Graduate Student Poster Competition

Cimaterol Stimulates Growth and Reduces Calcium Dependent Proteinase Activity and Tenderness in Lamb Longissimus

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The purpose of this study was to investigate the effect of cimaterol, a β-adrenergic agonist, on muscle Calcium Dependent Proteinase (CDP) activity and the possible relationships between proteolytic activity, cimaterol-induced muscle hypertrophy and meat tenderness. Cimaterol was administrated at 0 or 10 ppm in a complete mixed diet to 28 ram lambs for 3 or 6 weeks. Dietary administration of cimaterol reduced micro-molar (μM) CDP activity in longissimus muscle by 62% ($P<.001$). Total CDP activity was not affected. Cimaterol treatment increased longissimus area 29.5% ($P<.001$), enhanced the growth of semitendinosus, semimembranosus and biceps femoris muscles 26%, 32.4% and 24.5%, respectively (all $P<.001$) and reduced kidney and pelvic fat 20.9% ($P<.035$). Cimaterol treatment increased Instron shear force values of cooked longissimus 14.5% ($P<.05$) and 44% ($P<.001$) at 3 and 6 weeks, respectively. The inhibitory effect of cimaterol on μM CDP activity may account for the 25%-35% cimaterol-induced hypertrophy of individual muscles and cause a reduction in postmortem myofibril degradation, contributing to the increased shear force values observed.

Physical and Compositional Characteristics of Beef Carcasses Selected for Leanness

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This study was designed to determine physical and compositional characteristics of carcasses selected on the basis of leanness. Eight typical (yield grade 2.5-3.5 with a slight to moderate amount of marbling) and eight lean (yield grade 2.0 or better with at least a slight amount of marbling) 273-330 kg beef carcasses were selected for this study. The following muscles and muscle groups were excised from the right side of each carcass: *Infraspinatus, Supraspinatus, Triceps brachii, Longissimus dorsi* rib end, *Longissimus dorsi* loin end, *Gluteal* complex, *Quadriceps* complex, *Semimembranosus, Semitendinosus* and *Biceps femoris*. Lean and typical carcasses had average final yield grades, marbling scores and hot carcass weights of 1.73 and 2.99, high Select and low Choice, and 300 kg and 297 kg, respectively. Based on the ten muscles excised; lean carcasses, on a raw basis, had higher ($P<0.05$) moisture content (74.35 cf. 72.69%), lower ($P<0.05$) fat content (3.98 cf. 5.89%), and higher ($P<0.05$) protein content (21.43 cf. 20.80%) compared to typical carcasses. No difference ($P>0.05$) was found between carcass types for collagen content. When muscles were cooked to an internal temperature of 70°C and used for comparison of lean and typical carcasses, no differences ($P>0.05$) were found for moisture, protein, cholesterol, cooking loss or shear force value. Differences ($P<0.05$) were found between lean and typical carcasses for fat content (5.96 cf. 7.44%) and total calories (176 cf. 189 kcal/100g). For the *Semitendinosus* muscle, sensory panelists rated typical carcasses higher for juiciness and tenderness. Differences ($P<0.05$) were detected between muscles for moisture, fat, protein, collagen, total calories, cholesterol (both on a cooked and dry matter basis), cooking loss and shear force value. No carcass-type muscle interactions ($P>0.05$) were found for any of the traits measured except for protein.

Effect of Trim Level, Cooking Method and Chop Type on Lipid Migration and Retention, Caloric Content and Cholesterol Level in Cooked Pork

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American consumers have changed their eating habits tremendously during the past two decades due to concerns over cholesterol, obesity, caloric consumption and saturated fat intake. The purpose of this investigation was to determine fat, caloric and cholesterol content and lipid retention of pork lean trimmed before or after cookery by several household cooking methods. Five top-loin chops (TL), rib chops (RC), and blade steaks (BS) were obtained from each side of seven pork carcasses. Cuts from one side of each carcass were trimmed of all subcutaneous fat (NF) and anatomically paired cuts from the opposite side were trimmed to 1.27 cm of subcutaneous fat (SF). Paired cuts were cooked to 71 C by

roasting, pan-frying, braising or microwaving. The remaining pair of matched cuts were analyzed raw. Cooked and raw samples were dissected into bone, fat and lean. Moisture, fat and protein were determined on the knife-separable lean component. Cholesterol content of lean from TL chops was determined. Lean from TL chops containing SF displayed more fat and calories, and similar amounts of cholesterol than NF chops, regardless of cooking method. Lean from SF and NF microwaved TL chops ($P<0.01$) exhibited the greatest percentage difference in fat (34.0%). Smaller differences were noticed in fat and caloric content within cooked lean of RC. No differences ($P>0.10$) were noted among BS differing in external fat trim, perhaps due to seam fat. Cuts having SF exhibited higher total fat retention values than NF counterparts across all cooking methods. Rib chops displayed the highest total retention values compared to other cut types, possibly due to fat migrating from the tail region of the chop. It appears elimination of subcutaneous fat prior to cooking, rather than afterwards, favorably reduced consumable fat in lean, which in turn decreased total calories consumed.

The Influence of Sex, Breed and Age on the Ossification of the Epiphyseal Plate in Sheep

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Lamb value is reduced when the epiphyseal plates at the distal ends of both metacarpal bones become fused and carcass classification changes from lamb to yearling mutton or mutton. In this study, a total of 51 ewes, 50 wethers and 51 rams of Finn x whiteface breeding or Suffolk x whiteface breeding were slaughtered at 271, 361, 459, 557 and 652 d of age to determine the factors affecting epiphyseal closure. Epiphyseal plates of the earlier maturing Finn cross ewes closed by 459 d of age. All epiphyseal plates of the later maturing Suffolk cross ewes and rams closed by 557 d but no wethers had closed by 652 d. Yearling classifications by teeth occurred in half the sheep by 459 d and all were yearlings by 557 d. Classification by teeth were not sex related as was epiphyseal plate closure. Ram testosterone levels and testicle weights were highest in July at 459 d and decreased significantly ($P<.05$) thereafter. Splenius muscle weights increased with testosterone levels but remained high relative to decreasing hormonal concentrations and testicle weight after July. Slaughter age in d correlated significantly ($P<.01$) with: eye lens weight, .72; epiphyseal plate thickness, −.83; and overall maturity, .85. Stepwise regression indicated that age was best predicted by the linear effects of eye lens weight, muscle color and texture, rib bone maturity, epiphyseal plate thickness and the quadratic effect of eye lens weight ($R^2 = .96$). Eye lens weight and classification by teeth were more indicative of age than was the sex-dependent epiphyseal plate closure.

Effects of *Bos Indicus* Breeding on Palatability and Muscle Properties

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Recent emphasis by the packing industry to discriminate against slaughter cattle showing obvious *Bos Indicus* breeding has prompted the need for a thorough investigation of the justification for these price discounts, and if justified, to gain a better understanding of why these differences exist. Steers ($n=125$) of known percentage Brahman (B) and Angus (A) breeding were used to study effects of breed type (A, 3/4A-1/4B, 1/2A-1/2B, 1/4A-3/4B) on muscle palatability, sarcomere length, fragmentation index and collagen content. Comparisons of these cattle to earlier maturing *Bos Taurus* cattle should be done at equivalent compositional end points; therefore, cattle were slaughtered at estimated preassigned fat thickness endpoints and data were analyzed with adjusted fat over the ribeye as a covariate. Steaks from A and 1/4B had lower ($P<.05$) Warner-Bratzler shear (WBS) values than steaks from 3/4B and WBS values for steaks from 1/2B tended ($P<.06$) to be lower than those from 3/4B. The A and 1/4B produced steaks with higher ($P<.05$) longissimus muscle fat percentages than the steaks coming from 1/2B and 3/4B. Sensory panel analyses showed that steaks from A and 1/4B were juicier ($P<.05$) than steaks from 1/2B and 3/4B. Steaks from A and 1/4B were rated as more tender ($P<.05$) by the sensory panel. The A steers produced steaks with lower ($P<.05$) fragmentation index values than steaks from 1/2B and 3/4B. No differences ($P>.05$) were noted for sarcomere length. The 1/2B had steaks with more total collagen and more sensory panel detectable connective tissue than all other breed groups. Increases in toughness of steaks from cattle with B breeding however, could not be explained by differences in sensory panel connective tissue, total collagen (mg/g) or percentage soluble collagen.

Effects of Glucose and Internal Cooking Temperature on the Characteristics of Low Fat, Pre- and Post-Rigor, Restructured Beef Roasts

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Meat from Holstein steers ($rep=6$) was used to produce low-fat, restructured beef roasts. Major muscle groups were excised from the chuck, rib, loin and round either pre-rigor (hot-boned, HB) or post-rigor (conventionally boned, CB) and

were subjected to four ingredient treatments: 1.) 4% water, 2% NaCl, 0.5% phosphate, 2% glucose (SPG); 2.) 4% water, 2% NaCl, 0.5% phosphate (SP); 3.) 4% water, 2% NaCl, 2% glucose (SG); and 4.) 4% water, 0.5% phosphate, 2% glucose (PG). Roasts were cooked to an internal temperature of either 63 or 93 C. Slices of the roasts were placed under continuous display conditions (4 C; 2152 lux GE Natural fluorescent lighting) for 10 days. As expected, roasts without added salt and those cooked to 93 C had a lower percentage moisture, less cohesiveness and a lower cooking yield than roasts with added salt and those which were cooked to 63 C. However, roasts cooked to 93 C had less purge upon thawing, received higher consumer acceptability scores and were perceived to have less warmed-over flavor (WOF) throughout display than those cooked to 63C. Photomicrographs showed less visible protein between muscle pieces when salt was omitted from the ingredient treatment, and roasts cooked to 93 C had larger voids in the extracted protein between muscle pieces than the roasts cooked to 63 C. Roasts from CB muscles had higher consumer acceptability scores than HB roasts when the internal temperature was 63 C. Roasts with ingredients SPG and SP had the highest acceptability scores while roasts with PG had the lowest acceptability. However, all roasts were scored acceptable regardless of the ingredient treatment. Rancidity (as indicated by sensory WOF scores and TBA values), pH values and cooking yield were higher for HB roasts than CB roasts when differences existed between HB and CB roasts. Roasts with SPG (HG and CB) and SP (CB only) maintained the lowest level of rancidity. These data show that the addition of glucose to a salt and phosphate ingredient treatment helped maintain low WOF scores, and kept TBA values below threshold (<1.0) without adversely affecting sensory cohesiveness, consumer acceptability or cooking yield.

Changes in Adipose Tissue Cellularity, Carcass Characteristics and Lipogenesis in Steers Fed Clenbuterol for 50 Days With a 90-Day Withdrawal Period

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Effects of the feeding and subsequent withdrawal of clenbuterol on adipose cellularity, lipogenesis and carcass traits were observed. Forty Angus steers (250 kg) were forage-fed to approximately 300 kg. At this time a baseline group of 8 animals was slaughtered. The remaining 32 animals were fed 7 mg/hd/d clenbuterol or no clenbuterol for 50 d. One-half of all animals were then slaughtered. Remaining steers were fed an additional 90 d withdrawal period prior to slaughter. 9-10-11th rib longissimus dorsi weight increased in clenbuterol-treated steers from 0-50 d. From 50-140 d, these weights decreased in treated animals and approached values for control steers. Decreases ($P<.05$) in USDA marbling scores and quality grades, as well as lean texture scores, occurred in treated steers from 0-140 d. Shear force values were increased by 19% ($P<.05$) by feeding clenbuterol for 50 d. These values decreased after compound withdrawal, but were still higher in treated animals. Actual and adjusted fat thicknesses, kidney, pelvic and heart fat, maturity scores and USDA yield grades were unaffected ($P>.05$) within each slaughter group from 0-140 d. Subcutaneous and perirenal adipocytes in clenbuterol-fed steers were smaller ($P<.05$) than those of controls after 50 d on trial. After 90 d withdrawal, subcutaneous cells were still smaller, but perirenal cells were not different, in treated versus control animals. Cell size distributions indicated that no new adipocyte populations had arisen in any of the animal groups. The number of subcutaneous adipocytes per gram tissue was unchanged ($P>.05$) after 50 d, but was greater in treated animals ($P<.05$) after the withdrawal period. The number of adipocytes in the 9-10-11th rib section tended to be lower in the clenbuterol-treated steers after 50 d, but tended to be greater than that of controls after compound withdrawal. Acetate incorporation into triglycerides did not differ between treated and control animals after 50 d treatment nor after 90 d withdrawal. It appears that clenbuterol elicits an increase in muscling with a concomitant decrease in overall lean quality. Clenbuterol also appears to suppress adipocyte hypertrophy, and extended withdrawal from the compound may stimulate secondary hyperplasia in the 9-10-11th subcutaneous adipose depot in young steers.

Differentiation Between Fresh and Frozen-Thawed Game Muscle

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Differences in activity of the mitochondrial matrix enzyme beta-hydroxyacyl-CoA dehydrogenase (HADH) were used to distinguish fresh from frozen-thawed game muscle. Semimembranosus muscle from mule deer, elk, pronghorn and cattle were used. Muscles were cut into 100-250 g portions, wrapped and refrigerated at 2°C. Surface tissue was thoroughly trimmed from samples after day 1. Press juice (10 kg/cm^2) was obtained from muscle samples the day of the kill, 7 and 14 days postmortem, and assayed. For each time period, a second sample was frozen at −20°C for 48 hr, thawed at room temperature, press juice obtained and assayed. The assay was a spectrophotometric procedure which continuously monitored the catalysis by HADH of NADH to NAD$^+$ at 340 nm for a set period of time at 25°C. HADH activity was reported in International units/ml. Average values in fresh meat on day 1 ranged from a low 2.8 IU/ml in beef to 11.0 IU/ml in mule deer. In muscle subsequently frozen 48 hr, values ranged from 15 IU/ml in beef to 95.8 IU/ml in deer. Activity levels were higher in press juice from frozen-thawed muscle

from mule deer and pronghorn than from elk and cattle ($P<0.02$). HADH activity in press juice from all species studied was significantly higher ($P<0.01$) for frozen-thawed meat than from fresh meat at all aging intervals.

The Migration Patterns of Dense Particles in Meat During Grinding

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This study was designed to evaluate the effectiveness of flow characteristics and the importance of operating conditions on the removal of dense particles from meat by bone chip removal systems. A system consisting of a channelled-central bone removal plate mounted on a 219mm grinder was evaluated by grinding 45.3kg batches of beef that contained 0.5% by weight of either SM (small bone chips-9.5mm) or LG (large bone chips-13mm) each of which were then ground at an internal temperature of either −2.2°C or 3.3°C. Alkaline digestion of samples obtained from the final ground product, exhaust product and barrel product showed that in this system there was no significant ($P>.05$) difference in grinding temperature on the amount of bone found in the three fractions analyzed. Size of bone chip was also insignificant in this system, with 17.0% of the bone found in the final product, 11.6% in the exhaust product and 58.5% remaining in the barrel of the grinder. Since such a large portion remained in the barrel, the question of flow pattern of particles during grinding was approached with a clear, Lexan® grinder and a translucent grinding medium of carboxymethyl cellulose. This showed a counter-migration of dense particles and grinding medium against the rotation of the worm auger when an accumulation of dense particles developed at the grinding interface. This demonstrated the need for a modified approach to improving exhausted product flow. Studies of products from a commercial source have also shown that a major portion of dense particles accumulate in the barrel where they ride the knife-plate interface, leading to bone shearing and decreased product quality.

The Effects of Exogenous Porcine Somatotropin (pST) on the Growth Performance and Carcass Characteristics of Fast and Slow Growing Swine

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A 2X2 factorial design was used to study the effects of pST administration on the growth rate and carcass attributes of pigs growing at a fast (FG) or slow (SG) rate. Littermate pigs were designated as either FG or SG, based on weights at birth, weaning and 56 d. Twelve pigs were assigned to FG with their twelve littermates being assigned to the SG. Half of each group was treated with 70μg of pST/kg body weight daily beginning at 40 kg body weight while the other half received placebo injections. All pigs were fed a 20% crude protein ration ad libitum until the group average body weight was 60 kg, at which time the protein level was reduced to 18%. All pigs were slaughtered at approximately 108 kg body weight. The pST-treated pigs consumed less ($P<.01$) feed than non-treated pigs (202.8 vs 247.7 kg) thereby improving ($P<.01$) feed efficiency (3.55 vs 4.34 kg feed/kg gain). The pST-treated pigs had less ($P<.01$) average backfat (2.72 vs 3.96 cm), larger ($P<.05$) loineyes (32.3 vs 28.2 cm^2) and therefore higher ($P<.01$) percent lean cuts, (58.8 vs 54.0) percent muscle (56.2 vs 50.3), and superior ($P<.01$) USDA grade scores (1.15 vs 2.93). FG pigs had higher ($P<.01$) ADG (.98 vs .85 kg/d) and required fewer days on feed (57 vs 70) to slaughter than SG pigs. FG pigs also consumed less ($P<.01$) feed (212 vs 238 kg) than SG pigs. In addition, FG pigs had superior ($P<.05$) muscling scores (2.30 vs 2.00). There was not a pST X growth rate interaction ($P>.05$) for any of the measurements, indicating that the pST treatment affected both types of pigs in a similar fashion.

Effect of Subcutaneous Fat Trim Level on the Yield and Value of Beef Carcasses

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Fifty beef carcasses were selected based on USDA quality grade (58% Choice; 42% Select), USDA yield grade (10% YG1; 40% YG2; 42% YG3; 8% YG4), warm carcass weight (steers: 272.2 to 385.6 kg; heifers: 226.8 to 340.2 kg) and sex class (66% steers; 34% heifers). One side of each carcass was fabricated into major boneless subprimals and minor tissue components (lean trim, various types of fat and connective tissue) using Institutional Meat Purchase Specifications (IMPS). In addition, several sections from selected subprimals were fabricated separately to allow some flexibility in fitting the product mix of different packers or retailers. After fabrication, the subcutaneous fat was trimmed from each subprimal by 0.64 cm increments – beginning at 2.54 and ending at zero cm. The trimmed subprimals were dissected into knife-separable major tissue components (lean, seam fat and connective tissue). Those Choice grade major subprimals typically marketed with subcutaneous fat (114 shoulder clod, 120 brisket, 167 sirloin tip, 168 top round, 171 gooseneck round, 180 strip loin and 184 top butt) had 4.1, 8.2, 19.9 and 69.3% less fat as subcutaneous fat was trimmed from 2.54 to 1.91 to 1.27 to 0.64 cm, respectively. Two Choice grade subprimals typically sold without subcutaneous fat (112A ribeye roll and 116A chuck roll) had 22.4 and 20.2% fat, respectively. Those subprimals from Select grade

carcasses had slightly less percentage fat at all trim levels. Fabricated subprimals and associated by-products were reconstructed as in the USDA Market News Report (March 29, 1988) and prices were calculated for each yield grade at different subcutaneous fat trim levels. Data indicate that USDA Choice, Yield Grade 2.0 (Ch 2.0) would return $5.24, $6.73 and $8.36 per 100 kg more than a Ch 3.0 if trimmed from 2.54 to 1.91 to 1.27 to 0.64 cm, respectively ($10.49, $13.49 and $16.72 for Ch 4.0). Similar (but slightly lower) values were observed for Select carcasses.

Microbial Loads of Precooked, Sliced, Vacuum-Packaged Roast Beef as Affected by Potassium Sorbate, Secondary Heat Treatment and Storage Temperature

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Beef *Semimembranosus* muscles were processed into roast beef with and without 0.2% potassium sorbate. The roasts were sliced and vacuum packaged with half of the control packages being subjected to a secondary heat treatment. Packaged slices were stored at 2, 7, & 12C and monitored for total aerobes, anaerobes, and aerobic and anaerobic spore-forming bacteria over a 30-day storage period. Least squares means of microbial counts for all treatments stored at 2C were not different ($P>0.10$). Aerobic counts of slices subjected to the secondary heat treatment were lower ($P<0.10$) than counts from control or sorbate treated samples stored at 7 and 12C. Shelf-life was determined by the number of days required for aerobic counts to reach 10^6 cells/g. Slices exposed to secondary heat treatment took approximately 23 days at 2 and 12C, while the slices held at 7C remained below 10^6 cells/g throughout the 30-day storage period. Control slices reached 10^6 cells/g by days 18 and 12 at 2 and 7C, respectively. Slices containing sorbate held at 2 and 7C reached 10^6 cells/g at 20 and 21 days, respectively. Anaerobic counts stayed below 10^6 cells/g throughout the 30-day storage period at 2 and 7C. Roast beef slices containing sorbate reached 10^6 cells/g 8 days after control slices at 2C and 13 days after control slices at 7C. Anaerobic and aerobic spore-forming bacterial counts remained low throughout the 30-day sampling period.

Pork Carcass Evaluation With a New Instrumental Technique

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The objective of this study was to develop regression equations predicting pork carcass lean yield with ultrasonic measurements and other carcass measurements. A total of 221 carcasses were involved: 103 from the Purdue normal market hogs(G1), 48 from the Penn State hogs(G2) and 70 from the Cornell hogs(G3). The last two groups were part of porcine somatotropin studies. Ultrasonic scans with ALOKA 210DX and 3 MHz transducer were obtained on hot carcasses at the 10th rib, last rib and on the ham, recorded on VCR videotapes, and then played back on a 30 cm monitor from which measurements were determined with a sonic digitizer, GP-7 GRAFBAR, that was connected to an IBM-compatible personal computer. Dependent variables on an absolute weight (kg) or percentage (%) basis were dissectible lean (LN and PLN) and LN and PLN adjusted to 10% fat (LN10 and PLN10) for G1, LN10 and PLN10 for G2, protein (PROT and PPROT) and four lean cuts (CUTS4 and PCUTS4) for G3. The results consistently indicated the best factors were hot carcass weight (HCWT,kg) and 10th rib ¾ fat depth(cm), accounting for 82.84, 68.86, 80.07, and 69.32% of the variation in LN, PLN, LN10, and PLN10 for G1, 64.73, 64.69, 80.04, and 40.81% of the variation in PROT, PPROT, CUTS4, and PCUTS4 for G3, respectively. HCWT and fat depth at the 10th rib 5 cm off midline predicted LN10 and PLN10 with R^2 of 87.01 and 94.09%, respectively, for G2. Special care, however, must be given when R^2 is used as a selection criterion for equations predicting different compositional end points.

Influence of Meat Restructuring Systems on Lipid Oxidation in Beef

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This study evaluated the effect of meat restructuring ingredients on lipid oxidation during storage of beef. Fresh ground riblifter meat, 24 hr postmortem, was restructured with individual components and combinations of salt and phosphate, and alginate, $CaCO_3$ and lactic acid. Restructured meat slices (100-110 g) were wrapped with oxygen-barrier or non-barrier film and stored at 2°-4°C for up to 15 days or at −20°C for up to 90 days. Lipid oxidation was measured by thiobarbituric acid (TBA) numbers, phospholipid contents and their fatty acids and sensory evaluation. Mixing of meat without additives, or addition of salt (1.4%), alginate (1%), $CaCO_3$ (0.2%), lactic acid (0.3%) and their combination, accelerated increases in TBA numbers, while sodium tripolyphosphate (0.32%) inhibited oxidation. The products stored at 2°-4°C were generally rejected after 6 days due to objectionable rancid odor, while those stored at −20°C were not rancid for up to 90 days. Vacuum packaging decreased TBA numbers. Cooking increased the TBA numbers and decreased the polyenoic fatty acid content in the phospholipid fraction. In the raw state, rancidity development in algin/calcium restructured beef should be at a rate similar to products with salt, while in the cooked state the TBA number was higher in the salt-containing products.