

Graduate Student Research Poster Competition

M.S. DIVISION

Quality evaluation of case-ready beef steaks from various USDA grades

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Introduction of case-ready fresh meats to the marketplace has demonstrated a need to evaluate the benefits of this technology. The objectives of this study were to evaluate visual and chemical attributes of three different USDA quality grades (High Choice and above, Low Choice, Select) and three different muscles (semimembranosus, semitendinosus, and biceps femoris) of beef steaks encased in high-oxygen (80% O₂/20% CO₂) modified atmosphere packaging (MAP). Steaks from each treatment group (3 muscles, 3 grades, 2 packaging types) were displayed under retail conditions for 1, 3, 5, 7, and 10 d. Three steaks from each muscle-grade-package type combination were evaluated on each day by a five-member trained panel for visual color (lean color, discoloration, overall acceptability) and analyzed with a Minolta Chroma Meter CR-300 for L* a* b* values (lightness, redness, yellowness). Chemical analysis included percent metmyoglobin and lipid oxidation (TBARS). There were no grade x packaging interactions ($P > 0.05$) for lean color, discoloration, overall appearance, or L*, a* and b* values. However, the main effect of grades for these quality parameters was significant, with Low Choice and Select being higher than High Choice for L* values and Low Choice being more desirable than both High Choice and Select for lean color, discoloration, overall appearance, and a* and b* values. There were no grade x packaging interactions for percent metmyoglobin and TBARS values, however, grade had a main effect ($P < 0.05$) on percent metmyoglobin content, with High Choice being higher than both Low Choice and Select. TBARS values also differed ($P < 0.05$) among grades. These findings indicate quality grade has a major influence on color stability of high-oxygen packaged beef steaks. Regardless of muscle type and grade, however, whole muscle steaks from the round can achieve an extended shelf-life by use of novel MAP technology.

Key Words: Case-ready, Quality, Oxidation

Effects of high protein/low carbohydrate swine diets during the final finishing phase on pork muscle quality

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The aim of this study was to lower the glycogen stores in pork muscle in order to improve pork muscle quality by feeding an ultra-high protein/low carbohydrate (HIPRO) diet. Fifty barrows (average live weight = 92 kg) were assigned across five treatments and two reps (five pigs per treatment by rep combination). All barrows were fed a control diet (13.1% CP) until their assigned treatment began. A treatment was the number of days the barrows were fed the HIPRO diet prior to harvest (0, 2, 4, 7, and 14 d). The HIPRO diet (35.9% CP) was 97% extruded soybeans. Daily feed intake and weekly live weights were recorded for all barrows. At-death blood glucose levels were determined. Muscle pH, temperature and electrical impedance were measured in the longissimus lumborum and semimembranosus muscles at 45 min, 3 h and 24 h postmortem. Glycolytic potential, Minolta L*a*b* values, visual scores for color, firmness and marbling, water-holding capacity traits (drip loss, purge loss and cooking loss) and Warner-Bratzler shear force values were determined in the longissimus thoracis et lumborum. Weight gain per day decreased the longer the pigs were fed the HIPRO diet ($P < 0.05$). Daily feed intake decreased during the first week on the HIPRO diet, but returned to near-control levels during the second week, which when coupled with the continued decreases in daily gain, resulted in substantial decreases in feed efficiency during the second week on the HIPRO diet ($P < 0.05$). Blood glucose levels and glycolytic potentials were not lowered by feeding the HIPRO diet ($P > 0.05$); and therefore, no differences in rate of pH decline or ultimate pH among dietary treatments were found ($P > 0.05$). Likewise, there were no differences among dietary treatments in any of the measured meat quality attributes ($P > 0.05$). Feeding barrows the HIPRO diet for a time period prior to slaughter decreased feed intake, rate of gain, and feed efficiency, and was not effective at lowering glycolytic potential or improving pork muscle quality.

Key Words: Pork quality, muscle glycogen, Muscle pH

Processing and product development of goat meat products: fermented cabrito snack stick and cabrito smoked sausage

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The production of high quality, value added goat meat products could increase the consumption, acceptability and marketability of goat meat. The objectives of this study were to develop a fermented cabrito snack stick and a cabrito smoked sausage containing different levels of soy protein concentrate in an effort to reduce their final product costs; conduct consumer acceptance, proximate analysis, pH, water activity and smokehouse yields and losses to evaluate and ensure quality and acceptance of these goat meat products; and to perform a comparative cost analysis to determine cost benefit of using soy protein concentrate in formulation of fermented cabrito snack stick and cabrito smoked sausage products. The levels of soy protein concentrate used to replace the goat meat were 0%, 1.75% and 3.50%.

The trained panelists detected no significant "soy" off-flavor differences ($P > 0.05$) between the three formulation levels of soy protein concentrate for the fermented cabrito snack stick and cabrito smoked sausage. The consumer panelists detected no significant differences ($P > 0.05$) in the flavor, texture and overall acceptance attributes for the fermented cabrito snack sticks, and the cabrito smoked sausage products formulated with 0% and 3.50% soy protein concentrate.

The fermented cabrito snack sticks formulated with 3.50% soy protein concentrate had a lower ($P < 0.05$) fat content than the 0% level. The fermented cabrito snack sticks formulated with 0% soy protein concentrate had the highest price of \$1.31, and the 3.50% level had the lowest price of \$1.25 per 42.61g serving size. There were no differences ($P > 0.05$) in moisture, fat and protein for the cabrito smoked sausage formulated with 0% and 3.50% soy protein concentrate. The addition of soy protein concentrate resulted in a \$1.30 per kg reduction in the price of the cabrito smoked sausage formulated with 3.50% soy protein concentrate (i.e., cost was \$13.49 per kg), when compared to the sausage formulated with 0% soy protein concentrate (i.e., cost was \$14.79 per kg).

This project will enhance the marketability of goat meat and provide new and successful markets for Florida's goat industry.

Key Words: Goat Meat, Fermented Cabrito Snack Stick, Cabrito Smoked Sausage

Ozonation of animal wastewater to reduce environmental impact

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Samples of wastewater from a confined animal feeding operation (CAFO) and a slaughter facility were ozonated and analyzed for reduction in biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), coliform bacterial content, and aerobic bacterial content. Samples from the swine farm were collected from the flush pit of a 125 head swine-feeding floor. Subsamples were collected after 0.0, 0.5, and 1.0 hr of laboratory ozonation. At the cattle packing plant (500 head per day), samples were collected from the harvest floor and from the anaerobic lagoon discharge. After transport to the laboratory, samples were ozonated for 0.0, 0.25, 0.5, 0.75, and 1.0 hr. Ten-milliliter subsamples were collected for analysis at each time interval. BOD_5 and COD determinations indicated reductions across all times on all samples. Coliform and aerobic bacterial content were measured using 3M Petrifilm®. Results indicated significant reduction ($P < 0.05$) in mean bacterial plate counts of 1 to 3 log for all samples over all times for both coliform and aerobic plate determinations.

Key Words: Wastewater, Ozonation, Environment

Development of decontamination procedures for beef trimmings

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Escherichia coli O157:H7 has become recognized as an important foodborne pathogen, with undercooked ground beef identified as the most frequent outbreak cause. Beef trimmings present a challenge to the meat industry due to a higher degree of bacterial contamination occurring in ground beef than in whole-muscle products because of extensive handling procedures during production. Interventions are needed to reduce microbiological levels on beef trimmings. Beef trimmings of 73/27 or 50/50 lean and fat content were obtained from a commercial plant. Trimmings were randomly assigned to four treatments: control, 4% lactic acid (LA), 4% lactic acid plus hot water (LA+HW), and 4% lactic acid plus 10% trisodium phosphate plus hot water (LA+TSP+HW). Meat color was evaluated on both trimming types before and after treatment and on ground beef chubs on days 0, 7, 14, 21, and 28 of storage. The L^* , a^* , and b^* color space values were determined to measure objective color, and trained color panel was used to measure subjective color. After treatment, the lean color of all trimming types was darker ($P < 0.01$) or grayer ($P <$

0.01) in the LA+HW or LA+TSP+HW treated trimmings. Lean color of the ground beef was not noticeably darker ($P < 0.05$) due to treatment after grinding, but the LA treatment resulted in visually darker ($P < 0.01$) ground beef especially with subsequent storage time. A trained descriptive attribute panel evaluated flavor quality characteristics of the ground beef patties on each storage day. The LA treated patties had slightly lower levels of cooked beef/brothy ($P < 0.01$), cooked beef fat ($P < 0.01$), and grainy ($P < 0.01$) flavors. Total aerobic plate counts (APC) were measured on excised sample after treatment and on ground samples on each storage day. The LA+HW and LA+TSP+HW treatments reduced surface APC of trimmings by 1 \log_{10} CFU/cm. However, treating beef trimming with LA reduced the APCs of the ground beef by 1.3 \log_{10} CFU/g and lowered ($P < 0.01$) APCs on days 7, 14, and 21 compared to control and other treatments. These treatments, especially LA+HW would be an acceptable intervention step to be further examined to assist in decontamination of beef trimmings without adversely effecting shelf-life and flavor attributes.

Key Words: beef, decontamination

Relationships between mechanical tenderness measurements and trained sensory panel attributes of beef *Longissimus lumborum* muscle

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Mechanical assessment of beef tenderness is widely used. Varying methods have been reported in the scientific literature: Warner-Bratzler shear force (WB), Allo-Kramer shear force (AK), and slice shear force (SS). In addition, trained meat descriptive attribute sensory evaluation of myofibrillar tenderness (MT), connective tissue amount (CT) and overall tenderness (OT) are used to evaluate tenderness of beef. The objective of this research was to understand the relationships between these mechanical measures of tenderness and trained meat descriptive attribute sensory panel ratings of beef tenderness. Beef steers ($n = 63$) varying in live animal characteristics to induce variation in tenderness were slaughtered, electrically stimulated, and two strip loins (IMPS -180) were removed 48 h postmortem. Loins were subsequently vacuum-packaged, aged 14 d at 5°C and then cut into 2.54 cm thick steaks. Within each animal, steaks were randomly assigned to one of four treatments: WB, AK, SS or trained sensory evaluation of MT, CT and OT using 8-point scales (1 = extremely tough, abundant and extremely tough; 8 = extremely tender, none,

extremely tender, respectively). Steaks varied in tenderness across mechanical and sensory measures (2.4 to 7.4 kg for WB, 8.1 to 27.8 kg for AK, 7.0 to 42.4 kg for SS, 3.7 to 7.6 for MF, 4.7 to 7.9 for CT and 3.7 to 7.6 for OT). Mean measures for tenderness were 4.1 kg for WB, 13.6 kg for AK, 15.7 kg for SS, 6.3 for MT, 7.0 for CT and 6.3 for OT. The OT and WB values were correlated at -0.70 ($P < 0.01$) whereas OT and AK were correlated at -0.61 ($P < 0.01$) and OT and SS at -0.70 ($P < 0.0001$). Respective correlation coefficients between MT and WB, AK and SS were -0.70, -0.59 and -0.60; while simple correlation coefficients between CT and WB, AK and SS were -0.66, -0.60 and -0.51, respectively. As expected, correlation coefficients among sensory measures were high (> 0.9 , $P < 0.01$). These data indicate that the common mechanical measurements of beef tenderness are highly correlated to each other and they are highly correlated to trained sensory measures of beef tenderness, although the apparent lower correlation between SS and OT as compare to WB and AK may be due to differences in cooking method (belt grill vs. electric grill).

Key Words: beef, shear force, tenderness

Effects of cold shortening and cooking rate on tenderness, postmortem proteolysis, and cooking traits of beef *longissimus* and *triceps brachii* muscles

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Our study evaluated the effects of cold shortening and cooking rate on postmortem proteolysis, tenderness, and cooking traits of beef *longissimus thoracis* (LT) and *triceps brachii*, long head (TB) muscles. The LT and TB were removed at 45 min (left side) and 24 h (right side) postmortem from 12 carcasses and trimmed of fat. Muscles removed at 45 min were placed in an ice bath to induce cold shortening. At 24 h postmortem, muscles were cut into 2.54 cm steaks and assigned to aging (1 or 14d) and RAW and cooking (FAST or SLOW) treatments. Steaks were cooked at 260°C (FAST) or 93°C (SLOW). Cooking loss (CL), cooking time (CT), and Warner-Bratzler shear force (WBSF) were measured for cooked steaks. Sarcomere length (SL) and the extent of proteolysis of desmin were measured on all steaks. Rapid chilling resulted in shorter ($P = .05$) SL. TB steaks had longer ($P = .05$) SL than LD steaks. RAW steaks had longer ($P = .05$) SL than cooked steaks regardless of shortening. FAST cooking resulted in shorter ($P = .05$) SL than SLOW cooking in normal steaks, but cooking rate had no effect on shortened steaks. Generally, TB steaks required longer ($P = .05$) CT and had higher ($P = .05$) CL than LT steaks, and FAST cooked steaks had greater ($P = .05$) CL than SLOW cooked steaks. Short-

ened steaks had less ($P=.05$) degradation of desmin than normal steaks (31 vs. 41%, respectively). Aging for 14d increased ($P=.05$) desmin degradation. Cold shortening resulted in much higher ($P=.05$) and aging resulted in lower ($P=.05$) WBSF values. SLOW cooked TB steaks were more tender ($P=.05$) than FAST cooked TB and FAST and SLOW cooked LT steaks. These data indicate that shortened muscles undergo proteolysis, but at a slower rate than normal muscles. Cooking rate did not affect tenderness of LT steaks, but SLOW cooking resulted in lower WBSF values for TB muscles, presumably because of collagen solubilization.

Key Words: Beef Tenderness, Proteolysis, Cooking

Use of sodium citrate to enhance tenderness and palatability of pre-rigor beef muscles

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Previous research demonstrated glycolytic inhibition enhanced beef tenderness, despite causing substantial contraction by injection and tumbling of pre-rigor muscles. This project was designed to evaluate the effects of pre-rigor treatment with sodium citrate on the tenderness and palatability of beef muscles from the thoracic limb; the muscles were injected while maintaining skeletal restraints to contraction. Thoracic limbs from 14 steers were removed within 2 hr post-mortem and pumped to 10% of muscle weight with water, 200 mM, or 400 mM sodium citrate solutions. Controls remained on the carcass during chilling. Steaks (2.54 cm thick) were removed after 24 hours from the *Infraspinatus*, *Supraspinatus*, and *Triceps brachii* muscles and were either frozen immediately or aged for 6 more days. A consumer panel evaluated palatability (juiciness, tenderness, connective tissue amount, and flavor desirability) on *Infraspinatus* and *Triceps brachii* steaks using 9-point hedonic scales. Warner-Bratzler shear force values on 1.27 cm-diameter cores were determined on all muscles. Treatment with 400 mM sodium citrate improved shear force values over the control in all three muscles (3.32 vs. 3.61 kg and 2.79 vs. 3.50 kg for d1 and d7 *Infraspinatus* [$P<.10$]; 3.55 vs. 3.71 kg and 3.09 vs. 3.59 kg for d1 and d7 *Triceps brachii* [$P<.10$]; 4.19 vs. 5.30 kg and 4.03 vs. 4.78 kg for d1 and d7 *Supraspinatus* [$P<.05$], respectively). Tenderness ratings followed the same trend as shear force values. Flavor desirability ratings of beef treated with 200 or 400 mM sodium citrate were equal or superior control muscles. These data indicate that sodium citrate may be applied to pre-rigor beef muscles (constrained from contraction) to enhance tenderness and palatability.

Key Words: Beef, Tenderness, Palatability

Mapping intramuscular tenderness variation in four major muscles of the beef round

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The objective of this project was to quantify intramuscular tenderness variation within four muscles from the beef round: biceps femoris (BF), semitendinosus (ST), semimembranosus (SM), and adductor (AD). At 48 h postmortem, the BF, ST, SM, and AD were dissected from either the left or right side of ten carcasses, vacuum packaged, and aged for an additional 8 d. Each muscle was then frozen and cut into 2.54-cm-thick steaks perpendicular to the long axis of the muscle. Steaks were broiled on electric broilers to an internal temperature of 71° C. Location-specific cores were obtained from each cooked steak and Warner-Bratzler shear force was evaluated. Definable intramuscular tenderness variation (SD = 0.56 kg) was almost twice as large as between-animal tenderness variation (SD = 0.29 kg) and 2.8 times as large as between-muscle variation (SD = 0.20 kg). The ranking of muscles from greatest to least definable intramuscular tenderness variation was BF, SM, ST, and AD (SD = 1.09, 0.72, 0.29, and 0.15 kg, respectively). The BF had its lowest shear force values at the origin (sirloin end), intermediate shear force values at the insertion, and its highest shear force values in a middle region 7 to 10 cm posterior the sirloin-round break point ($P < 0.05$). The BF had lower shear force values towards the ST side than towards the vastus lateralis side ($P < 0.05$). The ST had its lowest shear force values in a 10 cm region in the middle, and its highest shear force values towards each end ($P < 0.05$). The SM had its lowest shear force values in the first 10 cm from the ischial end (origin), and its highest shear force values in a 13 cm region at the insertion end ($P < 0.05$). Generally, shear force was lower towards the superficial (medial) side than towards the deep side of the SM ($P < 0.05$). There were no intramuscular differences in shear force values within the AD ($P < 0.05$). These data indicate that definable intramuscular tenderness variation is substantial and could be used to develop alternative fabrication and (or) merchandising methods for beef round muscles.

Key Words: Beef, Intramuscular, Tenderness

Chemical characterization of beef inside and outside semimembranosus for improved color stability

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The color instability of the beef semimembranosus (SM) has been troublesome to the meat industry and continues to be problematic in modified atmosphere packaging. The deep or inside portion of the SM (ISM) is lighter in color and discolors faster than the superficial or outside SM (OSM). The relationships of 5 assays for metmyoglobin reducing ability with color stability were determined at 5 and 14-days of storage. Combinations of cold or hot boning with and without electrical stimulation were used to create different postmortem declines in temperature and pH for the ISM and OSM to examine effects on chemical characteristics and initial color and stability. Aerobic reducing ability and reduction of nitric oxide metmyoglobin showed less activity in the ISM than OSM, and in tissue stored 14 compared to 5 days. The assay for total reducing activity and reduction of dichlorophenolindophenol showed more activity in muscles stored 5 compared to 14 days but showed few differences between the muscle portions. Reductions of horse and bovine metmyoglobins were inconsistent between muscle portions and storage times. Aerobic reducing ability correlated best with visual panel scores and metmyoglobin accumulation in the SM. Cold-boned ISM had a slower chill rate; faster pH decline; more denatured protein; less metmyoglobin reducing ability, oxygen consumption, and water-holding capacity; and a lighter, less stable color than the OSM. Cold-boned steaks were two-toned in color and discolored by day 3 of display. Hot-boned ISM and OSM chilled at the same rate and had similar pH declines, similar chemical characteristics, and acceptable color traits up to day 5 of display. Myoglobin concentration, heme iron, nonheme iron, and lipid oxidation did not explain differences in color stability between the ISM and OSM. Methods that chill the ISM more rapidly should produce a more uniform, stable color

by conserving reducing ability and protein integrity. Extending the color life of the ISM should reduce the need for reworking and discounting after only 2 days of retail display.

Key Words: Semimembranosus, Metmyoglobin, Color Stability

Assessing Real Time Augmentation of USDA Yield Grade Application to Beef Carcasses Using Video Image Analysis (VIA) Instrumentation

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This study assessed the ability of two video image analysis (VIA) instruments, VIAscan™ and Canadian Vision System (CVS™), to augment the assignment of USDA Yield Grades (YG) to beef carcasses, to the nearest tenth of a grade, under commercial operating conditions, and to test the accuracy of cutability predictions. Steer and heifer carcass sides ($n = 290$) were selected to vary in fatness, muscling and weight. Carcasses were assigned augmented YG (AYG), to the nearest tenth (i.e., YG 1.3, 2.6, 4.9), on an automated grading chain (360 head/hour) by each of the two VIA systems, and subsequently fabricated into closely-trimmed (.6 cm) subprimal cuts. Augmented YG that included line graders' estimates for adjusted PYG, and VIA measured ribeye area were highly correlated ($r = .92$ and $.95$ for VIAscan™ and CVS™, respectively) with Gold Standard YG (committee of experts, at their leisure). Cutability prediction accuracy increased to levels near those achieved by expert whole YG, where VIAscan™ AYG, CVS™ AYG and expert whole YG accounted for 59, 60, and 62 percent of the variation in fabricated yields of closely-trimmed subprimal cuts, respectively. Video Image Analysis technology for use in the augmentation of USDA YG appears to be a useful tool for increasing the accuracy and objectivity of USDA YG application, as well as for improving the accuracy of prediction of subprimal yields.

Augmentation of USDA YG through use of VIA instrumentation improves USDA line graders YG assignment accuracy. Assigning USDA YG to the nearest tenth would provide substantial economic benefit to the beef industry, allowing fabrication styles and inventories to be more closely managed. VIA instrumentation is a viable augmentation option for use by USDA line graders in assigning YG to the nearest tenth.

Key Words: Subprimal, Yield, Augmentation, Video Image Analysis