Graduate Student Research Poster Competition

The Effect of Internal Temperature at Time of Processing on Storage, Retail and Palatability of Beef Rounds

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The effect of accelerated processing on internal temperature and on storage, retail and palatability characteristics was studied using IMPS #160 rounds from 21 steer carcasses, all of approximately the same maturity, weight and finish. Rounds were removed from the carcasses at 24 hr, vacuum packaged and either boxed immediately or chilled in a cascading shower of −4° or −11°C propylene glycol. Rounds for the control treatment were removed at 48 hr postmortem, vacuum packaged and boxed. Prior to packaging, rounds removed at 24 hr had an average internal temperature of 14°C as compared to 5°C for the control treatment. Control rounds chilled more quickly than those in other treatments. Rounds processed at 24 hr without a glycol chilling treatment chilled slower than those in other treatments. For the glycol chilled rounds, the −11°C treatment resulted in more rapid chilling than the −4°C treatment. Internal temperatures equilibrated to 4°C by Day 3. After 15 days at 0° to 1°C, there were few differences in storage characteristics among treatments. Rounds from the −11°C had more ($P<.05$) fat cover discoloration than did those from other treatments, perhaps a result of the crust freezing that occurred at this glycol temperature. Retail display characteristics of top round steaks, evaluated at 1, 24 and 48 hr of display, indicated no differences among treatments. All steaks were acceptable at 1 and 24 hr but were slightly unacceptable at 48 hr. No differences among treatments were detected for Warner-Bratzler shear force values or moisture percentages. Lack of significant treatment differences suggests that beef rounds could be processed at 24 hr with accelerated processing systems without detriment to the product.

Physical and Sensory Attributes of Stimulated and Non Stimulated Vacuum Packaged Pork

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Boneless loin segments (blade end and sirloin end) and Boston shoulders were obtained from 12 electrically stimulated (ES) and 12 nonstimulated (NS) carcasses to determine the effects of electrical stimulation and various processing treatments on the physical and sensory attributes of vacuum packaged pork. ES carcasses were pulse stimulated (1.9s on, 1.5s off) with 550V, 5.5A for 105s. The ES left sides (ESHP) were deboned 1h postmortem, vacuum packaged and brine chilled to an internal temperature of 3°C, while the ES right sides (ESCP) were conventionally chilled (2°C) for 24h, then deboned and vacuum packaged. The left sides (NSHP) from the NS carcasses were conditioned at 17°C for 3h prior to deboning, vacuum packaging and brine chilling to 3°C. NS right sides (NSCP) were chilled (2°C) for 24h, then deboned and vacuum packaged. Upon completion of each processing treatment, the vacuum packaged cuts were stored at 0°C for 21d. Mean values for percentage cumulative weight loss of the loins and percentage purge for the Boston shoulders did not differ significantly among treatment groups. However, NSHP blade end and ESCP sirloin end segments exhibited the highest levels ($P<.05$) of purge. Loin chops from ESCP carcasses received the lowest ($P<.05$) sensory ratings for flavor and overall desirability. ESCP chops were also rated as less juicy than chops from either NSCP or ESHP carcasses. Subjective and objective tenderness measurements revealed that loin chops from ES carcasses were significantly less tender than those from NS carcasses. Overall, boneless loins and Boston shoulders from ES and NS carcasses were similar in packaging characteristics. However, sensory traits of chops from ES carcasses were marginal in acceptance.

Effects of Electrical Stimulation and Hot Boning on Functional Characteristics of Preblended Beef Muscle in Model Systems

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This study was designed to determine the effects of electrical stimulation (ES) and hot boning on the emulsifying capacity (EC) and thermal emulsion stability (TES) of preblended Triceps brachii (TB) muscle (long head) samples from beef sides (n = 60) assigned to one of four treatments: 1) conventionally boned after chilling at 2° to 8°C until 48 hr postmortem (CB); 2) hot boned at 1 hr postmortem (HB); 3) ES at the time of bleeding and conventionally boned after chilling at 2° to 8°C until 48 hr postmortem (ESCB); and 4) ES at the time of bleeding and hot boned at 1 hr postmortem (ESHB). Coarse ground TB muscle was preblended with salt (3%) and stored at 4°C for 24 hr. At all pH measurement times, HB muscle had higher ($P<0.05$) pH values than CB muscle in both stimulated and nonstimulated carcasses, but ES decreased ($P<0.05$) these values in HB sides. HB preblended samples had greater EC and TES values than CB preblended samples from both nonstimulated ($P<0.05$) and stimulated carcasses, but ES decreased ($P<0.05$) these values in both HB and CB sides. The accelerated pH decline rate caused by ES, along with high carcass temperature, may alter muscle protein solubility and thus decrease the EC and TES of preblends from stimulated sides. Preblending appeared to maintain the desirable functional characteristics of HB muscle during 24 hr of storage. Correlation analyses showed positive correlations ($P<0.05$) between pH values and EC and negative correlations ($P<0.01$) between pH values and emulsion cooking loss.

The Effect of High-Voltage Electrical Stimulation on Tenderness Parameters in Straightbred and Crossbred Cattle Produced from Three Limited Grain Feeding Times

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Thirty-four straightbred and crossbred steers were randomly assigned feeding times of 60, 92 and 135 days on grain and slaughtered immediately upon termination of these treatments. Breed composition of these steers included Angus (A) and Brahman (B) along with crosses of $A_{11}B_5$ and $B_9H_5A_2$. A randomly selected side from each carcass was electrically stimulated (500 volts) for 90 seconds. After 48 hours, carcass information was collected and the short loin portions of the longissimus muscle, along with the semitendinosus muscle, were frozen at −10°C for sensory evaluation, Instron shear test, myofibrillar fragmentation and sarcomere length determination.

Brahman carcasses had the lowest quality grade and the least back fat, which resulted in the lowest yield grade while Angus carcasses had the highest quality grade, as well as highest yield grade. Brahman crossbreds averaged between the two straightbred groups for carcass traits. Carcass traits were not affected by electrical stimulation.

Temperature decline during chilling was not affected by electrical stimulation or fat thickness. The heavier crossbred cattle tended to chill at a slower rate than B or A. Fat thickness increased as the steers remained on feed for a longer time. Feeding time had little or no detectable effect in the organoleptic scores for flavor and juiciness; however percentage cook loss increased with time on feed. Electrical stimulation did not affect flavor, juiciness or cook loss.

Electrical stimulation improved sensory panel tenderness and connective tissue ratings as well as shear force values ($P<.05$) for the B carcasses. Sensory tenderness and connective tissue scores were found to be highly correlated with shear values ($r = -.73, -.74$, respectively). ES had no effect on the fragmentation index or sarcomere length.

Thermally-Induced Gelation and Interactions of Myosin, Albumin and Fibrinogen

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Myosin, fibrinogen, albumin, myosin-albumin and myosin-fibrinogen gels were formed by heating in pH 6.0 phosphate buffer at three heating rates. Turbidity (A_{660} nm) and solubility were monitored along with gel strength. Myosin, fibrinogen, and myosin-fibrinogen gels formed by heating at 12°C/hr were disrupted with guanidine hydrochloride, urea, and 2-mercaptoethanol. The degree of disruption was quantitated by turbidity and soluble complexes were analyzed by gel filtration and by gel electrophoresis. Myosin, albumin and fibrinogen suspensions became turbid and solubility decreased at temperatures prior to development of gel strength. Linear heating rates of 12°C/hr and 50°C/hr produced the strongest myosin gels at 70°C, whereas albumin gels were strongest when formed either by heating to 95°C at 12°C/hr or constant heating for 20 min at 95°C. Myosin and fibrinogen interacted to form a gel which was stronger than the sum of the gel strengths for the two individual proteins. The strength of myosin-fibrinogen gels formed between 55°C and 70°C was related to heating method. Myosin-albumin gels were generally lower in strength than myosin-fibrinogen gels. Myosin and albumin did not interact to form a gel matrix

until 80°C. Myosin, fibrinogen, and myosin-fibrinogen gels were stabilized by both non-covalent and disulfide bonds and gels formed at 70°C were more difficult to solubilize than gels formed at 50°C.

The Enhancement of Non-heme Iron Bioavailability by Muscle Proteins

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Muscle protein can substantially promote non-heme iron bioavailability in man. The mechanism for this effect is unknown. The first objective of this study was to demonstrate that the rat could be used as an animal model to study the "meat factor" effect. Anemic rats were used to compare the availability of iron from rice bran protein or soy protein concentrate when beef protein was added to the diet in place of lactoalbumin. The relative biological value of iron from these diets was determined by comparing hemoglobin regeneration and growth rate to that of a control group of animals receiving a reference standard ($FeS0_4$). The beef protein was washed with distilled water to remove the water soluble heme fraction. Washed beef improved the relative biological value of soy protein iron from 88% to 93% (N.S.) and significantly enhanced the availability of iron in rice bran protein from 47% to 71% ($P<0.05$). Phosphorus has been reported to adversely affect iron bioavailability. A second objective of the study was to investigate the possibility that washed beef counteracted an inhibitory effect due to phosphorus or phosphorus-containing compounds, such as phytate. Washed beef was compared to lactoalbumin at three levels of inorganic phosphorus and three levels of rice protein. Beef protein was again found to significantly enhance the rice bran protein iron availability ($P<0.05$). An interaction between rice protein and washed beef was also observed ($P<0.05$), but inorganic phosphorus had no effect on iron availability. Results of this research establish that an animal model exists which could be used to further study the mechanism of the "meat factor" effect. Beef protein seems to be interacting with dietary constituents to cause the enhancement; this interaction is not with inorganic phosphorus.

Cooked Yield Factors and Palatability Characteristics of Fresh and Frozen Bottom and Top Round Roasts

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Cookery methods can influence the cooked yield and palatability of roast beef. The roast storage temperature and individual muscles (AD = Adductor, BF = Biceps femoris, SM = Semimembranosus) may also play an important role in the economic and sensory aspects of roast beef cookery. The objective of the study was to evaluate the effect of fresh or frozen bottom (BF) and top (split: AD or SM) round roasts on cooked yield factors and palatability. Fresh or frozen (tempered 48 hours at 1.6°C) roasts were placed on racks in pans containing 1 kg water, covered, tightly sealed with aluminum foil, and cooked in a 93.3°C convection oven to an internal roast temperature of 60°C. Weights were recorded for calculation of roast yield data. Sliced samples were evaluated by a trained sensory panel for muscle fiber tenderness, connective tissue amount and juiciness. Lee-Kramer Shear Force and Instron Adhesion values were obtained as measures of connective tissue. The AD and SM muscles differed only in muscle fiber tenderness and connective tissue amount (SM superior for each trait). Both the AD and SM ratings were greater than the BF scores. For other comparisons, values from the AD and SM were pooled. Fresh roasts had significantly greater cooked and sliced yields and shorter cooking times than did frozen roasts. Top round roasts were significantly more juicy and tender (higher muscle fiber ratings, lower connective tissue scores, lower adhesion peak force and area under the curve), had more desirable composition (lower percent fat, higher percent moisture) and were more economical (more servings/kg and less cost/serving) than bottom round roasts. These data indicate that fresh roasts maximize cooked and sliced yield while top round roasts improve yield, cost and palatability.

The Interaction Between Salt Levels and Rigor Condition as It Affects Physical, Chemical and Quality Parameters of Tumbled, Cured Porcine Muscle

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This experiment was designed to determine the effects of salt level and rigor condition in long and short term tumbled porcine muscle on: (1) the degree of muscle distortion and cellular disruption; (2) the resulting levels of salt soluble proteins (SSP) and muscle water holding capacity (WHC); and (3) cooked product cohesiveness, yield, appearance and eating quality. Eighty boneless hams were cured to achieve a finished salt level of 1.25% or 2.25%. Post-cure processing consisted of: (1) cured post-rigor intermittently tumbled for 18 hr; or cured pre-rigor and (2) held without tumbling; (3) tumbled intermittently for 18 hr; (4) tumbled intermittently for 6 hr; or (5) tumbled continuously for one hr. All pre-rigor cured treatments showed a significant ($P<0.01$) decrease in pH during the 18 hr tumbling or holding period, indicating that salt did not completely stop glycolysis. Tumbling pre-rigor (18 hr) cured product slowed glycolysis and rigor and gave

significantly ($P<0.05$) more uniform cured color and appearance than the post-rigor treatment. Short term tumbling (6 hr) gave results comparable to traditional tumbling of post-rigor (18 hr) hams, but would require a higher (2.25%) salt level and suggests considerable energy savings. Low salt (1.25%) in pre-rigor tissue helped cohesiveness and sliced appearance in 18 hr pre- and post-rigor cured hams, but would hurt pre-rigor cured 6 hr tumbled hams. The higher salt level significantly ($P<0.01$) improved cured flavor scores in all processing treatments. The use of reduced salt level in tumbled pre-rigor meat appears possible if consumer acceptance for low salt products can be achieved.

Palatability and Muscle Properties of Beef as Influenced by Pre-Slaughter Growth Rate

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This study was undertaken to determine if growth rate before slaughter affected beef palatability. Thirty-six Hereford-Angus yearling steers, average weight 247 kg, were assigned to 1 of 3 feeding regimens for 120 d. Treatment 1 (T-1) steers were fed ad libitum to obtain maximal live weight gain; average daily gain (ADG) was 1.42 kg. Treatment 2 (T-2) steers were restricted to an ADG of .77 kg. Treatment 3 (T-3) steers were restricted to an ADG of .34 kg. Left sides of carcasses from T-2 and T-3 were chilled so that rate of temperature decline in the longissimus (LD) muscle matched that of the fatter, heavier carcasses from T-1. A trained sensory panel rated steaks from the LD and semimembranosous (SM) muscles of T-1 steers more tender ($P<.05$) than those from T-2 or T-3. Warner-Bratzler shear values agreed with the sensory panel data. Steaks from T-3 were slightly less tender than those from T-2. Lower tenderness in T-2 and T-3 was associated with slightly higher intramuscular collagen thermal shrinkage temperatures of LD and SM muscles and greater collagen content and lower ($P<.05$) percentage soluble collagen in the SM. Plasma non-protein hydroxyproline concentrations were higher ($P<.05$) in T-1 steers throughout the feeding period. The LD from T-3 carcasses had shorter sarcomeres than that from either T-1 or T-2 even though carcasses were chilled at the same rate. Myofibril fragmentation did not differ among treatments. Results show that growth rate affects beef tenderness. This result is most likely mediated through the turnover and maturation rate of intramuscular collagen.

Effects of pH and Time of Grinding on Lipid Oxidation of Fresh Ground Pork

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Prerigor ground pork has been shown to be less susceptible to lipid oxidation than postrigor ground pork. Experiments were designed to test for pH and time of grinding effects on lipid oxidation. Groups of pigs were subjected to antemortem epinephrine injections or postmortem carcass electrical stimulation to manipulate ultimate postmortem pH. Prerigor samples of M. triceps brachii were excised within 45 min of exsanguination and trimmed of fat and connective tissue. Samples were ground, pressed into thin layers, wrapped in oxygen-permeable, moisture-impermeable wrap and stored at 3°C. Postrigor samples were excised 24 hr postmortem and prepared identically to the prerigor samples. Ultimate pH values were determined on all samples 24 hr postmortem. Thiobarbituric acid (TBA) values were determined at 1, 4, 8 and 12 d postmortem, and metmyoglobin percentages were determined 1, 4, 8 and 12 d after grinding. There was an inverse relationship between pH and TBA values. Samples with high pH (>6.10) had lower TBA values than samples with low pH. The nonsignificant difference in TBA values ($p>.05$) between high pH prerigor and postrigor ground samples indicated that, at common high pH values, time of grinding had no effect on lipid oxidation. Differences in TBA values ($p<.05$) between prerigor high and low pH samples and postrigor high and low pH samples indicated that, with identical grinding treatments, inhibition of oxidation occurred at high pH. Metmyoglobin levels were relatively high in both low and high pH muscle. Thus, metmyoglobin was not catalytically active at high pH.

Prediction of Pork Belly Composition Using Various Measurements of the Carcass or Belly

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As a means of developing a procedure for evaluating the merit of pork bellies for producing sliced bacon, measurements and evaluations were obtained for each of a group of 100 carcasses and for one untrimmed belly from each such carcass. Each belly was subsequently skinned and then thoroughly ground and mixed for analysis of fat content of the entire untrimmed belly. Stepwise multiple regression analysis was employed to determine the carcass or belly measures

that best identified the variation in percentage lean [100 X (belly weight - chemical fat weight) ÷ belly weight] or average visual leanness score of the cross-sectioned belly. Specific gravity of one side of the carcass was the single measurement which was most closely related to percentage lean or visual leanness score (R^2=.63; RSD = 3.34 versus R^2=.44; RSD = 1.69, respectively). The same near-optimum subset of most practical independent variables for identifying both percentage lean and average visual leanness score consisted of fat depth at the center of the longissimus muscle at the 10th rib and USDA carcass muscling score. These two variables identified 54% (RSD = 3.73) of the variation in percentage lean and 34% (RSD = 1.84) of the variation in visual leanness score. Of belly measures considered, cross-sectional visual leanness evaluation at 1/4 the length of the belly from the shoulder end best identified the variation (R^2=.55; RSD = 3.86) encountered in percentage lean in the 100 bellies. Carcass measures were almost always superior to belly measures when identifying either percentage lean or average leanness score. If more precision should be desired, less practical methods, such as specific gravity of one side of the carcass, could be included to account for more substantial portions of the variation in composition of pork bellies.

Consumer Preferences for Fat and Chop Thickness in Fresh Pork Chops

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Consumer preference responses for fresh pork loin chops were collected in three phases to determine the preferred subcutaneous fat thickness (FT), loineye area (LEA) and chop thickness. In the first phase, responses were collected in a retail market from 111 consumers based on 24 color photographs of chops which had four FT (0, 0.8, 1.5 and 2.1 cm) and LEA (26.5, 28.6, 33.2, 35.7, 37.9 and 41.2 cm^2) levels. Chops with an average FT of 0.8 cm were preferred by 53% of the respondents. Over 24% of these same consumers also preferred a LEA of 37.9 cm^2). The predominant reasons given for these preferences were amount of muscle (32%) and degree of marbling (36%). In the second phase, 120 other consumers were surveyed for their preference for thickness of pork chops using color photographs glued to styrofoam slices. The same six LEA levels were displayed on styrofoam thicknesses of 0.6, 1.3, 1.9, 2.5, 3.2 or 3.8 cm. Nearly one-half of the consumers surveyed preferred a thickness of 1.9 cm. Over 90% of the consumers preferred the thicknesses ranging from 1.3 to 2.5 cm. Only 4% preferred the "wafer thin" 0.6 cm chops often presented as family packs in supermarkets. In the third phase of the study, preferences were obtained from 90 consumers for subcutaneous FT from none to the level (0.8 cm) most preferred in Phase I. The FT presented were 0, 0.3, 0.6 and 0.8 cm. FT of 0.3 cm or less was preferred by 87% of the consumers surveyed. The 0 FT was preferred by 52% of the respondents. These results indicate that consumers prefer a large, desirably shaped LEA, FT of 0.3 cm or less and a thickness between 1.3 and 2.5 cm.

The Effect of Iron Supplementation on Growth of *Clostridium Botulinum* Type A in Chemically Defined Medium

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C. botulinum type A was studied for its growth requirements of iron, as measured by its response to iron supplementation. The bacteria were grown in a chemically defined medium containing known levels of all required nutrients. Ferrous iron was added at levels of 1, 2, 3, 4, 5, and 10 ug per ml. The basal medium containing 0.075 ug Fe per ml, as determined by atomic absorption spectroscopy, was used as control. One hundred *C. botulinum* spores were added per ml medium. Growth was measured by turbidity at 500 nm after incubation at 35°C for 12, 18, and 24 hours. No significant growth was observed at any level of added iron at 12 and 18 hours. At 24 hours, even the basal medium with only 0.075 ug iron per ml showed considerable growth. However, maximum growth was observed at the level of 3 ug of iron per ml. These preliminary experiments suggest that *C. botulinum* type A has a very low iron requirement for growth.

The Use of Butylated Hydroxyanisole and Ascorbic Acid in Restructured Pork to Assure Stability

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A frozen restructured pork patty with adequate shelf life was produced using an antioxidant to decrease autoxidation. Shoulders (with shanks removed) were taken from market hogs and boned. The lean was trimmed of excessive fat, frozen for 24 hrs and tempered to −4.4°C, after which it was flaked. The fat was frozen separately and then ground using a ⅛" plate. A mixture of lean and fat was formulated to give approximately a 20% fat content. The mixture was then divided into eight equal weight groups and assigned to treatments as follows: I. (control) 0.75% salt (NaCl); II. NaCl and 0.01% butylated hydroxyanisole (BHA) (based on fat content); III. NaCl and 0.01% ascorbic acid (AA) (based on fat content); IV. NaCl, BHA and AA combination (0.02% based on fat content); V. NaCl and 0.125% sodium

tripolyphosphate (STP); VI. NaCl, STP, BHA; VII. NaCl, STP and AA; VIII. NaCl, STP, BHA and AA. After thorough mixing, each group was formed into logs, tempered and then pressed. The resulting logs were packaged in freezer paper, frozen and then cut into 1 cm thick patties. The treatment groups I through VIII were sampled for moisture, fat, protein, NaCl, and 2-thiobarbituric acid (TBA) initially and after 30, 60 and 90 days of freezer storage. Cooked samples were evaluated for sensory attributes of flavor, texture and juiciness. Kramer Shear values, tensile strength and Warner-Bratzler shear values were performed on cooked samples. The raw samples were evaluated by the panel for color, cohesiveness, fat distribution and general appearance. BHA had a significant antioxidant effect, used singly or with adjuncts, as measured by TBA. In contrast, AA was less effective. Panel members' evaluations of the patties varied so widely that no firm conclusions could be made.