General Abstracts

Protein Extraction From Beef Bone Residue For Use In Sausage Batters

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The objective of this project was to investigate the efficacy of protein extractability using various extraction solutions (4% sodium chloride; 4% sodium chloride with either 0.3% sodium tripolyphosphate, 0.3% tetrasodium pyrophosphate or 0.05M sodium hydroxide) on three different bone residues (vertebra, rib or leg). In addition, the extraction protein was evaluated as an ingredient in finely comminuted sausage products. Proteins were extracted from crushed bone residue by combining bone and solution in a centrifuge bottle, agitating on a wrist shaker for 24 hrs and centrifuging. Protein content of the supernatant was determined and original protein content of bone was used to calculate the efficiency of extraction. Proteins were recovered from the supernatant by dialysis against 0.3 M KPO_4 or by acid precipitation with 3 N HCl. Highest protein recovery was observed from vertebra and rib bones. Dialysis worked best to recover proteins when the protein concentration in the extraction solution was low. Acid precipitation worked best when concentrations were high. Proteins extracted from beef bone residues performed equally as well as other commercially available proteins (soy, whey, and plasma) when added to a finely comminuted sausage product.

Antimicrobial Activity of Cetylpyridinium Chloride Washes Against Pathogenic Bacteria on Beef Surfaces

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Cetylpyridinium chloride (CPC) is a water soluble, neutral pH, colorless compound that has been used for over 40 years in oral hygiene products including toothpaste, throat lozenges, and mouthwashes. CPC can effectively reduce populations of *Campylobacter jejuni*, *Escherichia coli* O157:H7, and *Salmonella typhimurium* on poultry surfaces. CPC also prevents the growth of *Salmonella* spp. if CPC-treated carcasses become cross contaminated during processing. In this study, a fecal slurry containing antibiotic resistant *E. coli* O157:H7 and *S. typhimurium* was inoculated on to pre-rigor beef shortplates, left untreated, or spray washed (125 psi, 15 s, 35°C) with water or 10 mg/ml CPC. Not only did CPC immediately reduce populations of *E. coli* O157:H7 and *S. typhimurium* to virtually undetectable levels (0 $\log_{10}$ CFU/cm^2), but aerobic plate counts (APC) were also effectively reduced to 0.6 $\log_{10}$ CFU/cm^2. After 35 days of refrigerated (4°C), vacuum-packaged storage, it was demonstrated that CPC also exhibited residual activity such that populations of APC, *E. coli* O157:H7 and *S. typhimurium* were suppressed to levels of 1.70, 0.00, 0.00 $\log_{10}$ CFU/cm^2, respectively. Selective enrichment of day 35 samples did not recover either of the pathogens. Preliminary sensory evaluation indicated that no unacceptable organoleptic properties (flavor, color, texture) were detected when beef steaks were treated with 10 mg/ml CPC and cooked. This study demonstrates that CPC is effective for reducing both aerobic and pathogenic bacteria, thereby improving the microbiological safety, stability, and overall quality of beef products.

[1]Names are necessary to report factually on available data, however the USDA neither guarantees nor warrents the standard product, and the use of the name by USDA implies no approval of the product to the exclusion of others that may also be suitable.

Evaluation of Antioxidant Effectiveness For Improving Quality of Irradiated Ground Beef

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Irradiation has recently been approved for beef products to reduce pathogenic microorganisms and extend shelf life. The effectiveness of irradiation for microbial control is well-documented, however, effects of irradiation on beef product quality is not well established. Some observations of irradiated meat at high doses also suggest oxidative change may occur as a result of irradiation treatments. Oxidation of fresh ground beef normally leads to decreased shelf life and undesirable color characteristics, which equates to economic losses to the meat retailers.

This study was designed to determine the effects of packaging and antioxidants during irradiation on the shelf life of irradiated fresh ground beef. Rosemary oleoresin and sodium erythorbate were added to coarse ground beef at a rate of 0.25%. In a separate treatment, vitamin E was fed at

a rate of 2000 IU per day for 42 days prior to slaughter. The ground beef was made into patties and packaged in three packaging environments for irradiation: permeable overwrap, vacuum packages with oxygen impermeable film and vacuum packages with oxygen absorbers. Half of each treatment and package type were irradiated. Packages were randomly selected during storage for color measurement indicated by a Hunter CIE system and oxidation as indicated by Thiobarbituric Acid test. The a* and b* values were higher ($p<.0001$) for non-irradiated vs. irradiated product. L* values were different ($p<.0001$) for antioxidants, with means of 49.1, 50.2, and 51.0 for vitamin E, rosemary, and erythorbate, respectively. The a* and b* values were different ($p<.0001$) with an increasing trend for rosemary, vitamin E, and erythorbate, respectively. TBA values were lower ($p<.0001$) for non-irradiated vs. irradiated product. Antioxidants provided a significant improvement on TBA values of irradiated beef but did not significantly affect the color. Results suggest that all the antioxidant treatments have potential to improve quality in irradiated fresh ground beef.

Textural and Physical Properties of Fat-Free Turkey-Beef Frankfurters: Effects of Non-Meat Ingredients and End-Point Temperature

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The effects of NaCl (1 and 2%), added-water (AW; 30 and 40%), milk protein hydrolysate (MPH; 1, 2 and 3%), and end-point cooking temperature (EPT; 71.1 and 76.7 ^{o}C) were examined. Regardless of the formulation, all turkey-beef frankfurters contained less than 0.4% fat. As levels of NaCl in the formula increased, the frankfurters had lower ($p< 0.05$) penetration values (total energy and peak force) but higher ($p< 0.05$) shear stress and shear strain. In addition, higher salt resulted in lower ($p< 0.05$) cooking loss, moisture content, protein content, and in darker frankfurters. Increasing AW level reduced ($p< 0.05$) penetration values (total energy and peak force), shear stress, and hardness but increased ($p< 0.05$) cohesiveness. Higher level of AW not only resulted in a higher ($p< 0.05$) moisture content but also resulted in higher ($p< 0.05$) cooking loss and purge loss. Higher AW products were lighter ($p< 0.05$) in color and less red. Increasing the amount of MPH increased ($p< 0.05$) shear stress but lowered shear strain. Higher MPH reduced ($p< 0.05$) cooking loss and produced darker, more yellow, and less red frankfurters. Higher EPT increased ($p< 0.05$) cooking loss and shear stress, but decreased penetration values (total energy and peak force), shear strain, and cohesiveness. Higher EPT produced lighter ($p< 0.05$) colored frankfurters. There were some two and three-way independent variable interactions ($p< 0.05$) for shear stress, shear strain, and cohesiveness. Of the four independent variables evaluated, AW and EPT most influenced textural properties. By using various combinations of these four independent variables, the meat processors should be able to improve the quality characteristics of fat-free frankfurters.

The Influence of Dietary Chicken Litter on the Retail, Palatability, and Consumer Acceptance Properties of Beef

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Twenty Holstein steers were randomly allocated to two groups (control and treatment) at a mean weight of 334.3 kg and were put on backgrounding rations consisting of 97.1% corn silage, 2.6% canola meal, and 0.3% mineral mix for controls and a 95.3% corn silage, 4.4% poultry litter, and 0.3% mineral mix for treated animals. The poultry litter was a pelleted supplement prepared from caged layer litter from a single producer. Both control and treated animals remained on the background ration for 133 days. They were then switched to a finishing ration for 99 days or until a mean slaughter weight of 536.6 kg was achieved. Finishing rations consisted of 72.6% corn silage, 3.9% canola meal, 23% barley, and 0.2% mineral mix for controls and 62.1% corn silage, 5.6% poultry litter, 22% barley, and 0.2% mineral mix for treated animals. Boneless longissimus lumborum and thoracis steaks were aged for six days. For all intentional purposes, treated samples were indistinguishable from control samples in both palatability and consumer acceptance, based upon palatability. However, treated samples exhibited an additional day of color stability and retail case-life during four days of simulated aerobic display.

The Predictive Value of the MIRINZ Tenderness Probe

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An instrument was proposed, designed, and built at the Meat Industry Research Institute of New Zealand (MIRINZ) to predict the tenderness of meat. The instrument consists of two sets of pins on which meat samples are impaled. Tension is applied to the muscle fibers by one set of pins which rotate relative to a static set of pins. The torque required to rotate the inner (rotating) pin set is measured. Two configurations have been developed for the two sets of pins. One configuration is designed to provide a shearing action while the other applies tension only. Peak torque value (Peak), maximum slope before the peak (slope), torque at 60°C of rotation (D60), area under the curve before the peak (Area 1), area under the curve before 60°C of rotation (Area 2), and area under the entire curve (Area 3) were used as potential predictors of tenderness. For raw samples of two different muscle D60 values were the most highly rated to both sensory and consumer properties, and were the values of choice, since all probe values were ap-

parently measuring the same characteristics. Assessments made using both the tension and shear heads on raw and cooked striploin steaks confirmed probe values were essentially measuring the same characteristics, but indicated raw tension head, area 2 values were more highly related to both sensory and consumer properties than were D60 values. However, probe values from raw samples did not account for a sufficient amount of variation in either sensory or consumer properties to be useful predictors of these traits, and stepwise linear regression did not improve the predictive value of raw probe values. Probe values on cooked samples indicated the shear head and area 3 values were the values of choice, since stepwise linear regression did not significantly improve their predictive value. Based upon the amount of variation accounted for in sensory and consumer traits, probe area 3 values using the shear head on cooked samples provided greater predictive value for both sensory and consumer traits than did Warner-Bratzler shear values obtained from cooked steaks, which were either fresh or frozen and thawed. Correlations with individual parametric character notes from the texture profiles of two different muscles provided no clear indication as to the textural properties being assessed by the probe.

Destruction of Pathogens in Processed Meat by High Hydrostatic Pressure and Moderate Temperature

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High hydrostatic pressure kills microorganisms and can be used to enhance safety and shelf-life of food. In this study, we determined an effective combination of hydrostatic pressure, temperature and a bacteriocin (pediocin AcH) to reduce a high population of pathogens and to enhance safety of processed meats during extended storage at 25°C. Roast beef, Cotto salami, and summer sausage were inoculated separately with *Staphylococcus aureus* 582, *Listeria monocytogenes* Scott A, *Salmonella typhimurium* ATCC 14028 and *Escherichia coli* O157:H7 #932. Pediocin AcH was applied at 3,000 AU/g to bacteriocin treated samples. Inoculation levels of 10^7 to 10^8 cells/g or 10^3 to 10^4 cells/g were used in separate studies. Samples were pressurized at 345 MPa at 50°C for 5 minutes and immediately cooled to 4°C. In the first study, samples were enumerated immediately after pressurization in nonselective and selective media. Roast beef pressurization resulted in viability loss of 4 to 7 log cycles with *E. coli* showing the most sensitivity. Viability loss was higher in *Sta. aureus* and *Lis. monocytogenes* in presence of bacteriocin. In Cotto salami, pressurization gave 5 to 7 log cycles viability loss and pressurization with bacteriocin killed more cells. The highest viability loss was in summer sausage. In the second study, pressurized samples were stored at 25°C and tested at selected intervals up to 12 weeks for presence of pathogens. In roast beef, no cells of three pathogens were detected after 84 days of storage; however, *Sta. aureus* was detected after 1 week. None of the four pathogens were detected in summer sausage during 84 days of storage. These results suggest that a combination of hydrostatic pressure, temperature and bacteriocin may be used to increase the safety and shelf-life of processed meats.

Color Modified Pork

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The improvement of storage properties of color modified pork through the addition of diaminocyclo-hexanetetraacetic acid monohydrate (CDTA) were investigated. Restructured pork chops were manufactured from ground pork shoulders that had been color modified by washing with phosphate buffer solutions, color modified with the addition of CDTA, or not color modified as a control. Proximate analysis, cooking loss, pH, sensory traits, color (subjective and objective), and Thiobarbituric acid reactive substances (TBA) were evaluated. Color modified washed samples with or without CDTA had higher ($p<0.05$) pH and moisture content and lower ($p<0.05$) percentage protein and cooking loss than the control treatment. There was no difference ($p>0.05$) between control and color modified products for sensory traits. These traits did not change from 1 to 10 days except for flavor intensity which decreased for the color modified product. TBA values revealed that the washed product did not become rancid with or without CDTA, until after 10 days of display; whereas, the control samples were as rancid the first day. The modification produced a lighter colored ($p<0.05$) product that is less vulnerable to rancidity.

Effects of Revalor Implants on Fresh Beef Color and Quality

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Sixty-six steers initially averaging 253 kg were used to evaluate the effects of Revalor-S implants on fresh meat quality, color, and physiological maturity. One-third of the steers were randomly allotted as controls (C), one-third of the steers were implanted with Ralgro on d-0 and reimplanted on d-56 with Revalor-S (Rev1), and the remaining 22 steers were implanted with Revalor-S on both d-0 and d-56 (Rev2). Following administration of the second implant, cattle were fed for a minimum of 100 days. Twenty-four hours postmortem, carcass data and samples were collected. Steaks from the loin were removed, vacuum packaged, and aged for 14 d. After aging, steaks were placed in a foam boat overwrapped with PVC and displayed in a retail case at $0 \pm 3^{\circ}$ C for 3 days. On d-0, 1, 2, and 3 of retail display, fresh beef color was objectively

determined with a Minolta Chroma Meter. Additionally, 3 cartilagenous buttons from the dorsal processes of the 9-11th thoracic vertebrae were removed 24 h postmortem and stored frozen (-20°C) until analyzed for mineral content as an objective determinant of physiological maturity. The GLM procedure of SAS was used to analyze the data using days on feed as a covariate. The L* value was not affected by treatment. The a* and b* values were reduced by implant treatments, and the effect was magnified on d 1-3 of retail display. The a* values for C, Rev1, and Rev2 treated steaks were 17.70, 16.94, 16.00 $\pm$ .54 (P<.09) on d-0; 18.66, 17.65, 17.20 $\pm$ .54 (P<.06) on d-1; 17.85, 16.62, 16.49 $\pm$ .42 (P<.04) on d-2; and 17.82, 16.57, 16.29 $\pm$ .41 (P<.02) on d-3; whereas b* values were 9.84, 9.03, 8.82 $\pm$ .35 (P<.11) on d-0; 10.52, 9.53, 9.39 $\pm$ .30 (P<.02) on d-1; 10.17, 9.17, 8.96 $\pm$ .28 (P<.01) on d-2; and 9.94, 9.10, 8.86 $\pm$ .41 (P<.01) on d-3, respectively. Percentage of ash in the thoracic buttons increased (P<.01) due to implants (1.82, 3.01, and 4.53 $\pm$ .38% for C, Rev1, and Rev2 cattle, respectively). Using objective determinants for color and maturity, aggressive implant programs may reduce the a* and b* objective color values and increase bone ossification.

The Influence of Glucose, Fructose, Sucrose, NaCl, Alcohol and Their Concentrations Upon Lipid and Oxymyoglobin Oxidation in Liposomes

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Glucose, fructose, sucrose, NaCl and alcohol are commonly used in regular diets, food preparation and food processing. Liposomes have been used as a model system to study oxidation behavior of lipids, lipid-soluable compounds and proteins such as myoglobin. In this study, phosphatidyl choline (PC) liposomes (MLV) incorporated with oxymyoglobin (oxyMb) were used as a model to investigate the influence of glucose, fructose, sucrose, NaCl, alcohol and their concentrations upon phospholipid (PL) and oxyMb oxidation. The concentrations of glucose, fructose, and sucrose were 0.1, 0.2, 0.3, and 0.4 M. The concentrations of NaCl were 0.03, 0.07, 0.1, 0.2, 0.3, and 0.4 M. Alcohol at concentrations of 2%, 5%, 10%, and 15% was used. These materials were directly added into oxyMb solution, liposomes, oxyMb-liposomes right before incubation (37°C for 12 hr). Lipid oxidation of liposomes and Mb-liposomes was measured by TBA assay. Oxymyoglobin oxidation was determined by measuring percent metMb (MetMb %) formation in Mb solution and Mb-liposomes.

Glucose and sucrose at concentrations of 0.2, 0.3, and 0.4 M accelerated both membrane PL and oxyMb oxidation (p<.0.05). The prooxidant effect of sucrose was greater than glucose at equal concentrations (p<0.05). Fructose at concentrations of 0.1, 0.2, 0.3, 0.4 M was not a prooxidant to PL (p>0.05), but had a protective effect to oxyMb (p<0.05). NaCl at concentrations >/0.1 M and alcohol at concentrations 10%, 15% reduced the stability of both membrane PL and oxyMb (p<0.05). For most treatments, greater PL and oxyMb oxidation were found in Mb-liposomes than in lipsosomes or Mb solution (p<0.05).

In this liposome model, glucose, sucrose, NaCl and alcohol at high concentrations reduced the stability of membrane lipid and oxyMb. These materials at these concentrations may be prooxidants in muscle foods. Therefore, the use of these materials at high concentrations in muscle foods should be carefully.

Effects of pST and β-agonist on growth performance carcass composition and meat quality on Taihu crossbred pigs.

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Effects of Clenbuterol and pST on Pig's Performance

Treatment	Food intake (kg/d)	Live weight (kg)	Carcass weight (kg)	Eye muscle area (cm^2)	Backfat 6-7 rib (cm)	Backfat Mean 3 Point (cm)	Heart (kg)	Live (kg)	Shear Force (kg)	Water Loss (%)
CL	2.96	86.44	63.9	47.3**	1.93*	2.17*	323	1.48	4.83	13.8
pST	2.72	86.39	63.3	40.3	2.43	2.37	388	1.8	4.23	16.8
CL+pST	1.76	73.39	55.4	39.7	1.62**	1.87**	327	1.38	4.61	15.7

Note: 1. 9 pigs for each treatment
*2. * p<0.05; ** p<0.01 compared with the control group*

Thirty-six castrated crossbred [Large White X (Large White X Taihu)]pigs were used to investigate the effects of β-adrenergic agonist clenbuterol (CL) and porcine somatotropin (pST) on their growth performance, carcass characteristics, and meat quality. Pigs weighing about 70 kg were randomly divided into four groups. The animals were housed in four pens and were allowed free access to water and feed that contained about 17.6% crude protein and 12.3 MJ of digestable energy (DE). Pigs in the first group were given CL in their diet (3mg/kg); the second group were given daily muscle injections of 5mg pST for each animal; pigs in the third group were treated with CL as well as pST, a fourth group served as the control. The treatment lasted for 14 days. Weight gain and feed consumption were recorded. After pigs were slaughtered, carcass weight, dressing %, backfat depth, and loin eye muscle area were recorded. A sample of *longissimus* muscle was also removed from each carcass and used to measure water holding capacity, meat color, shear force, and intra muscular fat content.

Compared with the control, CL treatment reduced back fat by 15.6% - 23.1%, and increased eye muscle area by 19%, pST reduced back fat by 7.8%, but no effect was found on eye muscle area. An unexpected response was observed when pST and clenbuterol were given in combi-

nation. The marked decrease in live weight gain reported in the table below was reflected by a similar decrease in voluntary food intake. The 9.7 kg difference in body weight between treated and control pigs was reflected by a 6.25kg difference in carcass weight, but it appeared that all of this difference was accounted for by a decrease in fat. Thus eye muscle area was unaffected by the treatment, whereas backfat thickness was decreased by between 27 and 35%.

It was also found that pST treatment resulted in an enlarged heart and liver, CL treatment increased pork's shear force, while reducing its water loss. But these differences between treatments and the control were not statistically significant.