directly on smokehouse racks and thermally processed. The samples were evaluated for proximate composition, color, pigment content, residual nitrate and nitrite, and lipid oxidation...
over an extended storage time to determine if differences existed in finished jerky. TRTs 2 and 3 were found to be the least similar to the nitrite-added control with lower (P<0.05) concentrations of cured pigment and percentages of converted curing pigment. TRT 1 revealed significantly more (P<0.05) converted cured pigment than TRTs 2 and 3 but less (P<0.05) than C. For cured pigments, C had significantly higher (P<0.05) concentrations than all TRTs, indicating nitrate-to-nitrite conversion of all TRTs was not comparable to ingoing amounts of formulation nitrite in C. Also, TRT 1 showed higher (P<0.05) cured pigment concentrations than TRTs 2 and 3 on days 0, 28, and 56, indicating little nitrate-to-nitrite conversion occurred in the vacuum packaged treatments. Significantly higher (P<0.05) CIE a* values were shown for C compared to all other TRTs, indicating greater amounts of reddish-cured pigment. Overall, TRT 1 was found to exhibit some cured meat characteristics, while TRTs 2 and 3 were found to possess very little compared to C. Therefore, the processing methods investigated to manufacture “naturally cured” whole muscle jerky in this study were ineffective in resulting in products similar to those cured with sodium nitrite.

Keywords: Natural and organic, Uncured, Jerky

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Stabilization of myoglobin redox forms using glycolytic and mitochondrial metabolites

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Fresh meat color is determined predominantly by myoglobin concentration and redox form status. During the conversion of muscle to meat, the depletion of enzymatic activity and substrate availability also impact meat color stability. Reduced nicotinamide adenine dinucleotide (NADH), a substrate for myoglobin reductase activity (MRA) in meat, plays a vital role in enzymatic and nonenzymatic reduction of metmyoglobin (MMb). As NADH declines, so does MRA, which eventually leads to more MMb and less stable color. Malate dehydrogenase (MDH) is a ubiquitous enzyme in animal, plant, and microbial sources that has potential to generate NADH via a MDH–malate–NADH pathway, and MMb-reducing enzymes can use the resultant NADH to stabilize meat color. Experiments were conducted to (1) determine the influence of pH, temperature, NAD+, and malate (M) concentration on MDH-mediated MMb reduction kinetics in vitro; (2) investigate the reducing ability of compartmentalized MDH and lactic dehydrogenase (LDH) from mitochondria and cytoplasmic sources on MMb reduction; and (3) assess the effects of M, lactate (L), and pyruvate (P) alone or in combination on myoglobin redox stability during storage and display. A model system was developed to mimic the enzymatic reduction of MMb via MDH–M–NADH system. Experiment 1: Kinetic analyses showed that nonenzymatic reduction of MMb in a MDH–M–NADH in vitro system increased (P<0.05) as temperature, pH, and concentrations of NAD+ and l-malate increased. Experiment 2: Addition of M and L to isolated mitochondrial and cytoplasmic isolates at pH 7.2 increased (P<0.05) MMb reduction in vitro, which was equal to or greater than MMb reduction resulting from M alone. These results provide evidence that mitochondria and cytoplasmic proteins isolated from skeletal muscle differ in enzymatic composition and that enhancing muscle with specific substrates could improve meat color stability if substrates could be supplied to both enzyme compartments. Experiment 3: Eighteen combinations of M, L, and P were added at 1% and 2% to beef Longissimus lumborum, Psoas major, and Semitendinosus muscle homogenates to study their effects on MRA at 25 °C. Changes in surface color at 0, 2, 4, 8, and 12 h were evaluated using reflecto-spectrophotometry (both L*a*b* and wave-lengths specific for MMb). Addition of individual metabolites (M, L, or P) was more effective (P<0.05) at 2% than at 1% for retarding MMb formation. The order of MMb reduction at 2% inclusion was L–M–P in the Semitendinosus and M–L–P in the Psoas major and Longissimus lumborum muscles. MMb was reduced most effectively (P<0.05) with combinations of metabolites (M+L–M+P–L+P). Results from these experiments suggest that enhancement of meat with M, L, and P alone or in combination can effectively extend the color life of post-rigor meat by providing more reducing conditions for myoglobin, thus increasing myoglobin redox form stability. Reduction of MMb via MDH–NADH activity is a new mechanism for MMb reduction, and the apparent compartmentalization of MDH and/or LDH in mitochondrial and cytoplasmic fractions offers new insight into myoglobin redox chemistry.

Keywords: Lactate, Malate, Meat color, Myoglobin, Pyruvate

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Are three replications from a single lot adequate to assess antimicrobial efficacy?

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The microbiological safety of fresh eviscerated poultry has continued to be a major concern of the public and poultry industry due to the frequent foodborne illnesses caused by Salmonella spp. Numerous antimicrobial agents have been studied to determine their efficacy against pathogenic bacteria in model systems. Bacterial potential of weak organic acids is well documented; however, inconsistencies exist in the efficacy of antimicrobials among the studies. The skin attachment model (SAM) was used to evaluate a bactericidal potential of oxalic acid (OA) to eliminate Salmonella spp. from the surface of broiler chicken skin during simulated scalding (53 °C for 3, 2 and 1 min), chilling (3 °C for 60, 45 and 30 min), and post-chill dipping (22 °C for 40, 30, 20 and 10 sec) applications. To mimic natural variation that occurs in industry, chicken skins were collected at three different time periods (batch 1 (February, 2009), batch 2 (May, 2009), and batch 3 (August, 2009)). Treatment samples were stomached in buffered peptone water, serially diluted and plated on XLD agar using the thin agar layer technique for acid-injured cells. The results were compared to controls to determine log reduction and statistical significance. More significant variation in a mean Salmonella log reduction was observed among the three batches than the variation between each of three replications within each batch. Treatment with 0.5% OA applied at 53 °C for 3 min resulted in 3.46, 1.65, and 2.16 log reduction in batch 1, batch 2, and batch 3, respectively. The mean reduction in recoverable cells at chilling application at 60 min contact time was 3.33 log for batch 1, 1.22 log for batch 2, and 2.18 log for batch 3. When 2% OA applied at simulated 40 s post-chill dipping, Salmonella mean reduction for batch 1, batch 2, and batch 3 was 1.30, 0.87, and 1.19 log, respectively. The effect of contact time and OA concentration on Salmonella reduction was dependent on the batch (P<0.05). Various hypotheses were considered to explain the variation in a mean Salmonella log reduction among the batches including the effect of freezing, irradiation, age of broilers and chemical contamination. Scanning electron microscopy (SEM) was used to evaluate differences in skin morphology between batch 2 and batch 3. Variation in water temperature during conventional scalding operation may impact the thickness of lost epidermis and influence the bacterial attachment, as well as cause entrapment of the cells in channels and crevices of the revealed skin layer where bacteria would be protected from antimicrobial agent action. Variation in antimicrobial log reduction among the different chicken skin batches
Validation of beefxide on the reduction of Salmonella and Escherichia coli O157:H7 on a beef carcasses calf model
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Introduction: Lactic acid sprays are currently used as a beef safety intervention throughout the beef processing industry. Beefxide, a blend of lactic and citric acids, is a new antimicrobial approved by the USDA for application to beef carcasses. Purpose: The purpose of this study was to validate Beefxide as a food safety intervention for Salmonella and Escherichia coli O157:H7 on calf carcasses. Methods: The study is a completely randomized design, replicated three times. For each replication, 4 calves aged 1 to 10 days were used. The calves were purchased, transported to the Texas Tech University G.W. Davis Meat Laboratory, and harvested under humane and sanitary conditions. Hot carcasses were then transported to the Pathogen Processing Laboratory for microbiological testing. Carcass halves were dipped in a cocktail mixture of E. coli O157:H7 or Salmonella (with the exception of one carcass, which served as a negative control) and held for 30 min to allow for attachment. The sides were randomly assigned to one of the following treatments: 1) negative control (no inoculation or treatment); 2) positive control (inoculated but no treatment); 3) Beefxide (135–145 °F); or 4) sterile water (135–145 °F). Carcasses were sampled 1 min and 1 h after treatment. Sampling included four 100 cm² areas of the carcass using sterile SpongeSicles® and templates. The total Salmonella and E. coli O157:H7 present were determined by making serial dilutions and plating onto XLD agar and templates. The total Salmonella and E. coli O157:H7 present were determined by making serial dilutions and plating onto XLD agar and templates.

Results: Overall for Salmonella, significant differences were observed among treatments, with significant reductions observed on the Beefxide-treated carcasses (P<0.05). 60 min after treatment significant differences were observed between the positive control and Beefxide treatments (P=0.03). Overall for E. coli O157:H7, significant differences were seen between treatments (P<0.05). One minute after application Beefxide presented significant reductions of E. coli O157:H7 when compared to the water and the positive control (P<0.05). At the 60-min sampling point, significant differences were observed between treatments, with the Beefxide spray showing the largest reduction (P<0.05). Significance: Application of Beefxide is an effective intervention to reduce both E. coli O157:H7 and Salmonella on beef carcasses.

Keywords: E. coli O157:H7, Salmonella, Validation

In-plant validation of hot water wash and lactic acid as interventions to control microbial pathogens in beef carcasses as part of a HACCP reassessment plan

As established by the Code of Federal Regulations [CFR, Title 9, 417.4 (a) (1)] under the Federal Meat Inspection Act, every meat processing establishment shall validate and verify the adequacy of its HACCP plan in controlling hazards. Establishments use scientific literature to support their decisions, but concrete evidence under the actual operating conditions of the plant must be generated during the reassessment to establish the validity of the Critical Control Points (CCP) in their HACCP system, otherwise the CCP would be considered by the FSIS as theoretical and not validated. The objective of this study was to validate, during processing inside a harvest facility, the effectiveness of a lactic acid spray and a hot water wash when applied

Keywords: Antibiotic resistance, Cattle, Salmonella

Comparison of antibiotic resistance profiles of cattle associated Salmonella serotypes in United States and Mexico
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Salmonellosis is one of the leading causes of food borne illness contributing to 1.4 million estimated illnesses and 400 deaths annually in the United States. Antibiotic resistant (AR) Salmonella infections are increasing and account for 20–30% of the Salmonella isolated from infected humans. In addition to the U.S., developing countries carry a burden of Salmonellosis, especially in children from age 1–4. Antimicrobial drug resistance increases morbidity and mortality and costs associated with disease; therefore, it has been recognized as a major emerging problem by the World Health Organization (WHO). While integrated surveillance systems and comparison between countries is essential, little research has been done to compare the Salmonella serotypes and its AR profiles across nations; thus investigating patterns in Mexico and other countries could give insight into factors contributing to the emergence of resistance and meat safety. The objective of this study was to determine and compare antibiotic resistance profiles of prominent Salmonella serotypes, of isolates from U.S. and Mexican cattle and retail beef samples. A total of 413 Salmonella isolates from the U.S. and 183 Salmonella isolates from Mexico were collected and serotyped from a dairy, feedlot, at an abattoir (hide, fecal grab, carcass at pre-evisceration and in cooler) and retail outlets. Serotyping uses independent agglutination assays with antisera to react with the antigens to detect O and H antigens. National Antibiotic Resistance Monitoring System (NARMS) antibiotic testing was used. Minimum inhibitory concentrations (MIC) were determined using sensitive broth micro dilution technique. Descriptive statistics were generated using various procedures in Statistical Analysis Software (SAS). The most common resistance was to sulfoxazole in all U.S. and Mexico isolates. The Multidrug Resistance (MDR) patterns ACSSuT and MDR-AmpC were exhibited in 5.8% and 4.6% of all the U.S. isolates and none of the Mexico isolates. The percentage of isolates resistant to at least one antimicrobial drug is higher in Mexico (95.6%) compared to the US (46.5%). However, the resistance exhibited in Mexico isolates is limited to few antimicrobials compared to the US isolates which were resistant to a wider variety of antibiotics. This might be due to broad therapeutic and sub-therapeutic usage of antimicrobials for intensive food production in the United States and more concentrated use of antibiotics of smaller spectrum in Mexico. This study also indicates intensive usage of the two drugs sulfoxazole, tetracycline or related drugs in food animal farming in Mexico. Results from the present study indicate that cattle associated serotypes are very infrequently linked with human associated Salmonella serotypes and illnesses in the U.S. where as in Mexico, retail beef serotypes were associated with human associated serotypes which may indicate human transmission at the retail level. This study will help to identify areas where improvement of current processes and sanitation procedures are required. Overall, prudent use of antibiotics is essential in both countries, and more stringent record keeping on their use is suggested.

Keywords: Oxalic acid, Poultry, Salmonella

emphasizes the importance of collecting samples from different flocks, days, and seasons for testing antimicrobial agents. This would best simulate the natural variation that occurs within industry and more accurately assess the potential reduction range of antimicrobials while decreasing inconsistency among the studies.

Keywords: Oxalate, Poultry, Salmonella
to carcasses as two different interventions. In a beef processing facility, swab samples were collected randomly during a period of 3 weeks during the summer of 2009. Each week a total of 60 different carcass samples, 30 before and 30 after the application of the interventions, each obtained from an area measuring 1000 cm², were collected using aseptic techniques. The swabs were collected during the course of a processing day, that included the morning, midday, and evening shifts. The swabs were shipped overnight to the Texas Tech University Food Microbiology Laboratory under refrigerated conditions and tested within 24 h for generic E. coli, coliforms, and total plate counts (TPC) using standard microbiological methods. Microbial counts were transformed into log CFU per swab allowing control and stabilization of statistical variance and fulfillment of the requirements for normality prior to the analysis. All data were imported into a commercially available software package and analyzed using the proc ANOVA procedure in the Statistical Analysis System (SAS) 9.1.3 software. In all tests, the significance level was set at α = 0.05. Carcasses subjected to a hot water wash had a significant (P<0.0001) microbial reduction after the intervention. Coliforms and generic E. coli counts were reduced from 2.67 to 1.67 logs and from 2.66 to 1.31 logs, respectively. Total plate counts also were reduced from 5.53 to 3.63 logs (approximately 1.9 logs) after treatment with 2.66 to 1.31 logs, respectively. Total plate counts also were reduced from 2.60 to 1.60, 2.43 to 1.32, and 5.12 to 3.42 logs, respectively. This study validates the application of lactic acid and hot water sprays under industry conditions at this harvest facility as an effective intervention of sub-primal beef and pork subprimals and trimmings during carcass fabrication is destined for human consumption. Processors can use similar in-plant studies and conditions to ensure effectiveness and support CCP decision-making and as a reassessment of their HACCP plan as mandated by the USDA-FSIS.

Keywords: HACCP reassessment, In-plant validation, Lactic acid intervention

In-plant validation of the use of lactic acid spray as an intervention to control microbial loads in beef subprimals during a HACCP plan reassessment


The application of lactic acid solutions between 2 and 5 percent to beef and pork subprimals and trimmings during carcass fabrication is considered by the Food Safety and Inspection Service (FSIS) under Directive 7120.1 to be a safe and suitable action that can be used in the production of meat and poultry products. Due to the demonstrated effectiveness of lactic acid sprays to reduce pathogens in beef and pork carcasses, its use in subprimals during fabrication has increased recently by processors nationwide. As part of an annual HACCP reassessment in a beef processing facility as established by the Code of Federal Regulations [CFR, Title 9, 417.4 (a) (1)], packers must determine if the application of lactic acid to subprimals at a critical control point (CCP) is functioning as intended. The objective of this study was to validate, under the actual operating conditions inside a slaughter and processing facility, the effectiveness of a lactic acid spray when applied to different subprimals and environmental surfaces. In a beef processing facility, trim samples were collected randomly using the N=60 method before and after the application of lactic acid during the course of a processing day that included the morning, midday, and evening shifts. Trim samples included inside round, flat round, short loin, chuck roll, and ribs. Additionally, the surface of 2 different conveyor belts were tested with the sprayer turned on or off. At the end of the processing day, the samples were shipped overnight to the Texas Tech University Food Microbiology Laboratory under refrigerated conditions and tested within 24 h for generic E. coli, coliforms, and total plate counts (TPC) using standard microbiological methods. Microbial counts were transformed into log CFU per swab allowing control and stabilization of statistical variance and fulfillment of the requirements for normality prior to the analysis. All data were imported into a commercially available software package and analyzed using the proc ANOVA procedure in the Statistical Analysis System (SAS) 9.1.3 software. In all tests, the significance level was set at α = 0.05. Of all the subprimals and belts tested, only the short loins and the ribs presented significant (P<0.05) reductions in the number of coliforms. No significant reductions in the numbers of generic E. coli were observed in this study. The flat round, short loin, chuck roll, and ribs presented significant reductions in the TPC ranging from 1.7 to 3.5 logs CFU/100 cm² (P<0.05). Application of lactic acid sprays to different subprimals as interventions resulted in different degrees of effectiveness. Significant reductions in the TPC were observed for most of the subprimals, however, the coliforms presented significant reductions only in the short loins and chuck roll. No significant reductions were observed for generic E. coli in any of the cuts indicating the need for (i) another indicator if this microorganism is used as a pathogen surrogate and/or (ii) the need to reevaluate the number of nozzles and their positions in the spray cabinet in order to guarantee a more uniform distribution of the lactic acid intervention.

Keywords: HACCP reassessment, In-plant validation, Lactic acid spray intervention

Evaluation of commercially available compounds for antimicrobial intervention of sub-primal beef and pork

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Studies that compare and characterize bacterial reductions on sub-primal beef and pork using commercially available antimicrobial chemicals would be useful in the preliminary validation of critical control points within HACCP systems. The objective of this study was to compare the bacterial reductions caused by application of antimicrobial interventions via a spray cabinet at parameters applicable to industry. A five-strain cocktail of nonpathogenic Escherichia coli biotype 1 (BAA-1427, BAA-1428, BAA-1429, BAA-1430, and BAA-1431) surrogates for E. coli O157:H7 and Salmonella Typhimurium were used to inoculate 6 log CFU/cm² onto 100 cm² of trimmed whole muscle sections of beef brisket and 100 cm² of trimmed sections of pork Boston butt. Each inoculated sample was treated with either 180 or 220 ppm Blitz, 100 or 220 ppm Ispex 200, 2.0 or 5.0% lactic acid (LA), pH = 1.2 aqueous solution of SYNTrx 3300 (≥3%), or water. Treatments were administered via a commercial spray cabinet (Custom Built, Chad Co, Olathe, KS) at two pressures (1.03 and 4.83 bar), and two rates of application [0.227 and 6.624 liters per minute (lpm)] to replicate commercial practices for the use of these chemicals. Total plate counts (TPC) and total coliform counts (TCC) were enumerated on Difco Tryptic Soy Agar and Difco Violet Red Bile Agar with 4-methylumbelliferyl-β-D-glucuronide. Two samples were analyzed in three complete replicates; statistical analysis was performed using the PROC GLM and
Validation of a peracetic acid based direct food contact sanitizer for the reduction of *Escherichia coli* O157:H7 and *Salmonella* spp. on beef sub-primal and carcass tissues

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Organic acids, such as peracetic acid, may be used as interventions in the beef industry to reduce enteric food-borne pathogens and enhance the safety of the fresh product. The purpose of this study was to validate the pathogen reduction efficacy of a novel peracetic acid based direct food contact sanitizer on beef sub-primal and carcass tissues. Two separate studies were completed for the validation. Fresh beef tri-tips were separated and dip inoculated with either *Escherichia coli* O157:H7 or *Salmonella* spp. cocktails at a tissue target concentration of 6 log CFU/100cm² followed by a 30 min attachment period at 5 °C. Inoculated pieces were subjected to treatment in an industrial spray cabinet with either sterile water or a dilution of the sanitizer formulation containing 180 ppm peracetic acid followed by 6.62 lpm compared to 0.23 lpm. No difference ($P \geq 0.05$) in TPC or TCC reductions due to the rate of application were observed with SYNTRx 3300 or water. Based on these results, SYNTRx 3300 (optimal application — 1.03 bar and 0.23 lpm) was more effective compared to Blitz (optimal application — 1.03 bar, 0.23 lpm, 180 ppm) and LA (optimal application — 1.03 bar, 6.62 lpm, 5.0%).

Keywords: Beef, Pathogen intervention, Pork

Controlling *Listeria monocytogenes* in natural and organic, ready-to-eat meat and poultry products

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In recent years, there has been a substantial increase in the demand for both natural and organic ready-to-eat meat and poultry products. These products contain no added sodium nitrite, which has demonstrated antilisterial activity. As a result, additional antimicrobial ingredients need to be identified to ensure the safety of these products during extended refrigerated storage. The purpose of this study was to 1) screen a variety of natural ingredients for antilisterial activity and 2) validate the antilisterial activity of three natural antimicrobial systems found most effective in naturally cured ham, uncured roast beef, and uncured deli-style turkey breast. Turkey slurries (25% ground turkey breast meat, 2.0% salt, final pH 5.8-6.0) were prepared and included the following treatments: 1) uncured, 2) traditionally cured with 156 ppm sodium nitrite, 3) indirectly cured using celery powder and a nitrate-reducing *Staphylococcus carnosus*, and 4) indirectly cured using a pre-converted celery-powder as a natural nitrite source. Treatments ($n=4$) were supplemented with 15 different ingredients, including natural flavorings, plant extracts, and microbial fermentation byproducts. Cooked slurries were inoculated with 3-log CFU/g *Listeria monocytogenes* (LM) and stored at 4 °C for 4 weeks. LM was enumerated weekly in duplicate samples on Modified Oxford agar. The three most successful ingredients, 1.5% lemon/cherry/vinegar blend, 2.5% buffered vinegar, 3.0% cultured cane sugar/vinegar blend, were incorporated into naturally cured ham, uncured roast beef, and uncured deli-style turkey breast. Controls included naturally cured ham, roast beef, and deli-style turkey breast without antimicrobials and a nitrite cured ham with 2.8% lactate/diacetate. Cooked, sliced product was inoculated with 3-log CFU/g of a 5-strain mixture of LM, vacuum packaged, and stored at 4 °C for up to 8 weeks. LM was enumerated in triplicate samples at 0, 2, 4, 6, and 8 weeks. A 2-log CFU/g increase in LM was observed for ham and turkey without antimicrobials at 2 weeks of storage and at 4 weeks for beef without antimicrobials. Growth ($\geq$1-log increase) in the traditionally cured ham with lactate/diacetate was delayed until week 6 of sampling. Each of the three antimicrobials delayed ($P \geq 0.05$) growth of LM compared to the no antimicrobial containing controls.
Compared to the control, the addition of either 1.5% lemon/cherry/ 
vinegar blend or 2.5% buffered vinegar delayed growth for an 
additional 2 weeks while the addition of 3.0% cultured cane sugar/ 
vinegar blend delayed growth for an additional 4 weeks for both ham 
and turkey. The greatest delay was observed (P<0.05) in beef 
products containing any of the three antimicrobials, with no LM 
growth detected through 6 weeks at 4 °C for all the treatments. In 
addition to the effect of the antimicrobials, delay in the growth of LM 
may also be attributed to differences in product moisture and pH. 
Ham averaged 70% moisture and pH 6.3, turkey 73% moisture and pH 
6.2, beef 66% moisture and pH 5.8. These data suggest that natural 
antimicrobials can enhance the safety of natural and organic ready-to- 
eat meat and poultry products, but their efficacy is enhanced in the 
presence of nitrite and in products with lower moisture and pH.

Keywords: Antimicrobials, Listeria monocytogenes, Natural, Organic

Use of natural antimicrobials to improve the control of Listeria monocytogenes in a model cured meat system
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Growing concern among consumers about nitrite in processed 
meats has created demand for natural products without preservatives. In order to meet demand for what are labeled as “uncured” products 
while retaining typical cured meat properties, processors have begun 
manufacturing these products by adding natural ingredients, usually 
vegetable powder, that are high in nitrate. Bacterial reduction of 
nitrate provides the nitrite required for a typical curing reaction. 
However, in this case, there is less control of the amount of nitrite. Due 
to the regulatory requirement that no direct addition of nitrate or 
nitrite is permitted, increased growth of foodborne pathogens is 
likely. Because of this concern, several commercial brands of meat 
products (frankfurters, hams, bacon) manufactured without direct 
addition of nitrate or nitrite were challenged with inoculations of 
Clostridium perfringens and Listeria monocytogenes to assess pathogen 
growth (A. Jackson, K. Schrader, unpublished data). Reduced CP and 
LM inhibition (P<0.05) were observed in the majority of the 
commercial uncured meat products when compared to controls 
with sodium nitrite directly added. Because of the natural label 
requirements, the most feasible options to improve the safety of these 
products are increasing the effectiveness of nitrate and/or adding 
natural antimicrobials. To evaluate potential inhibitory effects on LM, 
several antimicrobials alone and in combination were studied in a 
model meat system. The treatments included addition of sodium 
lactate, sodium diacetate, cherry, lemon, lime, cranberry powder and 
grape seed extract. The meat model system was composed of 80:20 lean: fat 
lean: fat boneless pork, 2% salt, 10% water, 150 or 50 ppm ingoing 
nitrite and selected antimicrobials. The meat was placed in beakers 
and cooked to an internal temperature of 71 °C. A 5-strain mixed 
nitrite and selected antimicrobials. The meat was placed in beakers 
in a model cured meat system

4.6 log CFU/g after 4.6 h of drying. Temperatures peaked at 55.6 °C and 62.2 °C in the 3 T and 5 T dehydrators, 
respectively, after 4 h of drying and maintained these temperatures 
until the end of processing. Initial Salmonella populations were 
approximately 7.3 CFU/cm². Samples were taken from the top, 
middle, and bottom trays after 3 and 6 h of drying. Salmonella log 
reductions were similar for 3 T and 5 T dehydrators and were 
1.5 CFU/cm² after 3 h and 3.2 CFU/cm² after 6 h. There was a main 
effect (P<0.05) on Salmonella reduction due to sample location. 
Samples taken from the bottom tray had a 4 log CFU/cm² 
Salmonella reduction while samples taken from the top and middle 
trays had 4.1 and 3.9 log CFU/cm² reductions, respectively. This 
could possibly be due to evaporative cooling from the water placed 
in a dish immediately below the bottom tray or the air flow pattern 
in the dehydrators. The water activity after 6 h drying was 0.77 
regardless of tray location or dehydrator (P>0.05). When whole 
muscle chicken was dried using home-style dehydrators, increasing 
chicken dehydrator load (3 T vs 5 T) did not significantly increase 
RH or achieve greater Salmonella log reductions. Tray location, 
however, had a significant impact on Salmonella log reduction. 
Furthermore, home-style dehydrators do not provide adequate 
lethality to reduce Salmonella on whole-muscle chicken when 
chamber temperatures were below 62.2 °C with a peak RH of 31% 
followed by a RH level of less than 16% for the remainder of the 
drying process.

Keywords: Home-style dehydrators, Salmonella, Whole-muscle chicken

Efficacy of home-style dehydrators for controlling Salmonella on 
whole-muscle chicken
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Home-style dehydrators commonly used by consumers to dry 
meat products have limited relative humidity (RH) and temperature 
control. To evaluate impact of dehydrator load on RH and 
temperature for reducing Salmonella on whole-muscle chicken, 
locally obtained retail boneless, skinless chicken breasts were rolled 
to a 1 mm thickness, cut into 6 x 6 cm² samples, and inoculated with 
a 5-strain Salmonella cocktail or sterile tryptic soy broth (control). 
After air drying for 15 min, six control and six inoculated chicken 
pieces were placed on each tray of either a 3-tray (3 T) or 5-tray 
(5 T) home-style dehydrator. Water was placed in a dish at the 
bottom of each dehydrator to increase the RH above 10%. Data 
loggers recorded chamber temperature and RH. Preliminary re-
search showed that an end target water activity of below 0.85 would 
be reached by drying chicken for 6 h. There was no difference 
(P>0.05) in RH or temperature between the 3 T and 5 T dehydrators. 
Relative humidity peaked at the beginning of processing at 31 and 
25% in the 3 T and 5 T dehydrators, respectively, and gradually 
deceased to approximately 8.5% after 6 h of drying. Temperatures 
peaked at 55.6 °C and 62.2 °C in the 3 T and 5 T dehydrators, 
respectively, after 4 h of drying and maintained these temperatures 
until the end of processing. Initial Salmonella populations were 
approximately 7.3 CFU/cm². Samples were taken from the top, 
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in a dish immediately below the bottom tray or the air flow pattern 
in the dehydrators. The water activity after 6 h drying was 0.77 
regardless of tray location or dehydrator (P>0.05). When whole 
muscle chicken was dried using home-style dehydrators, increasing 
chicken dehydrator load (3 T vs 5 T) did not significantly increase 
RH or achieve greater Salmonella log reductions. Tray location, 
however, had a significant impact on Salmonella log reduction. 
Furthermore, home-style dehydrators do not provide adequate 
lethality to reduce Salmonella on whole-muscle chicken when 
chamber temperatures were below 62.2 °C with a peak RH of 31% 
followed by a RH level of less than 16% for the remainder of the 
drying process.

Keywords: Home-style dehydrators, Salmonella, Whole-muscle chicken
Comparison of commercially available uncured processed meats with conventionally cured products for physio-chemical properties that affect bacterial growth

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Natural or organic uncured processed meats have undergone tremendous market growth. Many of these products utilize alternative ingredients and processing steps to achieve cured meat characteristics without the direct addition of sodium nitrite. The objective of this study was to evaluate commercially available no-nitrite-or-nitrate added processed meat in comparison with traditionally cured products for their physio-chemical characteristics. In joint studies, frankfurters (n = 12, 2 controls), ham (n = 11, 4 controls) and bacon (n = 10, 1 control) were purchased and paired samples from the same lot code were used for physio-chemical analysis and challenged with *Clostridium perfringens* during 10 days of storage at room temperature. Samples were measured for residual nitrite (NO₂⁻), residual nitrate (NO₃⁻), pH and water activity (aw) on days 0, 4, and 10. On day 0 samples were also analyzed for salt, total (TOTAL), cured pigment (CURED) and percent cured pigment (%CP), moisture, fat, protein, and CIE L*, a*, and b* values. Three replicates were conducted. Similarly, frankfurters (n = 10, 2 controls) and ham (n = 8, 4 controls) were purchased and paired samples evaluated for physiochemical traits and challenged with *Listeria monocytogenes* during 35 days of storage at 10 °C. Samples were evaluated for NO₂⁻, NO₃⁻, aw on days 0, 7, 14, 21, 28, and 35, and for NO₃⁻ on days 0, 14, and 35. On day 0, samples were analyzed for all other traits as stated above. Two replicates were conducted. Physiochemical data from the two experiments were combined for each product prior to analysis. Statistical analysis was conducted using Proc GLM of SAS on each product for brand, day and brand by day interactions. Means separation was conducted using the least significant different. For frankfurters, significant brand differences (P < 0.05) were found for NO₂⁻, NO₃⁻, aw, salt, TOTAL, CURED, %CP, moisture, fat, protein, L*, a*, and b* values. Also, aw had significantly (P < 0.05) day effects and p (P < 0.05) had a significant day by brand interaction. Nitrite concentration (1.2–59.7 ppm) in frankfurters varied widely with three brands greater and one less than either control. Nitrate concentrations (7.3–55.2 ppm) also varied greatly. Salt concentrations ranged from 1.5 to 2.5% with 6 brands significantly lower than either control. Control brands had the lowest moisture and protein, and highest fat content. Similar trends were found for ham and bacon samples but these products had greater variability than the frankfurters. Wide ranges of values for the physiochemical characteristics of natural and organic products were found and many of these products had physio-chemical profiles including NO₂⁻, aw, salt, pH and proximate composition that allowed a faster rate of microbial growth. This could result in a shorter shelf life and greater possibility for food-borne illness outbreaks. Strong safety precautions must be taken during the production, storage and distribution of these products.

Keywords: Cured meats, No-nitrite added, Physio-chemical properties

Survival of *Escherichia coli* O157:H7 during frozen storage and subsequent cooking of beef steaks moisture-enhanced with different brining formulations

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Ingredients used in brining formulations may interfere with thermal inactivation of *Escherichia coli* O157:H7 that has become internalized in beef products during moisture enhancement processes. This study evaluated survival of *E. coli* O157:H7 during frozen storage and subsequent cooking to 60 °C, using three cooking methods, of restructured beef steaks moisture-enhanced with four different brining formulations. Coarse-ground beef (95% lean) was inoculated (6 log CFU/g) with rifampicin-resistant *E. coli* O157:H7 (strain composite) and then mixed with one of the following brine treatments, with a total of 10% water added: sodium chloride (NaCl, 0.5%) + sodium tripolyphosphate (STP, 0.25%), NaCl + STP + cetylpyridinium chloride (CPC, 0.2%), NaCl + STP + lactic acid (0.3%), or NaCl + STP + sodium metasilicate (0.2%). Inoculated and treated meat was prepared into steaks (2.5 cm thick), vacuum-packaged and stored at −20 °C (30 days). On day-0 and -30, steaks were cooked to 60 °C by pan-broiling (Presto®electric skillet), double pan-broiling (George Foreman grill) or roasting (Magic Chef standard kitchen oven). Uncooked and cooked steaks were analyzed (two replications, three samples/treatment/replication) for total bacterial and *E. coli* O157:H7 populations. Data (log CFU/g) were statistically analyzed using the GLMMIX procedure of SAS and least square means were separated using Duncan’s test (P < 0.05). Pathogen counts of steaks stored at −20 °C (30 days) were 0.6 log CFU/g lower (P < 0.05) than those of day-0 samples. CPC-treated samples had 0.7–0.9 log CFU/g lower (P < 0.05) counts compared to all other tested brine formulations. Extent of thermal inactivation of *E. coli* O157:H7 decreased in order of: double pan-broiling=pan-broiling=roasting, with reductions of 3.4, 1.4 and 1.6 log CFU/g, respectively. The time taken for steaks to reach the target internal temperature decreased in order of: roasted (23.3–27.5 min) > pan-broiling (14.5–25.0 min) > double pan-broiling (4.2–6.4 min). Results of this study should be useful for developing recommendations of time and temperature combinations needed to enhance the safety of moisture-enhanced restructured beef steaks cooked by pan-broiling, double pan-broiling or roasting.

Keywords: *Escherichia coli* O157:H7, Moisture enhancement, Thermal inactivation

Safety aspects of a bacteriogenic starter culture *Pediococcus acidilactici* MXVK133 isolated from mexican traditional chorizo


*Pediococcus acidilactici* is a lactic acid bacteria (LAB) widely used as starter culture to improve safety and organoleptic properties of fermented meat products. The studied strain was isolated from a traditional fermented meat, and produces a bacteriocin with high anti-Listeria activity. Recently, some studies have demonstrated that some bacteria, including LAB, may act as reservoirs for antibiotic resistance genes, as well as, for virulence determinants such as cytolsin (*cryMBA*), aggregation substance (agg), gelatinase (*gelE*) and protein involved in immune evasion (esp), among others. Those virulence factors might be transferred to gastrointestinal strains or even to pathogens. Additionally, fermented sausages might contain high amounts of biogenic amines (BA), derived from microbial amino decarboxylase activity; ingestion of high quantities of BA could be a potential risk for human health due to their toxicological effects. The aim of this work was to evaluate the presence of virulence factors and decarboxylase activity of *Pediococcus acidilactici* MXVK133 in order to ensure the use of this bacterium as starter for fermented meats. Antibiotic susceptibility was tested on Mueller-Hinton-agar by the disk diffusion method using BBL-Sensi-Disc (penicillin (10 UI), erythromycin (15 μg), cloxacillin (1 μg)).
Antibiotic susceptibility data was analyzed by the paired-t test. P. acidilactici was sensitive (P<0.001) to the tested antibiotics; except for tetracycline and vancomycin (P>0.001). Amplified fragments were visualized using agarose gel electrophoresis 0.8%. Genes agg, gelE, cyIMBA, cpl, cob and esp associated to pathogenicity were not detected for P. acidilactici or the probiotic strain; although both strains showed a positive amplification for the sex pheromone ccf gen, that has been also reported for other LAB. Finally, the test for BA was negative; indicating that P. acidilactici does not synthesize amino decarboxylases under the tested conditions. Therefore, P. acidilactici MXVK133 did not show either virulence determinants or production of BA. The resistance presented to antibiotics might be a limiting factor for its possible use as meat starter; thus further studies are needed in order to avoid the possible transfer of resistance genes to other microorganisms.

Keywords: Meat safety, P. acidilactici, Starter culture

Photonic growth patterns of biophotonic E. coli O157:H7 transformed with two unique plasmids to develop a novel real-time postharvest validation model

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This study was developed to help understand the photonic growth properties of transformed biophotonic E. coli O157:H7 for use in biophotonic in vivo tracking/monitoring and pathogen reduction intervention and validation programs for the meat industry. The objective of this trial was to evaluate the photonic growth pattern of E. coli O157:H7 transformed with two unique photonic plasmids (XEN-14 transposon and pAK1-lux). Both bioluminescent plasmids have antibiotic-resistant genes inserted into the cassette fragment to provide selective pressure: XEN-14 has a gene for kanamycin (KAN) and pAK1-lux has a gene for ampicillin (AMP). For both plasmids, 1 ml of overnight culture was placed into four flasks containing 224 ml of broth. For the XEN-14 plasmid, 2 flasks contained Tryptic Soy (TS) broth and 2 flasks contained TS + KAN broth (30 pg/ml of KAN). For pAK1-lux plasmid, 2 flasks contained TS broth and 2 contained TS + AMP broth (50 mg/ml of AMP). Cultures were incubated in an orbital shaker at 37°C for a period of 14 h. Over the 14 h incubation period, aliquots were sampled every 0.5 h for 4 h and then every 2 h subsequently thereafter. Aliquots (100 μl) were analyzed for OD (600 nm). Additional aliquots were placed in a black 96-well plate (100 μl; n = 8 replicates per culture) and imaged using Stanford Biophotonic imaging system. After imaging, each well was serially diluted in 900 μl of TS, TS + KAN, or TS + AMP and plated on TS, TS + AMP, or TS + KAN agar (corresponding to respective broth flask). Plates were incubated for 12 h, after which total CFU were determined and then emitting CFU and relative light units per (RLU) sec were determined using the Berthold Night Owl imaging system. For XEN-14, there was no difference (P>0.05) for total CFU or emitting CFU between TS or TS + KAN cultures, and maximum growth was achieved at approximately 3.5 h (8.93 and 8.83 log CFU/ml for TS and TS + KAN, respectively). There was no difference (P>0.05) in RLU/s between TS and TS + KAN cultures. For pAK1-lux, there was no difference (P>0.05) for total CFU and emitting CFU up to 2.5 h. However, at hours 3–14 total CFU and emitting CFU for TS were greater (P<0.01) compared to TS + AMP, with maximum growth occurring at 3.5 h (8.78 and 8.12 log CFU/ml for TS and TS + AMP, respectively). There was no difference (P>0.05) in RLU/s between the two cultures (TS and TS + AMP) for the duration of the incubation period. These data characterize the photonic growth pattern for E. coli O157:H7 transformed with the XEN-14 and pAK1-lux. Biophotonic E. coli O157:H7 holds enormous potential for a better understanding of E.coli O157:H7 colonization in vivo and microbial ecology. This study provides foundational knowledge of biophotonic E. coli O157:H7 growth patterns, as well as, a real-time model for validation of current and future novel post-harvest pathogen reduction interventions within the meat industry.

Keywords: Biophotonic, E. coli, Food safety

Expanding meat science extension education with social media tools

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Social media (SM) expands direct exchanges between two parties from one-to-one to one-to-many by essentially presenting all of a given dialogue to any web user, thereby generating the potential for a variety of discussions and educational opportunities. Extension educators may choose SM as an educational tool for many reasons, including: (1) it essentially removes the expenses of travel, postage, and printing associated with traditional Extension programs, (2) it expands outreach to “new” audiences that may not otherwise engage in Extension programs, and (3) provides the opportunity for Extension personnel to provide real-time information about current events that pertain to meat science. The use of two SM tools, blogging and Twitter, as it pertains to meat science Extension education has been explored and the potential for impact is presented. In June 2009, a blog about meat science and muscle foods was developed as a means to post articles written explicitly to answer, or post articles related to, questions about meat, including meat quality, safety, environmental impact, and healthfulness. From June 2009 through March 2010, the blog has received >16,000 reads, has been accessed via connections in >70 countries, and evidence for translation into >6 languages has been accessed. There is worldwide interest in information that can be provided through meat science Extension. While blogging allows for the distribution of articles, Twitter posts feature <140 characters and operate much more conversationally than blog posts. The potential reach of a post is nearly exponential and related to the size of the various user networks involved. For example, one user’s message may be repeated to 100 users, and each of those may repeat it to different 100 users and thus, 10,000 users will have received the message originating from any given user. Using analytical tool tweetreach.com, the potential reach of messages associated with an individual Twitter account was assessed on 15 different days in January and February 2010. The maximum number different Twitter users reached during one assessment was 26,542, and the minimum was 5234 users. The average number of different users reached per evaluation period (3–7 days) was 12,774. There are livestock producers, meat processors, food retailers, chefs, barbecue enthusiasts, and food processors, food retailers, chefs, barbecue enthusiasts, and food
Develop and implement food safety instruction for Spanish speakers for the safe manufacture of jerky
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Jerky is a product usually made by salting and drying, which is relatively simple and inexpensive to produce (Yang and others 2009). Although jerky typically has a low water activity, pathogens such as Salmonella can survive the dehydration process if there is not sufficient humidity. Quinton and others (1997) showed that high Aw and fat content in jerky could allow the growth of several pathogenic microorganisms. For this reason, several outbreaks of Foodborne illness over the past few years in the State of New Mexico has required the involvement of the USDA-FSIS inspection to improve food safety through educational programs (USDA-FSIS 1996). Training in food safety via programs, workshops and videos must be available in Spanish because 42% of the population in New Mexico is Spanish-speaking (U.S. Census Bureau 2009). Providing education in Spanish will improve the efficiency of workers, allowing them to learn the correct process

Keywords: Academic institutions, Latin America, Research areas
affecting the final product. Therefore, developing and presenting a workshop in Spanish for the safe manufacture of jerky is required for Spanish speakers in order to have a food safe product. A two days safe manufacture jerky workshop was presented in Spanish language to owners/operators, supervisor or employers. A pre and post evaluation was given to attendees regarding knowledge of the jerky process and HACCP plan. Additionally, three different methods were demonstrated to make beef jerky by adding humidity during the first 120 min of thermal process followed by complete drying. One method was a completely sealed convection oven with no added moisture. A second method was an unsealed smoke/dehydrator with added steam. A third method was a rotisserie convection oven adding humidity with a pan of water sealed with foil along the door opening. Likewise, the first day meat strips were dipped into a wet marinade for 15 min and then thermally processed by the three different methods. The second day raw meat strips were sprinkled with dry seasoning and thermally processed in each of the different methods. At the end of workshop, participants sampled all jerky products made during the workshop. There was no clear favorite between the oven methods used. However, there was a tendency to prefer the flavor and texture of the dry rub product compared to the wet marinade product. All three thermal processing methods resulted in acceptable product. Both dry rub and Wet marinade jerky had an Aw< .850 specified by USDA regulations for meat and poultry products. Moreover on evaluating participant knowledge, there was a 40% increase on overall knowledge gained as a result of the jerky workshop. In addition, there was 10% increase in specific jerky knowledge after the workshop. Finally, there was a more significant increase in the HACCP plan knowledge with 51% at the end of the jerky workshop. In overall, safe manufacture jerky workshop gave tools to participants to make a safe product and to apply a HACCP plan. Further research is needed to determine how to improve educational access to small meat processors so that they can apply new methods and technology to their operations.

Keywords: HACCP, Jerky, Water activity

Prediction of pork carcass lean percentage by optical probes in past and recent research trials
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Currently, the majority of U.S., Canadian, and European pork processors utilize either carcass ultrasound or optical probe measurements to predict carcass lean composition and carcass value (Fortin et al., 2004; JAS). The accuracy of three optical probes (HGP4, Hennessy Grading Probe, PG-100 and PG200) to predict carcass percentage of fat-free lean (FFL) and lipid-free soft tissue (LFST) was evaluated on 203 barrows and gilts. FFL% (SD = 5.0%) was predicted with residual standard deviations (RSD) of 2.4 to 2.7% for equations including optical probe backfat and LM depth, and 2.3% for ribbed carcass measurements. The RSD’s for the prediction of LFST% (SD = 4.4%) ranged from 2.1 to 2.4% for the optical probes and 2.0% for ribbed carcass measurements. As reviewed by Fortin et al. (2004), the RSD of predicting lean yield percentage is the best single measure of the accuracy of prediction and usually range from 1.7 to 2.7%. However, more recent trials found RSD’s for FFL% ranged from 3.74 to 4.23% (SD = 5%) (Johnson et al., 2004; JAS) and 4.00 to 4.72% (Berg, 2003; SD = 5.3%), which indicate that these equations predict very little of the true variation in carcass composition. The accuracy of prediction equations for FFL% and LFST% is dependent on: (1) accuracy of the carcass measurements, (2) accuracy in which LFST or FFL mass was determined (level of dissection, accuracy of lipid analyses), (3) relationship of the carcass measurements to FFL and LFST%, and (4) accuracy of carcass identification. If optical probe measurement errors for the carcass measurements are proportional to the actual value of the measurements, equations will likely (1) include false quadratic variables (Schinckel et al., 2007; JAS), (2) predict that pigs with vastly different backfat depths (e.g. 20 and 45 mm) have similar FFL% and (3) result in equations including the same carcass measurements to be drastically different (Johnson et al., 2004). With greater levels of errors in carcass measurements, animal identification and/or determination of FFL or LFST mass, equations can result in which predicted FFL% decreases as backfat depth increases to approximately 32 mm and then FFL% increases as backfat depth increases above 32 mm. The European Community has established guidelines that all equations used to predict carcass dissected lean percentage must have RSD’s of 2.5% or less. No such standards exist for equations developed and used within the U.S.

Keywords: Carcass composition, Prediction equations, Pork

Optimization by response surface of the emulsifying properties of longissimus dorsi porcine myofibrillar proteins using meg3 fish oil
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Proteins are the basic components responsible for water and oil retention in meat emulsions. Myofibrillar proteins have the main role due to their high functionality, in particular myosin and actin. This functionality is due to their high solubility and spatial interactions, and affects oil and water holding ability and emulsion stability. Addition of n-3 polysaturated fatty acids (PUFAs) to meat products has been encouraged during the last decade, as the nutritional value of these fatty acids in the human diet is well recognized. Consumption of some PUFAs, particularly eicosapentaenoic (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6 n-3), is recommended by nutritionists. Fish oils are a good source of EPA and DHA. Due to the current interest in supplementing meat products with EPA and DHA, the objective of this study was to optimize the myofibrillar protein and DHA/EPA concentrations in a model meat emulsion to maximize the emulsion activity index (EAI) and emulsion stability index (ESI). Myofibrillar proteins were extracted from porcine longissimus dorsi muscle and stored at −20 °C. A mixture of DHA/EPA (MEG3) was purchased from Ocean Nutrition Canada™ (Halifax, Nova Scotia, Canada). Full factorial designs (2 factors, 3 levels and 3 replicates) were applied to study the effect of protein concentration and MEG3 on EAI and ESI. The factors and levels for EAI were: 1, 4.5 and 8 mg protein/mL, and 15, 20, 25% oil; whereas for ESI the factors and levels were: 6, 9, 12 mg protein/mL, and 15, 20, 25% oil. Model mean emulsions were prepared by mixing myofibrillar proteins and MEG3 for 30 s using a homogenizer. EAI and ESI were calculated by turbidimetry. Results showed interactions between protein concentration (mg/mL) and oil content (%) in the model meat emulsions with a P<0.05. Also, a quadratic effect was found for protein concentration and for oil percentage for EAI and ESI (P<0.05), respectively. Rotatable central composite designs 2α+star with central points and α = ± √2 were applied to optimize the protein concentration (mg/mL) and MEG3 content (%) by a response surface methodology. The factors and levels for EAI were: 1.59, 1.8, 2.3, 2.8 and 3 mg protein/mL and 12.5, 15, 20 and 25% oil; whereas for ESI the factors and levels were: 10.7, 11, 11.6, 12.3 and 12.5 mg protein/mL and 9.3, 9.5, 10, 10.5 and 10.7% oil. The combination of myofibrillar protein concentration and oil content maximizing EAI and ESI were: 1.59 mg protein/mL and 27% MEG3 oil.
and 10.7 mg protein/mL and 9.3% MEG3 oil, respectively. Optimization of emulsifying properties EAI and ESI of *longissimus dorsi* porcine myofibrillar proteins, as analyzed by the response surface methodology, are a function not only of the protein concentration, but also of the oil content used in the meat model emulsion.

Keywords: Emulsifying properties, Porcine myofibrillar proteins, MEG3 fish oil

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**A potential relationship between myosin light chain and instrumental tenderness**

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Predicting the ultimate tenderness of beef without devaluing of the product could be a great benefit to the beef industry. Purge or drip from a beef carcass contains proteins similar to those typically found in a sarcoplasmic extract. It may be possible to obtain information on the biochemical attributes of the product by using the proteins found in purge without physical destruction of the product. The objective of this study was to identify proteins from the sarcoplasmic fraction of 1 day postmortem (PM) muscle that could be used as a predictor of ultimate tenderness in beef. The *longissimus dorsi* was removed at 1 day PM from 10 market weight beef cattle and cut into 2.54-cm thick steaks and aged at 4°C for a total of 1, 7, or 14 days PM. The highly soluble sarcoplasmic fraction was extracted using 50 mM Tris-HCl, 1 mM EDTA, pH 8.5, and 4°C for a total of 1, 7, or 14 days PM. The highly soluble sarcoplasmic fraction was extracted using 50 mM Tris-HCl, 1 mM EDTA, pH 8.5, and instrumental texture (star probe) was determined on all samples. Two-dimensional (2D) Difference In Gel Electrophoresis (DIGE) was used to determine proteins that differed in relative abundance at 1 day PM between the animals that were the most tender at 14 days PM (n = 2) and the animals that were the least tender at 14 days PM (n = 2). The most notable result from 2D DIGE indicated that myosin light chain 1, a skeletal muscle isoform of myosin light chain, was relatively more abundant in the sarcoplasmic extract (P<0.01) in the most tender beef samples. Myosin light chain western blots were preformed on the sarcoplasmic fraction of samples from all ten animals at each aging period. Correlations between myosin light chain western blots and star probe data at the different aging periods were determined using the proc Corr procedure in SAS. At 1 day PM, the intensity of myosin light chain western blots was strongly correlated (r = 0.83, P < 0.01) to 1 day PM star probe measurements. The correlation between the intensity of myosin light chain western blots at 1 day PM and star probe measurements at 14 days PM is r = 0.49 (P = 0.14). These two correlations suggest that the intensity of myosin light chain western blots at day 1 PM can predict instrumental tenderness at 1 day PM, and that there is the potential to predict instrumental tenderness after 14 days of aging. This small scale study provides the basis for additional research in investigating the relationship between myosin light chain 1 and instrumental tenderness. Understanding the biochemical relationships between individual proteins and tenderness will benefit the beef industry by providing the link needed to predict tenderness without devaluing the product.

Keywords: Beef, Myosin light chain, Tenderness

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**Characterization of emu myoglobin**

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Emu is an alternative meat species gaining increased consumer acceptance in North America due to its low fat and low cholesterol contents. Although the primary structure of myoglobin (Mb) from several exotic meat-producing animals and birds has been reported, emu Mb is yet to be characterized. Therefore, our objective was to determine the primary structure of emu Mb. Emu Mb was isolated from skeletal muscles utilizing ammonium sulfate precipitation and gel-filtration chromatography. The molecular mass of emu Mb was determined by Matrix Assisted Laser Desorption Ionization-Time of Flight Mass Spectrometry, whereas Edman degradation was utilized to characterize the N-terminal amino acid sequence. The molecular mass of emu Mb (17,380 Da) was close to those reported for chicken, turkey, and ostrich myoglobins. Edman degradation revealed the identity of first 39 amino acids. Emu Mb shared more than 87% homology with avian myoglobins in the 39-residue segment, whereas it demonstrated less than 82% similarity with livestock myoglobins in the corresponding segment.

Keywords: Emu, Myoglobin, Primary structure

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**Mitochondrial oxygen consumption in permeabilized muscle and liver cells following frozen storage and exposure to low pH values in relation to metmyoglobin reduction**

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A major factor regarding meat color is the metmyoglobin reductase activity in the tissue generated by mitochondrial respiration. Consequently mitochondrial oxygen consumption is vital for the reduced state of myoglobin. Succinate donate electrons to Complex II in the respiratory chain, and it has been shown that succinate reduce metmyoglobin only in the presence of mitochondria. This is observed when the oxygen tension is low (almost zero) and rotenone is used to inhibit Complex I. Knowledge of the stability of enzymes participating in the electron transport chain at meat-relevant post mortem pH levels (typically pH 5.3–6.2) and storage temperatures (chilled and frozen) is important. Pork liver and muscle were collected just after slaughter, transported to our laboratory and oxygen consumption measurements initiated (~3 h) on permeabilized tissue. Samples frozen and stored at −20°C or frozen in liquid nitrogen with a subsequent storage at −80°C were analyzed accordingly. In general, pH reduction decreased the oxygen consumption of the permeabilized tissue following succinate, ADP and cytochrome c addition, when rotenone was used to inhibit Complex I in the respiratory chain. Freezing and thawing also reduced oxygen consumption as measured after addition of succinate, ADP and cytochrome c in permeabilized liver. The reduction in oxygen consumption, measured after succinate addition, was most severe in combination with low pH values (5.5–5.0) and freezing of permeabilized liver cells; i.e. an interaction effect was observed. However, this observation was not made for permeabilized muscle cells. Reducing pH still reduced oxygen consumption following succinate, ADP and cytochrome c addition for permeabilized muscle cells, however, freezing increased oxygen consumption following succinate, ADP and cytochrome addition. The interaction effect found between storage temperature and pH, with respect to oxygen consumption upon addition of succinate, ADP and cytochrome c to permeabilized liver cells, was not observed for permeabilized muscle cells. When comparing respiration before and after addition of cytochrome c to liver and muscle, we found that cytochrome c had a marked effect on respiration in liver cells as opposed to what was found in muscle. This is regarded as being due to the relative softness of liver as compared to muscle, and that the perfusion process also disintegrates the outer mitochondrial membrane in liver. Concluding from the presented data; the electrons for metmyoglobin reduction originate from respiration of succinate, and at the cytochrome c level they
are shuttled to metmyoglobin possibly via cytochrome b in the outer membrane. In order to elaborate on our understanding on how cytochrome c function as an electron-mediator in liver and muscle mitochondria, isolated mitochondria has to be studied.

Keywords: Metmyoglobin, Mitochondria, Reductase

Investigation of species-specific myoglobin oxidation
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Myoglobin (Mb) and lipid oxidation are interrelated in meat. Studies have shown that secondary lipid oxidation products (e.g., 4-hydroxy-2-nonenal: HNE) can covalently bind to Mb and enhance oxidation. HNE’s ability to form adducts depends on the primary structure of Mb. HNE has increased Mb oxidation rate by forming adducts with histidine residues via Michael addition. However, different species’ myoglobins have different numbers of histidine residues and hence the redox instability of myoglobin induced by HNE could be expected to be different. Our objectives were to (1) compare the effect of HNE on oxidation of Mbs from seven different species (i.e., equine, bovine, chicken, turkey, ovine, venison and porcine), and (2) to correlate OxyMb oxidation with formation of HNE: myoglobin adducts. Materials and Methods — Myoglobin from each species was isolated from skeletal or cardiac muscle using gel-filtration chromatography. OxyMb was prepared by sodium dithionite reduction and residual sodium dithionite was removed by passing Mb through a PD-10 desalting column pre-calibrated with sodium citrate buffer, pH 5.6. OxyMb (0.075 mM) prepared from each species was reacted with HNE (0.525 mM); controls received a volume of ethanol equivalent to that used to deliver HNE. Samples were incubated at 4 °C for 96 h, or 25 °C for 6 h. At specific time points samples were scanned from 650 to 450 nm using a UV–Vis spectrophotometer. The percentage of MetMb was calculated according to wavelength maxima at 503, 557, and 582 nm. Following color measurement, samples were passed through a PD-10 desalting column to remove untreated HNE and stored at −80 °C for MS analysis to identify potential HNE:Mb adducts. Results and Conclusions — Within all species, HNE increased OxyMb oxidation (P<0.05) at both 25 °C and 4 °C, pH 5.6. Mass spectral analysis revealed mono-HNE-adducts in all species except chicken and turkey following incubation at 25 °C (for 6 h) or 4 °C (for 96 h). In order to evaluate the effects of histidine number in the primary sequence Mbs from the seven species were divided into two groups, one group with 12 ± 1 histidine residues that included equine, bovine, ovine and venison Mbs, and a second group with 9 histidine residues that included chicken, turkey and porcine Mbs. The differences between HNE-induced oxidation and auto-oxidation were different for the histidine 12 ± 1 group and histidine 9 group at 25 °C and pH 5.6 such that the histidine 12 ± 1 group > histidine 9 group (P<0.05). However, within a group, there were no differences for HNE-induced oxidation and auto-oxidation between species (P=0.05). In conclusion, the difference of histidine residue number among different species’ Mbs resulted in a difference of myoglobin redox instability induced by HNE. This supported the hypothesis that HNE enhanced myoglobin oxidation can be species-specific.

Keywords: Lipid, Myoglobin, Oxidation

Zilpaterol HCl induces phosphorylation of adenosine monophosphate-activated protein kinase α (AMPK α) in the bovine muscle cell cultures
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Zilpaterol HCl (ZH), a beta-2 adrenergic agonist, has been used for enhancing muscle growth in feedlot cattle. The aim of these in vitro experiments was to determine the effect of ZH on changes in enzymes and growth factors important in skeletal muscle growth. We hypothesized that AMPK α, insulin-like growth factor I (IGF-I), and myosin heavy chain (MyHC) isoform Ix expression would increase in cells treated with ZH. Semimembranosus muscle (SM) from cattle (n = 3) was collected within 10 min of harvest for bovine satellite cell (BSC) isolation. A ZH antagonist (ICI-118,551) and 5-aminoimidazole-4carboxamide-1-ß-d-ribonucleoside (AICAR) were used in the experiments to moderate the effects of ZH. A ZH antagonist, such as ICI-118,551, should block the effects of ZH on BSC. In previous studies, AICAR has been shown to increase the phosphorylation of AMPK α. Primary cultures of bovine satellite cells were harvested after 120 hours of either ZH, ICI-118,551, or ZH plus ICI-118,551 exposure for AMPK α, IGF-I, and MyHC Ix protein and mRNA analysis. Abundance of AMPK α increased in BSC treated with ZH as compared to the control, ICI-118,551, and ZH plus ICI-118,551 treated BSC. Relative units of IGF-I mRNA (3.7 ± 0.6) increased in BSC treated with ZH as compared to the control (0.8 ± 0.4) and the addition of ICI-118,551 (0.9 ± 0.2) ameliorated these changes (P<0.05). The relative units of MyHC Ix mRNA (1.5 ± 0.4) had a tendency to increase (P<0.09) in BSC treated with ZH as compared to the control (0.8 ± 0.2). ICI-118,551 (0.8 ± 0.1), and ZH plus ICI-118,551 (0.8 ± 0.3) treated BSC. In a second experiment, primary cultures of BSC were harvested after 48 h of treatment with either ZH, ICI-118,551, AICAR, AICAR plus ICI-118,551, ZH plus ICI-118,551, or ZH plus ICI, 118,551 plus AICAR exposure for phosphorylated AMPK α (pAMPK α) and AMPK α protein analysis. The ratio of pAMPK α to AMPK α tended to increase (P=0.10). These data indicate that ZH alters mRNA abundance of AMPK α, IGF-I, and MyHC Ix as well as the protein concentrations of AMPK α in BSC. These effects may be mediated through the beta-2 adrenergic receptor. These findings further our understanding of the mechanism of action of ZH in stimulating lean tissue deposition in feedlot cattle.

Keywords: AMPK α, Bovine satellite cells, Zilpaterol hydrochloride

Effects of ractopamine hydrochloride on color attributes and meat quality in yearling heifers across days on feed
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Seventy-two commercial crossbred yearling heifers were fed twice a day at the Auburn University Beef Cattle Evaluation facility. Heifers were divided based on initial weight and weight, and randomly assigned to one of the following DOF groups: 79 (n = 16), 100 (n = 16), 121 (n = 16), 142 (n = 16), or 163 (n = 7) days. Within these 5 groups, heifers were randomly assigned to a treatment of either 300 mg hd⁻¹ d⁻¹ ractopamine-HCl (RAC; Elanco Animal Health, Greenfield, IN) for the final 35 d prior to slaughter or a control group (CON; mg hd⁻¹ d⁻¹ RAC). All animals were humanely slaughtered at the Lambert-Powell Meats Laboratory in Auburn, AL. Twenty-four hours postmortem, boneless loins were removed from the right side of each animal, vacuum-packaged, and aged for 21 d in the cooler (2 °C). After 21 d, loins were removed from the vacuum package and 7 strip steaks (2.54 cm thick) were cut for sensory, Warner-Brazier shear force, and lipid oxidation
analysis. The main effect of RAC had no effect ($P>0.05$) on carcass characteristics. Hot carcass weight was lowest ($P<0.05$) for DOF group 79 compared to other DOF treatment groups. Backfat thickness and KPH was highest ($P<0.05$) in DOF groups 121 and 142. Muscle fiber types were not different ($P>0.05$) for RAC-treated animals compared to CON. Intermediate fiber area was highest ($P<0.05$) for DOF group 121. The percentage of red fibers was highest ($P<0.05$) for DOF group 121. Shear force values were not affected ($P>0.05$) by RAC or DOF treatment. Initial and sustained tenderness was highest ($P<0.05$) for DOF group 163 RAC steaks, compared to all other treatments. Ractopamine supplementation had no effect on carcass characteristics and there were no deleterious effects on meat quality factors by the addition of RAC into the diet.

Keywords: Color, Fiber types, Ractopamine hydrochloride

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**Gene expression changes associated with increased marbling in beef cattle**


The objective of this study was to identify specific bovine genes expressed within skeletal muscle that are associated with the amount of intramuscular fat deposition. Twenty-eight steers and heifers were harvested at the University of Illinois Meat Science lab over the course of 4 months in early 2009. Samples of longissimus muscle were removed within 90 min post-mortem and stored at $-80^\circ$C prior to RNA extraction. At 24 h post-mortem, cattle were graded and pH, drip loss, color measurements were recorded. Steaks were removed for analysis of shear force and intramuscular fat content. Four pairs of animals were identified based on similar adjusted backfat thickness but differing in amounts of intramuscular fat within each pair. The high marbled group averaged 9.7% intramuscular fat while the low marbled group had just 4.8% intramuscular fat. RNA was extracted from muscle samples devoid of visible fat and microarray analysis was performed using the Agilent two-color bovine array using a paired design with dye flip. Based on this analysis, 9 genes were selected as differentially expressed due to intramuscular fat content, and expression was subsequently confirmed by qPCR. Expression levels of MYH3, HOXD10, and CASQ2 were increased in animals with high marbling, whereas levels of NPNT, MRC1, DNER, and CYPB4 were decreased in high marbling animals. The remaining genes, ACTN2 and MXRA8, were determined to be false positives from the array and were therefore excluded from further study. RNA was then extracted from the remaining animals and expression of the above 7 genes was determined by qPCR with 18srRNA as a housekeeping gene. Despite the positive results of the preliminary study, associations between gene expression and intramuscular fat content did not extend to the larger population of beef cattle. A significant negative association existed between expression of MRC1 and marbling level ($P=0.06$), but the amount of variability explained by this relationship was low ($R^2=0.10$). Interestingly, expression of MRC1 was also positively associated with $a^*$ ($P=0.03$, $R^2=0.16$) and tended to be negatively associated with $L^*$ ($P=0.09$, $R^2=0.10$). Therefore, this study was unable to identify a particular gene set whose expression correlated well with marbling levels in the larger population of beef cattle. Because intramuscular fat content was not well correlated with adjusted fat thickness in this study, further studies will focus on populations wherein backfat thickness was not controlled.

Keywords: Beef, Intramuscular fat, Gene expression