

# Graduate Student Poster Competition M.S. Division

## Reducing Bacterial Pathogens on Meat Surfaces Utilizing Electricity

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The effects of continuous electrical current, pulsed electrical current, and voltage level on bacterial pathogens on top round steaks were examined. Continuous application of electricity (620 v) for 20 and 60 s decreased ( $P < .05$ ) coliform bacteria counts by 81% compared to untreated steaks. Compared to non-sprayed steaks, coliform counts were lower ( $P < .05$ ) for steaks to which 3 ml of sterile deionized water was applied before application of electricity. Steaks subjected to 3, 6, 12 and 24 pulses (400 v/2.5 cm) reduced ( $P < .05$ ) *Salmonella typhimurium* counts compared to untreated steaks. A voltage level of 1,200 v/2.5 cm, distributed in 6 pulses of electrical current, reduced ( $P < .05$ ) the numbers of *Salmonella typhimurium* by 82% compared to those steaks that received no application of electricity. The present study shows that pulse power application of electricity is an effective means for significantly reducing pathogenic bacteria on beef surfaces.

## Electromagnetic Scanning to Predict Lean Content and Value in Hot Beef Sides

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Electromagnetic scanning was used to predict lean content and value of hot beef sides under commercial conditions. Hot beef sides ( $n=19$ ) ranged in weight from 114.1 to 157.3 kg. Muscle and tissue beneath the blade bone were cut to reposition the foreshank for scanning. Each side was scanned in triplicate at 2.5 MHz. After scanning, temperatures of the chuck and round were recorded. Carcass data were collected following a 22 hr chill period. Sides ranged in fat thickness from .38 to 1.9 cm and in calculated yield grades from 0.8 to 3.9. Sides were fabricated into boneless closely trimmed subprimals by production personnel, and weights were recorded. Lean trim was ground twice through a 0.95 cm plate and random samples were collected to analyze moisture and fat content by proximate analysis. Scanning curve peak and hot side weight were used to predict total lean and accounted

for 93.6% of the variation, with a root mean square error of 2.5 kg.  $R^2$  values for predicting major subprimal weights ranged from .51 to .79. Actual and predicted carcass values were calculated using U.S.D.A. prices and actual and predicted weights of all subprimals. Predicted carcass value was significantly correlated ( $r=.958$ ,  $P < .01$ ) with actual carcass value. Results indicate electromagnetic scanning can accurately predict total lean, subprimal weight, and value of hot beef sides under commercial beef processing conditions.

## Sensory Evaluation of Fresh Loin and Cured Ham Roasts from Hogs Fed Different Levels of Salmon Meal

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Flavor is a primary determinate of red meat acceptability. Although salmon meals have successfully replaced plant protein in animal diets, fishy off-flavors may result. However, reduction of salmon waste to by-products for use in animal rations would decrease environmental impacts associated with fish processing. Quality attributes of fresh and cured muscles from 25 Yorkshire X Duroc C Hampshire cross hogs fed salmon meal as a replacer for soybean meal on a 0, 25, 50, 75 and 100% crude-protein basis were assessed. An experienced, oriented sensory panel ( $n=23$ ) evaluated fresh loins and cured hams roasted to an endpoint temperature of 70°C using a 150-mm line scale. Data were analyzed with PROC GLM ( $p < 0.05$ ). Loin pork flavor intensity decreased whereas off-flavors and rancidity increased when salmon meal levels exceeded 25%. Variation in fatty mouth coating, fat character (oily vs. greasy) and moisture release was limited; tenderness increased with increased percentages of salmon meal. Overall quality of the control and 25% loin did not differ; remaining loins sampled were rated below the midpoint. Among ham samples, few differences were noted in moisture release, tenderness, fatty mouth coating, fat character, off-flavor intensity and rancidity. Significant differences found were unlikely to be of practical importance. Ham flavor intensity did not differ. Overall quality of the 25% was rated significantly higher than all other treatments. Incorporation of 25% salmon meal did not impair fresh loin or cured ham quality; overall, fewer detrimental quality effects were identified in ham.

## Lack of Colon-Promoting Carcinogenesis by Beef in the Rat Model

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Recent epidemiological studies have implicated red meat as a risk factor for colon cancer. The goal of this study was to compare, in an experimental model, the effects of beef protein and beef tallow with traditional casein and corn oil diets as promoters of colon carcinogenesis using 280 male Sprague-Dawley rats. Rats were fed from weaning 1 of 8 test diets containing fat at 5% or 20%, as either corn oil or beef tallow, and protein as either casein or beef at 20%, in a 2\*2 factorial design. All other nutrients were isocaloric. Colon tumors were induced by 10 doses of 1,2 dimethylhydrazine dihydrochloride (DMH) at 20 mg/kg of body weight per week. When beef was fed as a protein source, a lower incidence ( $P > .05$ ) of total tumors and colon adenocarcinomas was found compared to casein as the primary source of protein. No effect ( $P > .05$ ) between diets containing beef tallow and diets containing corn oil as fat sources was found in the development of tumors. However, increasing the fat levels increased the numbers of colon adenomas ( $P < .05$ ) in the diets containing 20% fat. The results from this study promote the importance of total dietary fat and protein sources as cancer risk factors, but do not support the belief that red meat consumption enhances the risk for colon carcinogenesis.

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## Fate of *Escherichia Coli* O157:H7 In Thermally-Processed Low-Fat Ground Beef Patties

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Recently, consumer attention has been focused on food safety and the amount of fat in their diet. The objective of this study was to determine the temperature and holding times necessary to inactivate *Escherichia coli* O157:H7 in low-fat, precooked ground beef patties. To develop temperature and holding times for treatments, ground beef (rep=3) was formulated to a 10% fat level in four treatments (control, carrageenan, soy, salt). Treatments were ground, mixed and patties (112g) were formed, then frozen (-20°C). Thawed ground beef patties were spray-inoculated with *E. coli* O157:H7 to achieve  $10^3$  CFU/g and subsequently reground and reformed. Thermal death times were established by placing inoculated patties in plastic bags and water cooking to internal temperatures of 72°, 68°, 66° or 60°C. Patties were removed at each endpoint temperature and held for varying time periods. After freezing, the patties were analyzed for *E. coli* O157:H7, utilizing enrichment plating on selective agar and subsequent serological testing. Water bath cooking results were subjected

to a manufacturing simulation utilizing an impingement oven. Ground beef patties (rep=2) were formulated, manufactured and inoculated as before. Patties were cooked in an impingement oven (218°C) to internal temperatures of 72°, 68°, 66°, 60°C and held for necessary holding times, frozen and tested for *E. coli* O157:H7. Water bath cooked patties cooked to 72°C, regardless of formulation, did not require holding times to produce a microbiologically safe product. Control, carrageenan and salt treatments cooked to 68° and 66°C did not require holding times. The soy treatment required 10-second holding times at 68° and 66°C. Treatments cooked to 60°C required holding times of: control and carrageenan 240 seconds, salt 120 seconds and soy 300 seconds. *E. coli* O157:H7 was not isolated from any of the inoculated patties cooked in the impingement oven to 72°, 68° or 66°C, regardless of formulation. However, control treatment patties cooked to 60°C were found to be microbiologically unsafe. Cooking ground beef below 66°C is not advised.

## Effect of a Growth Promotor (Lactocill-S) on Pig Carcass Quality

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The objective of the present study was to evaluate the effect of a growth promotor (Lactocill-S) on yield of hot carcass (HC), cold carcass (CC), primal (Y), bacon (B), shoulder (S), loin (L), ham (H), edible viscera (EV), non-edible viscera (NEV), lean, fat and bone of pigs. In addition, rib eye area (REA) and dorsal fat (DF) were measured. Twenty-four castrated York x Landrace pigs of approximately the same age, but different weight, were fed during 108 days a sorghum-soja isoenergetic and isoproteic diet containing 0, 150, 250 and 350 g of Lactocill-S per ton of feed corresponding to treatments I, II, III and IV respectively. A completely random design with six replicates was performed taking the initial weight as a covariable, and least square mean (LSMEAN) and Tukey tests were used for mean comparison. Treatment III had the lowest yields for EV and lean ( $P < 0.05$ ) when compared to the other treatments, while treatment IV showed the highest yields ( $P < 0.05$ ). A positive linear trend for EV was observed ( $P < 0.06$ ), but lean did not have a defined trend ( $P > 0.05$ ). Treatment I showed the lowest bone yield and treatment IV the highest bone yield ( $P < 0.06$ ), bone showed a positive linear trend ( $P < 0.01$ ). No difference was found in the other variables, indicating that the Lactocill-S had no effect on these characteristics. However, a negative linear trend was observed for HC and CC ( $P < 0.13$ ) and for Y ( $P < 0.11$ ). The trend found for ham was positive linear ( $P < 0.11$ ) while the trend for bacon and fat was negative quadratic. It can be concluded that Lactocill-S increased bone yield and it had a trend to reduce hot carcass, cold carcass and primal yields; it also tended to increase edible viscera and ham. Treatment III proved to be the optimum probiotic level for bacon and fat yields.

### Determination of Rib-Eye Area and Fat Thickness by Ultrasound Images in Young Brangus Bulls Under a Performance Test

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In order to estimate the changes in rib-eye area (REA), fat thickness (FT) and the best prediction models to final REA and FT, 111 young Brangus bulls were evaluated in a performance test of 112 days duration in "La Campana" experimental station, Chihuahua, Mexico. The animals were fed "ad libitum" with a commercial concentrate (14% CP, 68% TDN and 2.62 Mcal ME) plus oat hay. The weight (W) and hip height (HH) were taken every 28 days until day 112 and the ultrasound images were taken at 0, 28, 56 and 112 days with an Aloka 256 II real-time ultrasound, with a linear transducer of 3.5 mhz. Ultrasound images were recorded in an 8 mm videotape and the determinations of REA and FT were estimated by the computational software "Animorph." The statistical analysis was made by SAS with the GLM and REG procedure. The mean and standard error for initial age, weight (Wo), REA (REAO), FT (FTO) and HH (HHO) were 558.92 ± 15.06 d; 444.61 ± 8.88 kg; 50.78 ± 1.14 cm<sup>2</sup>; 0.44 ± 0.01 cm and 134.7 ± 0.72 cm, respectively and for final Wf, REAf, FTf and HHf were 585.93 ± 6.23 kg; 68.52 ± 0.98 cm<sup>2</sup>; 0.69 ± 0.01 cm and 137.85 ± 0.52 cm respectively. All the traits showed a linear tendency (p<.001). The best prediction model to final REA was  $Y = -53.27 - 0.1355 (W28d) + 0.094 (Wf) + 0.3151 (REAO) + 0.3780 (REA56d) + 24.09 (FT56d)$  with  $r^2 = 0.5628$  and  $p < .001$ ; and for final FT was  $Y = .01257 - .0014 (W28d) + 0.0018 (fW) + .0024 (REA56d)$  with  $r^2 = 0.3805$  and  $p < .0001$ . For these experimental conditions, the results suggest that while initial weight has no effect on final REA and FT, all the traits showed a linear tendency. The ultrasound is a precise technique to estimate some carcass traits in live beef cattle and it is possible to estimate final REA and FT with previous measurements.

### Discoloration and Bacterial Growth on Beef from Control and Vitamin E-Supplemented Holstein Steers

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The objective of this study was to investigate the effect of vitamin E on color stability and microbial growth and colonization of beef. Holstein steers were supplemented with three different levels of d1-tocopheryl acetate; 0 (E-), 500 (E-500) and 2000 (E-2000) mg/head/day for 126 days. Following slaughter, beef cores (12 cm<sup>2</sup> x 1 cm) were cut from *longissimus* muscle and stored at 4°C for 12 days (non-abused), or at 25°C for 24 hr and then at 4°C for 12 days (temperature-abused). Pigment oxidation (%-metmyoglobin) was measured spectrophotometrically and microbial growth determined by

total aerobic plate count. Light microscopy (LM) and scanning electron microscopy (SEM) were used to visualize microbial colonization and penetration on beef surfaces. Metmyoglobin E-0 samples were greater than in E-500 and E-2000 (p<0.05). Samples from different vitamin E-treatment groups showed no differences (p>0.05) in total microbial growth during 12 days storage in either non-abused or temperature-abused studies. Abuse of beef samples at 25°C for 24 hr increased total bacterial load and metmyoglobin percentage in all treatment groups when compared with non-abused samples. LM and SEM demonstrated no difference among treatments for bacterial penetration and colonization. Dietary vitamin E did not affect bacterial growth, but enhanced color stability of beef samples of Holstein steers.

### The Effects of Muscle Condition, Temperature and pH on the Color and Water-Holding Capacity of Fresh Pork

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*Longissimus* sections from normal (N), dark firm and dry (DFD) and halothane carrier (HC) pigs were placed into intermediate (IT) and high temperature (HT) incubation treatments for 0, 1, 2, 4, 6 or 8 hours. Post-mortem pH and temperature declines, Hunter color (L\*, a\* and b\*) values, percent purge loss (PL), drip loss (DL) and water-holding capacity (WHC) were measured. Muscle temperature did not differ between muscle conditions in most comparisons; however, the rate of decline differed for the various incubation times and temperatures. Time and incubation temperature did not affect the pH decline, PL, L\* values, or WHC for DFD samples. DFD samples had the least pH decline, lowest PL, lowest L\* value, the highest a\*, the lowest DL, and the highest WHC. HT increased pH decline, PL, L\* and b\* values and decreased WHC in N and HC samples. HT, N and HC samples had the highest PL and the lowest WHC. Results from this study suggest that there is a strong pH and temperature interaction on pork quality attributes. Incubation temperature had an effect on most quality parameters; however, muscle condition (N or HC) had limited effect on muscle quality.

### Preliminary Characterization of Neonatal Ovine Skeletal Muscle Proteoglycans

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Neonatal ovine *longissimus* and *biceps femoris* muscles were analyzed for proteoglycan content by buoyant density, molecular sieve characteristics, nitrous acid deamination, and chondroitinase digestion. Proteoglycans were separated into four fractions (D1 through D4) by CsCl isopycnic gradient separation. The majority of proteoglycans extracted had a low buoy-

ant density in the range 1.43 - 1.45 g/ml. Sephacryl S-200HR column chromatography revealed a proteoglycan population with an estimated  $M_r$  greater than or equal to 250,000 daltons in both muscles. Nitrous acid deamination and chondroitinase digestion showed that both muscles contain heparan sulfate and chondroitin/dermatan sulfate with no difference in the glycosaminoglycan component between the two muscles. The results from this investigation indicate the presence of heparan sulfate and chondroitin/dermatan sulfate proteoglycans in both the *longissimus* and *biceps femoris* muscles at the neonatal stage of ovine development.

### The Effect of Vitamin E Supplementation of Lamb Quality

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We studied the effect of vitamin E supplementation on lamb quality. Sixteen crossbred wethers averaging 44.1 kg. were divided into treatment and control groups. Treatment animals (n=8) were fed a diet supplemented with 2000 IU  $\alpha$ -tocopheryl acetate/day and control animals (n=8) were supplemented with 24 IU/day for 42 days. There were no treatment differences ( $P>0.05$ ) in feed intake, weight gain or carcass traits. Although a significant increase ( $P<0.05$ ) in plasma vitamin E concentrations in treatment animals (0.28 mg/ml) versus controls (0.05 mg/ml) was observed, retinol concentrations were not different ( $P>0.05$ ). There was no difference ( $P>0.05$ ) between control and treatment animals for myoglobin stability of loin and sirloin slices stored at 4°C. There was a delayed decrease ( $P<0.05$ ) in "a" values and slower increase in Hue values of minced *semimembranosus* from supplemented animals when compared to control animals after 6 days of storage, indicating color stability. Vitamin E supplementation significantly decreased ( $P<0.05$ ) lipid oxidation of minced *semimembranosus* after 3 days of storage at 4°C. No differences were evident in bacterial growth until day 9 when vitamin E samples demonstrated a lower load. The study indicates that vitamin E supplementation decreased lipid oxidation and partially stabilized color of minced lamb. Color stability of whole lamb slices was not affected by treatment.

### Tenderness and Aging Response of Beef Muscles Before and After Freezing

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This study was designed to determine the aging response and tenderness of six different beef muscles before and after freezing. The *infraspinatus*, *supraspinatus*, *longissimus dorsi*, *psaos major*, *semimembranosus*, and *semitendinosus* were cut into 2.5 cm steaks from the right and left sides of 28 beef carcasses representing the USDA quality grades of average Choice, low Choice, high Select and low Select. Two steaks/muscle/side were assigned to aging periods of 2, 5, 7, 14 or 21 days. One steak from each aging period was aged prior to

freezing and the second steak was frozen prior to aging. Steaks frozen before aging had higher ( $P<0.05$ ) purge and cook losses than steaks frozen after aging. Warner-Bratzler shear force values were similar ( $P>0.05$ ) for both treatments. The *infraspinatus*, *longissimus dorsi*, and *semitendinosus* muscles showed no decrease ( $P>0.05$ ) in shear values beyond 14 days of aging. The *psaos major*, *supraspinatus* and *semimembranosus* muscles did not change ( $P>0.05$ ) over the aging period. Except for the *infraspinatus*, all muscles from low Choice carcasses had lower shear values when compared to carcasses from other quality grades. No difference ( $P>0.05$ ) was observed for shear values of the *infraspinatus*, *longissimus dorsi*, *psaos major* and *semimembranosus* muscles from Select carcasses. Muscles from average Choice carcasses were higher ( $P<0.05$ ) in fat content than muscles within the low Choice and Select grades. This study indicates that freezing will not significantly affect the overall aging response and tenderness of muscles.

### Physicochemical and Electromagnetic Characterization of Post-Mortem Changes in Porcine Muscle

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Detection of quality defects in porcine muscle using electrical measurement and proton ( $^1\text{H}$ ) nuclear magnetic resonance (NMR) was investigated. Interrelationships among electrical and electromagnetic properties, pH values, ATP decline, temperature, time post-mortem, and final water-holding capacity (WHC) of porcine muscle were studied. Twenty-five hogs were used in the first portion of the study. Immediately after exsanguination, a section of the left *longissimus* (LM) muscle was excised to obtain rigor shortening patterns and complex impedance measurements over a 10-hour period at 37°C. Complex impedance measurements were taken using a tetrapolar electrode configuration at 1 kHz and 0.156 mA. At 15, 45 and 90 minutes post-mortem, pH, ATP/IMP absorbance (R), and conductivity measured by the Tecpro PQM probe (PQM) were measured on the right side LM. At 24 hours post-mortem, WHC, pH, R, PQM, Hunter Color Lab values, subjective quality scores, and NMR measurements were evaluated on the LM. WHC measurements were used to group carcasses into normal (n=17) and abnormal (n=8) categories. Mean pH and R at 45 and 90 minutes were different ( $P<0.05$ ). pH at 24 hours was not different between the normal and abnormal groups. PQM values were higher ( $P<0.05$ ) in the abnormal group at 90 minutes and 24 hours post-mortem. Excised muscle measurements of relative impedance (Z) and phase ( $\emptyset$ ) showed Z and  $\emptyset$  increased more rapidly within the first 15 minutes post-mortem ( $P<0.1$ ) for samples with abnormal WHC. No significant difference between means was measured by NMR relaxation times. LM samples from 19 randomly selected carcasses were used to investigate the relationship between NMR relaxation times and total water percentage, WHC measured by hydraulic press method and drip loss. Lower WHC and higher drip loss were correlated to the population of protons with short  $T_2$  relaxation times ( $r=.5$ ;  $P<0.1$ ).