

Consumer Topics

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CONSUMER ASSESSMENT OF HONDURAN AND U. S. SOURCED BEEF STRIP LOIN STEAKS

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Objectives: The United States is the largest beef producing country in the world. Additionally, the U.S. is the leading importer of meat products globally. Beef production practices in Central American countries differ greatly from U.S. industry practices, however, many of these countries export beef into the U.S. It was therefore the objective of this study to evaluate the palatability differences between U.S. and Central American sourced beef strip loin steaks and to determine U.S. consumer perception of Central American produced beef.

Materials and Methods: U. S. sourced strip loins from grain-finished cattle were selected to equally represent USDA Select (n=3) and Top Choice (upper 2/3 USDA Choice) (n=3), aged 35 days, quality grades. Additionally, strip loins (n = 3) from Honduran grass-finished cattle (n=3), and grain-finished cattle (n= 3), were collected from a packing plant in Siguatepeque, Honduras. Steak was used as the experimental unit. U.S. samples were vacuum packed and aged for 35 days and Honduran samples for 21 days, based on retail availability. Sub-primals were fabricated into 2.5 cm thick steaks and frozen (-20°C). Steaks were thawed for 24 h at 2-4°C prior to consumer evaluation and were cooked on clamshell grills to a well-done (77°C) degree of doneness. Each steak was then portioned into ten uniform pieces and served warm to U.S. panelists (n=240). Each sample was evaluated on an 8-point hedonic scale for the traits of flavor, tenderness, juiciness, and overall liking. Additionally, each sample was classified as acceptable or unacceptable for each palatability trait. Willingness to pay for each sample was rated in U.S dollars: \$0, \$3, \$6, \$10 per pound.

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Results: Top Choice samples received higher scores ($P < 0.05$) for tenderness, flavor and overall liking than any other treatment. Select samples rated higher ($P < 0.05$) than Honduran treatment samples for all palatability traits evaluated. However, Select samples were similar ($P > 0.05$) to Top Choice samples for juiciness, with both treatments receiving greater ($P < 0.05$) juiciness scores than either of the Honduran sourced treatments. No differences ($P > 0.05$) were found between the two Honduran sourced treatments for flavor or overall liking. For juiciness and tenderness traits, Honduran grain-finished strip loin samples were rated less tender and juicy ($P < 0.05$) than all other treatments. The percentage of samples rated as acceptable for tenderness, juiciness and flavor was greater ($P < 0.05$) for Top Choice samples compared to any other treatment. However, no differences ($P > 0.05$) in overall acceptability were found between samples from the two U.S. sourced treatments. Steaks from Honduran grain-finished cattle had a lower ($P < 0.05$) proportion of samples considered acceptable for tenderness and overall liking than any other treatment. No differences ($P > 0.05$) were found for juiciness and flavor acceptability between the two Honduran sourced treatments. Finally, U.S. consumers were willing to pay the most ($P < 0.05$) for Top Choice samples and the least ($P < 0.05$) for the two Honduran sourced samples.

Conclusion: In conclusion, the Honduran grass-finished samples were more acceptable than the grain-finished sample treatment by U.S consumers. Top Choice and Select strip loin samples were ranked above Honduran strip loin samples for all palatability showing U.S consumers prefer domestically sourced beef over that from Central America.

Keywords: beef, consumer, grass-fed, Honduras, *Longissimus dorsi*

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COMPARATIVE EFFECTS OF SUPPLEMENTING BEEF STEERS WITH ZILPATEROL HYDROCHLORIDE, RACTOPAMINE HYDROCHLORIDE, OR NO BETA-AGONIST ON STRIP LOIN COMPOSITION, SHEAR FORCE, AND CONSUMER ASSESSMENT OF STEAKS AGED FOR 14 OR 21 D POSTMORTEM

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Objectives: Supplementation with zilpaterol hydrochloride (**ZH**) or ractopamine hydrochloride (**RH**) has historically had a negative impact on shear force but previous consumer studies have shown tenderness and shear force differences from ZH supplementation do not always translate to adverse consumer responses for palatability and acceptance. Moreover, no consumer testing has been conducted as the result of studies directly comparing RH and ZH in the same cattle population. Therefore, the objective of this research was to characterize the effects of ZH, RH, and no beta adrenergic agonist (**βAA**) supplementation on the composition, instrumental tenderness, and consumer acceptability of strip loin steaks from high quality beef steers.

Materials and Methods: Beef steers (N = 1,914) were assigned to one of three βAA supplementation treatments: ZH (8.3 mg/kg of DM for 20 d with 3-d withdrawal), RH (308 mg/hd/d for 28 d), or no βAA (**CON**) to determine the effects on consumer eating quality. Strip loins (n = 1,101; CON = 400, RH = 355, ZH = 346) were obtained and fabricated into 2.5 cm thick steaks for proximate, Warner-Bratzler (**WBSF**) and slice shear force (**SSF**), and consumer analyses; steaks were aged until 14 or 21 d postmortem.

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Results: Fat and moisture contents were not affected by β AA supplementation ($P > 0.05$), but strip steaks from steers fed ZH had more protein ($P < 0.01$) than CON or RH, which were similar. An interaction between β AA and aging was observed ($P < 0.01$) for WBSF, but not SSF. Within steaks aged 14 d, ZH steaks required the most force to shear, RH were intermediate, and CON had the lowest WBSF values; however, RH had a stronger response to aging than CON or ZH, resulting in the lowest WBSF values at 21 d. Slice shear force values were greater ($P < 0.01$) in steaks from steers fed ZH than CON or RH, which did not differ. Following shear force analyses, steaks within 2 SD of each treatment mean for WBSF were selected randomly for consumer assessment of eating quality. Consumer testing ($n = 400$; 200/postmortem aging period) was arranged in a 3×3 factorial representing 3 quality grades [Select (**SEL**), Low Choice (**CHO**), and Premium Choice (**PCH**)] and 3 treatments (ZH, RH, & CON). In steaks aged 14 d, β AA supplementation affected ($P < 0.01$) tenderness, flavor and overall liking, and tenderness acceptability, resulting in lower consumer scores for ZH than CON and RH; however, juiciness, flavor, and overall acceptability were similar ($P > 0.05$). In steaks aged 21 d, feeding β AA only influenced ($P < 0.01$) tenderness and juiciness scores. Despite these differences, β AA did not affect ($P > 0.05$) acceptability. Quality grade impacted ($P < 0.01$) all traits and acceptability in steaks aged 14 d and 21 d. In 14-d steaks, PCH typically was scored higher than CHO or SEL; however, consumers rated 21- d CHO and PCH similarly – both receiving greater scores than SEL.

Conclusion: Consumers detected several differences in eating quality at 14 d because of β AA supplementation. Increasing aging from 14 to 21 d mitigated differences in shear force and tenderness scores because of feeding ZH, so that tenderness and overall acceptability were similar between ZH, RH, and CON.

Keywords: consumer acceptability, palatability, quality grade, ractopamine hydrochloride, zilpaterol hydrochloride

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CONSUMER ASSESSMENT OF BEEF STRIP STEAKS OF VARYING MARBLING AND ENHANCEMENT LEVELS COOKED TO THREE DEGREES OF DONENESS

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Objectives: A consumer study was conducted to measure the effects of varying marbling and enhancement levels on beef strip loin palatability of steaks cooked to three degrees of doneness.

Materials and Methods: Strip loins (N=60) were selected to equally represent seven treatments. Treatments included USDA Prime, Top Choice (upper 2/3 Choice), Low Choice (lower 1/3 Choice), Select, and Standard. An additional 24 USDA Select strip loins were selected for enhancement. Subprimals were aged 21 d under vacuum at 2-4°C. Following aging, Select strip loins (n = 12/level) were enhanced with a water, salt, and alkaline phosphate solution at two injection levels; High Enhanced (HE: 12% injection) and Low Enhanced (LE: 8% injection). All strip loins were fabricated into 2.5 cm thick steaks and stored at -20°C. Steaks were thawed for 24 h at 2-4°C and were cooked on a belt grill to three degrees of doneness; rare (60°C), medium (71°C), or well-done (77°C). After cooking, steaks were allowed to rest for 3 min prior to portioning into 1 cm cubes for consumer evaluation. Consumers (N=252) were screened for degree of doneness preference and randomly served one sample from each treatment prepared at their preferred degree of doneness. Each sample was evaluated for tenderness, juiciness, flavor identity, flavor liking, and overall liking on a 10 cm, verbally anchored line-scale. Acceptability of tenderness, juiciness, flavor liking, and overall

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liking was also rated. Finally, consumers characterized each sample as premium, better than everyday, everyday, or unacceptable quality.

Results: Select HE samples rated highest ($P < 0.05$) for tenderness, flavor identity, flavor liking and overall liking compared to all treatments. Select HE, Select LE and Prime samples had greater ($P < 0.05$) juiciness scores than all other treatments. Select LE samples rated higher ($P < 0.05$) than Prime samples for flavor identity and flavor liking. Non-enhanced Select and Standard samples were rated the lowest ($P < 0.05$) among treatments for all palatability traits. The percentage of consumer acceptability for tenderness, flavor and overall liking was higher ($P < 0.05$) for Select HE, Select LE and Prime compared to other treatments. Select LE and Top Choice acceptability for juiciness was similar ($P > 0.05$) with both rated higher ($P < 0.05$) than Low Choice samples. The percentage of samples rated as premium quality was greatest ($P < 0.05$) for Select HE. As degree of doneness increased from rare to well-done, juiciness ratings decreased ($P < 0.05$). No differences ($P > 0.05$) were found for tenderness, flavor liking, overall liking or perceived quality level due to degree of doneness.

Conclusion: Select HE and Select LE samples rated similar or higher than samples from higher quality grades for all palatability traits evaluated, indicating enhancement effectively improves palatability and adds value to USDA Select strip loins.

Keywords: consumer, degree of doneness, enhancement, palatability, USDA quality grades

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SENSORY ACCEPTABILITY OF PARTIAL REPLACEMENT OF SODIUM CHLORIDE BY POTASSIUM CHLORIDE AND CALCIUM CHLORIDE IN PRODUCTION OF SALAMI WITH LOW SODIUM

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Objectives: To evaluate the effects of sodium chloride reduction replaced by combinations of potassium chloride and calcium chloride on the sensory quality of salamis.

Materials and Methods: All treatments contain 1.0% of NaCl and KCl and CaCl₂ divided as follows: T1 (0.50% KCl+ 0.50% CaCl₂), T2 (0.45% KCl+ 0.45% CaCl₂), T3 (0.40% KCl+ 0.40% CaCl₂), T4 (0.35% KCl+ 0.35% CaCl₂), T5 (0.25% KCl+ 0.25% CaCl₂) and high control (HC) and low control (LC) contain only NaCl (HC – 2.5% and LC 1.0%). For all treatments, the meat formulation used was: pork meat (60%), beef (20%), pork back fat (20%), flavoring and additives (2.1%), sodium nitrate (0.015%), sodium nitrite (0.015%), and starter culture (*Staphylococcus xylosum* and *Pediococcus pentosaceus*) that were stuffed in the reconstituted collagen casing and subjected to fermentation (23-25°C and RH 85-90%) up to pH 5.0, and maturation/drying process (17-19°C and RH 85-75%) until water activity (Aw) reached 0.90. The sensory characteristics of salamis (color, flavor, texture, overall quality, and salt content) were evaluated through a consumer's acceptance analysis using a 9-point hedonic scale. The purchase intention was evaluated using a structured 5-point scale. The samples were offered individually to panalists in a completely randomized block design. We also assessed the

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sodium content. Results were statistically analysed using SAS.

Significance of differences between samples was determined (at the significance level $p \leq 0.05$) using Tukey's test.

Results: T5 obtained the closest scores to HC (2.5% NaCl) for flavor, texture, and overall quality, showing that the addition of 0.25% KCl + 0.25% CaCl₂, under the proposed conditions, was sufficient to mask the low NaCl content (1.0%).

Table 1. Acceptance values for color, flavor, texture, overall quality, salt content, and purchase intention for the studied formulations.

Attributes	CH	CL	T1	T2	T3	T4	T5
Color	7.3 ^a ±1.2	7.4 ^a ±1.4	7.0 ^a ±1.4	7.0 ^a ±1.3	7.5 ^a ±1.1	7.1 ^a ±1.3	7.3 ^a ±1.3
Flavor	7.2 ^a ±1.9	6.2 ^b ±1.9	5.9 ^b ±1.9	6.2 ^b ±1.7	6.5 ^{ab} ±1.8	6.3 ^{ab} ±1.5	6.8 ^{ab} ±1.8
Texture	7.5 ^a ±1.2	6.7 ^b ±1.5	6.2 ^b ±1.8	6.3 ^b ±1.6	6.6 ^b ±1.7	6.3 ^b ±1.6	6.7 ^b ±1.5
Overall quality	7.4 ^a ±1.4	6.5 ^b ±1.5	6.3 ^b ±1.7	6.4 ^b ±1.5	6.6 ^b ±1.5	6.4 ^b ±1.4	6.9 ^{ab} ±1.5
Salt content	4.3 ^a ±1.2	3.6 ^b ±1.1	4.0 ^{ab} ±1.3	3.5 ^b ±1.1	4.0 ^{ab} ±1.1	3.8 ^b ±1.4	3.9 ^{ab} ±1.1
Purchase intention	3.9 ^a ±1.1	3.2 ^b ±1.1	2.9 ^b ±1.2	3.1 ^b ±1.2	3.2 ^b ±1.2	3.0 ^b ±1.1	3.4 ^{ab} ±1.2

T5 had 62.5% of sodium reduction, reaching a final content of NaCl of 2.5% after 25 days of drying and maturation. Therefore, since the amount of sodium in marketed products reaches 6%, the reduction of NaCl content in dried and fermented products remains the main challenge for laboratorial research.

Conclusion: Consumers showed acceptance for salamis with reduced sodium and the replacement with potassium chloride 0.25% + calcium chloride 0.25% is the most suitable for the production of low-sodium salamis. This research also proved that the production of salamis with 1.0% sodium chloride and without replacement is viable.

Keywords: Low sodium , Salami, Sensory quality

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HONDURAN CONSUMER ASSESSMENT OF BEEF STRIP LOIN STEAKS FROM GRASS AND GRAIN FINISHED CATTLE

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Objectives: Consumer beef preference is influenced by palatability traits which can differ depending on cattle finishing diets. Traditionally, cattle in the U.S. are finished on a high concentrate diet, whereas in many other countries, cattle are finished exclusively on forage-based diets. The presence of U.S. beef in the international trade market has influenced some countries to change production systems to try and compete with U.S. product. Currently, there are no data that describes consumer perception of grain-finished U.S. imported and Honduran domestic beef. The objective of this study was to characterize beef from different countries and feeding regimes on the palatability traits and to assess the willingness of Honduran consumers to pay for these products.

Materials and Methods: U. S. sourced strip loins from grain-finished cattle, aged 35 d, were selected to equally represent Select (USDA Select; n = 3) and Top Choice (upper 2/3USDA Choice) (n = 3) quality grades. Additionally, strip loins (n = 3) from Honduran grass-finished cattle and grain-finished cattle (n= 3) were collected from a packing plant in Siguatepeque, Honduras and aged 21 d. Sub-primals were fabricated into 2.5 cm thick steaks, these being the experimental unit, and frozen (-20°C). Steaks were thawed for 24 h at 2-4°C prior to consumer evaluation and were cooked on clamshell grills to well-done (77°C). Each steak was portioned into ten uniform pieces and served warm to panelists. A consumer panel (n=240 panelists) was conducted during the yearly Pan-American Fair at Zamorano University in

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Honduras. Each sample was evaluated on an 8-point hedonic scale for flavor, tenderness, juiciness, and overall liking and was classified as acceptable or unacceptable for each palatability trait. Willingness to pay for each sample was rated in Honduran currency equivalent to U.S dollars: \$0, \$3, \$6, \$10 per pound.

Results: The two U.S treatments were scored higher ($P < 0.05$) for tenderness, flavor, and overall liking compared to both Honduran treatments; however, consumers rated Top Choice higher ($P < 0.05$) than Select for all traits. Regarding juiciness, no differences ($P > 0.05$) were found between Select and Honduran grass-fed treatments. Consumers scored Honduran grass-fed higher ($P < 0.05$) than Honduran grain-fed for each trait. Acceptability for tenderness and overall liking was similar ($P > 0.05$) between Top Choice and Select, but a greater ($P < 0.05$) percentage of U.S. samples were acceptable for tenderness and overall liking compared to either Honduran treatment. No difference ($P > 0.05$) for juiciness acceptability was found for Select and Honduran grass-fed samples. Likewise, flavor acceptability was similar ($P > 0.05$) between Select and Honduran grass-fed samples; however, both Honduran treatments did not differ ($P > 0.05$). Consumers from Honduras were willing to pay \$4.38 per pound for Top Choice samples, but were only willing to pay \$1.95 per pound for Honduran grass-fed samples.

Conclusion: Results indicate Honduran consumers' preference for imported U.S. beef strip loin steaks compared to domestic beef finished by grain or grass feeding. Changes may be needed and indicate a need for improvement in domestic beef production practices to improve palatability.

Keywords: beef, consumers, grain-finished, grass-fed, Honduras

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THE EFFECT OF COMMERCIALLY PREPARED BREAKFAST MEALS WITH VARYING LEVELS OF PROTEIN ON ACUTE SATIETY IN NON-RESTRAINED WOMEN

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Objectives: Protein (>25g) has consistently been reported to have greater acute satiety effects compared to carbohydrate or fat in equal caloric meals. This study assessed the acute effects of commercially prepared convenient breakfasts varying in protein on subjective ratings of appetite & energy intake at a subsequent meal in 36 non-restrained women (BMI 18 – 33 Kg/m²).

Materials and Methods: A within-subject preload design with repeated measures was conducted. Six conditions (~240kcal) varying in protein levels were presented in randomized order: 1) no breakfast, 2) turkey sausage, egg-based breakfast bowl ((TSE-BB) (39g protein)), 3) TSE-BB (22g protein), 4) TSE-BB (9g protein), 5) cereal & milk (8g protein) & 6) pancakes & syrup (3g protein). Visual analog scale ratings for appetite (hunger, fullness, prospective consumption, desire to eat) were measured at baseline & 30 min intervals for 240 min. Energy intake was recorded at an *ad libitum* lunch at 240 min.

Results: TSE-BB meals at 23g & 39g showed greater satiety ratings & lower energy intake at lunch vs. the lower protein (3g & 8g protein) breakfast meals ($P < 0.001$). All breakfast treatments resulted in greater acute satiety ratings compared to no breakfast ($P < 0.001$).

Conclusion: This study shows that commercially prepared, higher protein sausage and egg based breakfast meals provide greater acute appetite control compared to lower-protein based breakfast meals.

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Keywords: breakfast, protein, satiety

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USE OF CLUSTER ANALYSIS TO EVALUATE CONSUMER ACCEPTABILITY OF BEEF STRIP LOIN STEAKS

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Objectives: A difference in individual consumer's perception of beef palatability has been reported due to different cooking methods of preparation and end-point temperature (degree of doneness) to which the consumer prefers that the beef steak is prepared. Cluster analysis may be able to be used to group consumers vary in their liking and preference of food products. The purpose of this research was to determine if using cluster analysis can adequately group consumers together according liking and/or preference of beef strip loin steaks.

Materials and Methods: Were evaluated two methods of cooking (oven and counter-top griddles electric) with three endpoint temperatures (65, 71 and 77°C) in samples of beef striploin (m. *Longissimus dorsi*), totaling six treatments. The samples were analyzed by 118 consumers in block complete balanced design and in monadic presentation. The acceptance of samples was studied in relation to appearance, aroma, flavor, texture and overall impression, using an unstructured line scale of 9 cm (1 = dislike extremely to 9 = like extremely). For the statistical analysis the consumers were clustered together based on their liking for end-point temperature and cooking method by agglomerative hierarchical clustering using the Euclidian distance and Ward's method as aggregation criterion. Consumers were grouped together according to preference and liking of steaks using a dendrogram and a dissimilarity plot for beef strip loin consumer panels.

Results: The largest clusters (1, 2, 4 and 5) consisted of 108 (92%) of the consumers. Cluster 1 (36%) was the largest segment of consumers, and where consumers had the high degree of liking for all steaks the, with no

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difference between treatments ($P > 0.05$). Cluster 2 (18%) preferred ($P < 0.05$) grilled steaks than roasted steaks, for all end-point temperatures, with no difference ($P > 0.05$) of liking between end-points for the same cooking method. Cluster 4 (22%) preferred samples at higher temperature (77°C) when cooked in oven, however at lower and medium temperature (65 and 71°C) when cooked in griddle. Similar comportment was observed for cluster 5 (16%), where consumers preferred samples at higher temperature (77°C) when cooked in oven, however at lower temperature (65°C) when cooked in griddle. Cluster 3 (6%) preferred roasted steaks at 65 and 71°C, however had the lower degree of liking for grilled steaks at 77°C. Cluster 6 (2%) had a lower degree of liking for all treatments, with no difference between them ($P > 0.05$).

Conclusion: Cluster analysis was effective at grouping consumers together according to preference of steaks cooked at different methods and end-point temperatures.

Keywords: beef strip loin, cluster analysis, cooking method, end-point temperature

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EFFECT OF COOK METHOD ON CONSUMER PERCEPTION OF BACON

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Objectives: The objective of this research was to evaluate common cooking techniques and determine cooking preference of cooked bacon.

Materials and Methods: Bacon for this study was obtained from a Virginia production facility. Three treatments groups were evaluated: Treatment 1 was prepared by convection oven (CO) at 190°C for 3 min, rotated 180° degrees, and cooked for another 3 min. Treatment 2 was prepared on an electric skillet (ES) set at 177°C for 2 min and 30 s, rotated 180°, and cooked for another 2 min and 30 s. Treatment 3 was prepared in a 900 watt microwave oven (MO), samples were placed on microwave trays, cooked at full power for 2 min, rotated 180° degrees, and cooked for another 2 min. Subjective evaluation of cooked slice visual distortion was evaluated using a 5-point distortion scale according to Rentfrow et al. (2003). Bacon scoring 4 or 5 was discarded from the trial. Cooked bacon was held at 66°C for a maximum of 15 min prior to serving to consumers. Consumers (n = 100) were recruited from students, staff, and faculty at North Carolina State University through e-mails and fliers. Sample presentation order was randomized and balanced. Consumers evaluated overall liking, texture, and flavor of each bacon using a 9 point hedonic scale, where 1 = dislike extremely and 9 = like extremely. Consumers also answered just-about-right (JAR) questions where 1 and 2 = not enough, 3 = just about right, and 4 and 5 = too much. Consumers were then asked purchase intent of each treatment. A 5-point scale was used where 1 and 2 = definitely would not buy, 3 = may or may not buy, and 4 and 5 = definitely would buy. Finally, consumers ranked samples according to their preference. Data was analyzed by

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ANOVA with means separation conducted using Fisher's least square difference, JAR scores were evaluated using penalty analysis and chi-square, and preference ranking questions were analyzed using a chi-square test utilizing XLSTAT (Addinsoft, Paris, France).

Results: Consumer overall liking, texture liking, and willingness to purchase of bacon were affected by cook method ($P < 0.05$). No differences ($P < 0.05$) were detected between CO and ES for overall liking; however, CO scored higher ($P < 0.05$) than MO for overall liking. CO and ES scored higher ($P < 0.05$) than MO for texture liking. Penalty analysis results indicated overall liking scores were penalized ($P < 0.05$) when bacon crispness, salty taste, and fattiness were perceived by consumers as too limp, too salty, and when the slices were too fat. CO had the highest percentage of consumers that scored JAR in the 3 JAR categories evaluated, crispness, saltiness, fattiness. Consumers scored CO and ES were not different for purchase intent; MO scored significantly lower than CO ($P < 0.05$) but no differences were detected between MO and ES. No differences were detected between treatment groups for consumer preference ranking.

Conclusion: These results indicate convection oven and electric skillet are the most preferred cook methods for bacon in terms of consumer acceptance scores for overall liking and purchase intent.

References: Rentfrow, G., T. E. Sauber, G. L. Allee, and E. P. Berg. 2003. The influence of diets containing either conventional corn, conventional corn with choice white grease, high oil corn, or high oil high oleic corn on belly/bacon quality." *Meat science* 64, no. 4 (2003): 459-466.

Keywords: Bacon, Consumer Perception

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MULTI-STATE CONSUMER ACCEPTANCE OF PORK LOIN CHOPS OF VARIED INTRAMUSCULAR LIPID CONTENT

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Objectives: Meat quality factors play a vital role in consumer acceptance and marketing of meat products. Palatability in beef and lamb is commonly linked to intramuscular lipid (IML), as well as other quality factors. Studies have reported wide-ranging results when evaluating the effects of IML on consumer sensory perception in pork. The objective of this study was to evaluate sensory perception, acceptance and preference of pork loin from varied IML categories by consumers from five states.

Materials and Methods: Pork loins (NAMP #413; N=180) from a commercial abattoir were selected according to NPPC IML standards by trained personnel to acquire loins (N=60/category) of high (NPPC 10), medium (NPPC 5) and low (NPPC 1) IML content. Visual IML was confirmed with an AOAC approved laboratory method, and all loins possessed a pH between 5.3 – 5.7. Selected loins were vacuum packaged and transported (4°C) to the ASU Meat Laboratory where loins were fabricated on day 16 post-mortem (PM). Loins within IML category were assigned to one of two stores within one of five states, such that each store received six loins per IML category. At 16d PM loins were removed from storage and serially sliced into 2.54-cm chops beginning at the anterior end. Chops were then vacuum packaged and frozen until consumer panels. Chops were thawed 24 hr prior to consumer panels, subsequently prepared utilizing a heated clamshell grill and cooked to an internal temperature of 62°C. Chops were sliced into 2 cm² portions and placed in warming pans for service to 4 – 6 consumers/panel (N=1200 total consumers). Samples from each IML category were evaluated for flavor, juiciness, tenderness and overall acceptability by vertically marking

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a 160-mm line scale for each trait. Additionally, consumers were instructed to rank samples from most to least liked. Data were analyzed as a completely randomized design using the mixed model procedures of SAS with IML content, state and IML \times state interaction as fixed effects. Consumer ranking was analyzed for frequency distribution and chi-square analysis.

Results: As IML content increased, consumer's found samples to be more flavorful ($P < 0.001$), more juicy ($P < 0.001$), more tender ($P < 0.001$) and rated them higher in overall acceptability ($P < 0.001$).

Consumer's scores for High, Medium and Low IML categories were 92.15, 85.84 and 75.21, respectively. Similarly, juiciness scores increased from 84.64 for Low IML to 102.44 for High IML samples. High IML samples were much more tender (104.17) when compared to Medium IML (97.78) and Low IML (92.85). As expected from all the other sensory measurements, overall acceptability scores for High IML was 105.54, 99.16 for Medium IML and 90.21 for Low IML. When evaluating the effect of state on flavor ($P < 0.001$), juiciness ($P < 0.001$) and tenderness ($P < 0.001$) panel scoring of loin chops was highly inconsistent, with no evident pattern with the exception of overall acceptability. Texas consumers scored loin chops much lower in overall acceptability when compared to all other states ($P < 0.001$). There was no interaction of IML category \times state ($P > 0.05$). When evaluating preference of the three IML levels, 49.5% of consumers preferred High IML, 29.92% preferred Medium IML and 20.59% preferred Low IML ($P = 0.01$).

Conclusion: These results indicate that IML clearly plays a role in consumer acceptance of pork loins, suggesting further inquiry for use of IML content in marketing of pork.

Keywords: consumer acceptability, intramuscular lipid content, pork quality

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CONSUMER PANEL RESPONSES TO THE REDUCTION OF SODIUM IN PROCESSED MEATS USING NATURALLY BREWED SOY SAUCE AND NATURAL FLAVOR ENHANCER

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Objectives: With sodium reduction being a continued topic of importance for food companies, there is a need to better understand the effect sodium reduction technologies have on sensory and quality characteristics of processed meat products. The use of naturally brewed soy sauce (SS) and natural flavor enhancer (NFE), a product similar to soy sauce with less soy sauce flavor and color, has shown potential to enhance saltiness profiles in reduced sodium frankfurters while maintaining product quality. However, it is unknown if the same effects are observed using SS and NFE in other meat products with unique and product specific salt-related needs. This study investigated the reduction of sodium in bacon, beef jerky, boneless ham, and summer sausage using SS and NFE as salt (NaCl) sources.

Materials and Methods: Four treatments, two containing SS, two containing NFE, and a control were investigated in this study. Both groups of treatments containing SS or NFE received two sodium reductions. Reductions of 30% and 50% were investigated in both groups of treatments. The control included only flake NaCl at levels typical for that product type. Either SS or NFE was added as the base source of salt to each treatment at specific levels determined from a previous study. Treatments with 50% sodium reductions were supplemented with potassium chloride (KCl) to the original control level.

Results: Consumer sensory panels were performed at the University of Wisconsin sensory analysis laboratory. Each sample had a minimum of 96 panellist responses per replication. Consumer sensory results for

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bacon SS 30% and SS 50% reductions showed no change ($P > 0.05$) in overall liking, appearance, aroma, flavor, texture, and saltiness liking compared to the control. NFE 30% and 50% reductions showed decreases ($P < 0.05$) in aroma and flavor liking. Further, an increase ($P < 0.05$) in bitterness was observed in 50% sodium reductions and was likely due to added KCl. Beef jerky NFE 30% reductions showed no significant changes in all attributes ($P > 0.05$) compared to the control, while NFE 50% reported decreased ($P < 0.05$) overall liking, appearance and texture liking responses. SS 30% and SS 50% showed decreased ($P < 0.05$) overall liking and texture liking. An increase ($P < 0.05$) in saltiness liking was observed in SS 50% reductions. No increase ($P > 0.05$) in bitterness was observed in any beef jerky treatment. Boneless ham SS 30% reductions showed no significant attribute changes ($P > 0.05$) compared to the control ham through consumer sensory analysis. SS 50% showed decreased ($P < 0.05$) overall liking, flavor liking and saltiness liking. NFE 30% and 50% reductions showed decreases ($P < 0.05$) in overall liking. Additionally, NFE 50% decreased ($P < 0.05$) in texture, flavor and saltiness liking. An increase in bitterness was observed in both 50% sodium reductions treatments with added KCl. Summer sausage consumer sensory analysis showed decreases ($P < 0.05$) in overall liking, appearance, texture, aroma, flavor and saltiness liking in all SS and NFE sodium reductions. Additionally, an increase ($P < 0.05$) in bitterness was observed in all treatments.

Conclusion: Results from this study suggested that SS and NFE can be successfully used in sodium reduction systems offering potential to maintain overall consumer liking and potentially enhance certain flavor attributes in the meat products investigated.

Keywords: Meat, Sensory, Sodium reduction

Environment, Production Systems

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EFFECTS OF LONG TERM HEAT STRESS IN UTERO OR DURING FINISHING ON PORK CARCASS COMPOSITION

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Objectives: The objectives of this study were to investigate the effects of prolonged gestational or postnatal heat stress on growth performance and carcass composition of market weight pigs.

Materials and Methods: Primiparous gilts (n = 19) were exposed to gestational heat stress (GHS, cyclical 28 to 34°C) or thermal neutral (cyclical 18 to 22°C) conditions during the entire length of gestation or in either half of gestation. Starting at 14 weeks of age, male offspring (n = 11 to 13 per GHS treatment) were placed in heat stress (HS, 35°C, 24 to 43% relative humidity) or thermal neutral (TN, 21°C, 35 to 50% relative humidity) conditions in individual crates. Chronic HS or TN conditions lasted 7 to 10 weeks, until slaughter at a final body weight (BW) of approximately 109 ± 5 kg. Feed intake data and BW were recorded weekly, and body temperature parameters were monitored twice weekly. Organs were weighed at slaughter, and loin eye area (LEA) and backfat thickness (BF) were measured. Sides were separated into lean, separable fat, bone, and skin components and weighed. Moisture, lipid, and protein content were determined on a sample of the *Longissimus* taken from each carcass. Carcass data were analyzed using a four by two factorial design with random effect of slaughter group. Contrast statements were used to evaluate the overall effect of GHS, as well as GHS in the first or last half of gestation.

Results: GHS did not result in significant differences in postnatal performance or most body temperature parameters (P > 0.1). However, respiration rate was slightly increased in pigs heat stressed in the first half

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of gestation ($P = 0.04$). Dressing percent was increased as a result of GHS treatments ($P = 0.02$). GHS during the first half of gestation resulted in increased hot carcass weight (HCW, $P = 0.02$) and decreased percent head ($P = 0.002$) and skin ($P = 0.005$) weight. Second half GHS resulted in decreased percent bone weight ($P = 0.02$). Differences in head and bone percentage in response to GHS may be a result of growth retardation at specific developmental stages during gestation. Pigs heat stressed during postnatal growth had a decreased rate of gain compared to TN pigs ($P < 0.05$), which resulted in decreased live weight and HCW ($P < 0.0001$). It took 1-3 weeks longer for HS barrows to reach observed live weight endpoints compared to TN barrows. HS barrows had less BF ($P = 0.002$), as well as carcass separable fat ($P < 0.0001$) compared to TN barrows. However, intramuscular fat did not differ between the two groups ($P = 0.19$). Muscle from HS carcasses had a greater moisture to protein ratio ($P = 0.001$). HS barrows also had smaller heart ($P = 0.003$), liver ($P = 0.04$), and kidney ($P < 0.0001$) percent of BW compared to TN pigs. Percent lean tissue was increased in HS barrows ($P = 0.002$), but total lean and LEA were similar to TN carcasses ($P > 0.4$).

Conclusion: These data show that both GHS and HS during finishing may significantly affect carcass composition of market weight pigs. Prolonged postnatal HS may have a negative effect on key carcass measures such as HCW, percent lean, and BF, while GHS may result in greater dressing percentage, reduction in head size, and decreased percent bone. This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-67003-30007 from the USDA National Institute of Food and Agriculture.

Keywords: Composition, Gestation, Heat Stress, Pork

Environment, Production Systems

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USE OF METAGENOMIC HIGH-THROUGHPUT SEQUENCING TECHNOLOGY AND ROBUST BIOINFORMATICS TO ASSESS THE MICROBIOME OF CATTLE, THEIR ENVIRONMENTS, AND BEEF PRODUCTS TO DETERMINE THE DEGREE OF ANTIMICROBIAL RESISTANCE

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Objectives: Research funded by the beef checkoff was conducted to determine the prevalence and abundance of antimicrobial resistance genes in the cattle feeding and beef processing microbiome.

Materials and Methods: Samples of feces, water and soil from two pens at four feedlots (one sample of each per pen per feedlot) that were located in two major, geographically dispersed cattle feeding areas were aseptically collected for high-throughput complete DNA sequencing. Pen samples were collected at the time of cattle placement in the feedlot and again at the time that the same cattle were shipped for harvest. Subsequently, the same cattle were transported as market-ready cattle to two nearby packing plants for harvest. Upon arrival at the packing plant, the trucks and cattle were identified and swab samples of trailer walls, samples of pen feces and water (two samples of each type per feedlot per plant) were collected aseptically for sequencing. Eventually, at the end of the production lines where products from carcasses of the original cattle were packaged and boxed, pooled swab samples from the trimming belt, round and chuck table as well as 400g of trimming samples (two sample of each type per feedlot per plant) were collected aseptically for sequencing. Whole community DNA in each sample was extracted using Mo-Bio PowerFecal[®] and PowerSoil[®] DNA Isolation Kit, purified, and

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subjected to metagenomics shotgun sequencing on Illumina HiSeq. After filtering and trimming the sequencing data, reads were assembled using SPAdes. Contigs longer than 500bp were then compared to the ARG-ANNOT database using BLAST-Like Alignment Tool (BLAT). Results from the tool were then parsed to identify and quantify the resistance gene determinants present in each sample.

Results: The average sequencing reads per type of samples (arrival, exit, Truck, holding pens, fabrication room) was 48M (ranging from 24 to 69M), 38M (ranging from 13 to 63M), 70M (ranging from 59 to 93M), 27M (ranging from 8 to 54M) and 60M (ranging from 47 to 85M), respectively. The mean quality score for all sequencing samples was Q35. Additionally, 90% of the bases in the reads had a quality score above Q30. A total of 1,285 antimicrobial resistance genes were detected with over 80% coverage in 74 samples: average 25 (median=22) genes per arrival sample, average 17 (median=16) genes per exit sample, average 48 (median=47) genes per truck sample, average 12 per holding pen sample (median=11) and 0 antimicrobial resistance genes were found in any fabrication room samples. These genes were grouped into families as: tetracycline resistance genes (34.5%), beta-lactamases (27.3%), Macrolide-lincosamide-streptogramin (MLS) resistance family (22.3%), aminoglycoside resistance genes (11.4%), sulfonamide resistance genes (2.6%), and phenicol resistance genes (1.5%), trimethoprim genes (0.3%) and glycopeptides genes (0.2%).

Conclusion: The results provide proof-of-concept that metagenomic sequencing and bioinformatic analysis can be used to uncover resistance determinants that traditional microbiological methods may not be able to detect. The data from this research can be used to generate antimicrobial resistance gene profiles for beef production chain and help to highlight the potential risk points in the supply chain.

Keywords: antimicrobial-resistance, beef production, high-throughput sequencing, metagenomics, microbiome

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EFFECTS OF WATER- AND OIL-BASED ROSEMARY ON GROUND BEEF METMYOGLOBIN REDUCING ACTIVITY

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Objectives: Meat color is one of the most significant characteristics that impacts consumer-purchasing decisions. Previous studies have reported that the addition of antioxidants, including rosemary, improved meat color primarily by limiting lipid oxidation. Although, metmyoglobin reducing activity (MRA) is an important inherent property that extends color life, limited studies have determined the effects of antioxidants on MRA. Therefore, the objectives were to determine the effects of water- and oil-based rosemary extract on color and metmyoglobin reducing activity of ground beef patties in polyvinyl chloride (PVC) and high-oxygen modified atmosphere packaging (MAP).

Materials and Methods: Each fine ground beef chub (73% lean) was equally divided into 3 sections. Using a randomized complete block, each batch within a chub was assigned to 1 of 3 treatments including a control (no added antioxidants), water-, and oil-based rosemary extract. Both water- and oil-based rosemary extracts were added 0.2% w/w level. All three treatments were mixed for 2 minutes and 100 g patties (thickness 1.5 cm diameter 11 cm) were packaged in either PVC or MAP. The patties packaged in PVC were displayed under continuous fluorescent lighting (simulated retail display) from the day of preparation. However, MAP patties were stored in dark at 2 °C for 3 days, then displayed for 3 days. Surface color and nitric oxide metmyoglobin reducing activity of both PVC and MAP patties were determined on days 0, 1, and 3 of

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display at 4 °C. Surface color (a^* value) of patties were determined using a Hunter Lab Miniscan XE Plus spectrophotometer and MRA was determined as nitric oxide metmyoglobin reduction. The experiment was replicated 8 times. The data were analyzed using the Mixed Procedure of SAS and were considered significant at $P < 0.05$.

Results: There was a significant storage time x antioxidant interaction for surface color ($P < 0.05$). On day 3, oil-based rosemary extract added patties in PVC had greater redness compared with control (oil-based > water-based > control; $P < 0.05$). However, water-based rosemary extract added patties packaged in MAP on day 3 had greater redness compared with other two treatments ($P < 0.05$). In both packaging, oil-based rosemary had a greater MRA compared with control and water-based rosemary ($P < 0.05$). This results indicate that by stabilizing lipids, antioxidants can have protective effects on enzymes involved in metmyoglobin reduction.

Conclusion: Better understanding the antioxidant mechanism(s) in meat color will help the meat processors to design packaging and ingredient based strategies to improve meat quality.

Keywords: Antioxidant, Beef color, Metmyoglobin reducing activity, Rosemary

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EFFECT OF AN INSULIN-LIKE GROWTH FACTOR 2 SINGLE NUCLEOTIDE POLYMORPHISM ON FRESH BELLY CHARACTERISTICS AND BACON SLICING YIELDS OF FINISHING PIGS

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Objectives: Insulin-like growth factor 2 (IGF2) is a growth factor primarily responsible for increasing prenatal skeletal muscle growth. A single nucleotide polymorphism identified within a regulatory region of intron 3 of the IGF2 gene, G3072A, has been shown to be responsible for increased postnatal IGF2 expression in pigs possessing a paternally expressed A allele. Increased postnatal IGF2 expression results in increased leanness; however, there is currently limited data explaining how IGF2 genotype affects fresh belly characteristics and processing. Objectives of the study were to test the effect of IGF2 genotype mutation on fresh belly characteristics, fatty acid profiles, and bacon processing of finishing barrows and gilts.

Materials and Methods: A single heterozygote AG boar was bred to homozygous AA sows to create offspring expressing either the IGF2 G or A paternal allele. Bellies (n=35) were obtained from offspring of both sexes. Genotypes were determined by either PCR-RFLP assay or direct sequencing. Fresh belly length, width, thickness, flop distance, and durometer measurements were collected at 48 h after slaughter. Fatty acid profile was determined using flame-ionization gas chromatography, and iodine value (IV) was calculated using the AOCS (1998) equation. Bellies were sliced at a commercial bacon processing facility under commercial protocols. The 2 × 2 factorial arrangement of treatments were analyzed using the MIXED procedure of SAS, and least

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square means for the effects of paternal IGF2 allele, sex, and their interaction were separated using the PDIFF option.

Results: Of the offspring analyzed, 16 pigs had the paternal G allele (G^{pat}) and 19 pigs the paternal A allele (A^{pat}). Bellies from G^{pat} pigs were 7.17 mm thicker ($P = 0.01$), had 7.27 cm greater flop distance ($P = 0.05$), and tended to have 1.34 units lesser Iodine value ($P = 0.09$) when compared with bellies from A^{pat} pigs. Belly weights and processing yields were not different ($P \geq 0.10$). While not statistically different ($P = 0.30$), the magnitude of difference in slicing yield as a percentage of green weight was 1.57 percentage units between bellies from G^{pat} pigs (87.40%) and bellies from A^{pat} pigs (85.83%). The average green weight of the thirty-five bellies used in this study was 5.27 kg, thus bellies from G^{pat} pigs yielded 0.08 kg more bacon when compared to bellies from A^{pat} pigs. Bacon slice moisture was 4.73 percentage units less ($P < 0.01$) and fat percentage was 6.67 percentage units greater ($P < 0.01$) in bellies from G^{pat} pigs when compared to bellies from A^{pat} pigs. Furthermore, average bacon slice lean percentage (determined with image analysis) was 4.75 units less in bellies from G^{pat} pigs when compared to bellies from A^{pat} pigs.

Conclusion: Overall, bellies from G^{pat} pigs had fresh belly characteristics associated with increased firmness as indicated by a decreased percentage of polyunsaturated fatty acids when compared with bellies from A^{pat} pigs. While processing characteristics were not different in bellies from this population of pigs, bacon slice characteristics revealed greater fat percentage of the slice in bellies from G^{pat} pigs when compared to bellies from A^{pat} pigs.

Keywords: bacon, fat quality, IGF2 gene

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EFFECT OF FEEDING DISTILLER'S GRAINS AND SUPPLEMENTING WITH DIETARY ANTIOXIDANTS ON GROUND BEEF COLOR DURING RETAIL DISPLAY

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Objectives: The objective of this trial was to evaluate the effects of vitamin E and antioxidant blend of ethoxyquin and tert-Butylhydroquinone (Agrado Plus, Novus International, St. Louis, MO) supplementation on ground beef color from cattle fed distiller's grains during the finishing phase for 106 days.

Materials and Methods: Cattle (n=100) were randomly assigned to one of five finishing diets; corn (control), wet distiller's grains (WDGS), WDGS + 1000 IU/hd/d vitamin E, WDGS + 150 ppm/hd/d Agrado Plus, or WDGS + 500 IU/hd/d vitamin E + 150 ppm/hd/d Agrado Plus. At the conclusion of the finishing phase, cattle were harvested at commercial abattoir. Forty-eight h post-harvest, seven USDA Choice clods representing each dietary treatment group were collected from the right side of carcasses, vacuum packaged, and shipped to the University of Nebraska Loeffel Meat Laboratory. On day 14, each clod was independently ground and formed into 113 g patties using a manual single patty press. Two patties from each clod were overwrapped with oxygen permeable PVC film and placed under simulated retail display for 7 d at 2°C. During retail display, percent discoloration (%Dis; 5 person panel; 0% = no discoloration to 100% = full discoloration) and objective color (L* a* b*) were evaluated for 7 days. A/B ratio, hue angle, and saturation index were then calculated. Data were analyzed by treatment with repeated measures (day) utilizing the PROC MIXED procedures of SAS.

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Results: No significant dietary treatment effects were found for any of the color traits measured ($P > 0.05$). There was a time effect for percent discoloration, L^* , a^* , b^* , A/B ratio, hue angle and saturation index ($P < 0.0001$ for all). As retail display time increased, patties from all dietary treatments had greater %Dis and became darker, less red, and more yellow.

Conclusion: Overall, beef patties discolored during retail display but the rate and degree of discoloration were unaffected by animal diet or antioxidant supplementation.

Keywords: Agrado, Color, distillers grains, ground beef, Vitamin E

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INHIBITION OF LIPID OXIDATION IN GROUND TURKEY WITH ENCAPSULATED PHOSPHATES AS AFFECTED BY MEAT AGE, PHOSPHATE TYPE, AND TEMPERATURE RELEASE POINT

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Objectives: Encapsulation of polyphosphates could prevent their hydrolysis by phosphatases while in the meat, thereby preserving their strong antioxidative effects if the phosphatases are sufficiently heat inactivated before being released. Postmortem age may influence activity of the phosphatases and these enzymes may react differently depending on the type of polyphosphate added to the meat.

The objectives of this experiment included investigating the polyphosphate antioxidant abilities as influenced by meat age (AGE: 2, 4 d PM), polyphosphate type (PT: HMP = hexameta phosphate, SPP = sodium acid pyrophosphate, STP = sodium tripolyphosphate), encapsulation (ENC: u=unencapsulated, e=encapsulated with hydrogenated vegetable oil), encapsulation temperature release point (TRP: 140, 154 °F), pre-cook storage time (PRE=3, 6, 24 h), end point cooking temperature (EPT: 165, 175 °F), and post-cook storage time (CST: 0, 1, 7 d). Dependent variables included cooking loss, pH, soluble orthophosphate content (SOP), lipid hydroperoxides (LHP), and TBARS.

Materials and Methods: Ground turkey breasts were mixed with NaCl (1%), water (10%) and a phosphate treatment (uHMP, uSPP, uSTP, eHMP-140, eHMP-154, eSPP-140, eSPP-154, eSTP-140, eSTP-154). Samples were water cooked in plastic sausage casings. Two statistical analyses were performed on the replicated (3) experiment. A TRP model (AGE x PT x TRP x PRE x EPT x CST) was performed

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only on encapsulated phosphates to identify the most effective TRP. The second analysis evaluated a model (AGE x PT x ENC x PRE x EPT x CST) to compare the selected TRP polyphosphates to unencapsulated cohorts. PROC MIXED was used to report significant ($P < 0.05$) results.

Results: From the TRP model, eSPP-154 decreased the cooked SOP by approximately 7.7% compared with eSPP-140 (eSPP-140=4926, eSPP-154=4548 $\mu\text{g/g}$). TRP of 154 °F lowered the LHP values by 42.5% (155.9 $\mu\text{mol/kg}$, EPT 175) and 37.9% (281.8 $\mu\text{mol/kg}$, EPT 165) compared to a TRP of 140 °F (271.3 $\mu\text{mol/kg}$, EPT 175; 453.9 $\mu\text{mol/kg}$, EPT 165). TRP 154 °F inhibited TBARS better than TRP 140 °F on post-cook storage day 1 and 7 (d1: TRP 154=0.25 mg/kg, TRP 140=0.32 mg/kg; d7: TRP 154=0.40 mg/kg, TRP 140=0.52 mg/kg).

In the model testing encapsulation, raw sample SOP was controlled by eSPP-154 with a 1.2 fold lower value than the uSPP (uSPP = 6822, eSPP-154=5644 $\mu\text{g/g}$). Fresher turkey (2 d PM) resulted in 1.1 times lower raw SOP than 4 d aged samples when pre-cook storage was 6 h (2 d=5491, 4 d=6051 $\mu\text{g/g}$). eSPP-154 treated samples had 1.5 times lower cooked SOP than uSPP (uSPP = 7031, eSPP-154=4548 $\mu\text{g/g}$). eSTP-154 controlled LHP by 13.6 fold better than uSTP on post-cook stored day 1 samples (uSTP = 911.1, eSTP-155=67.1 $\mu\text{mol/kg}$). eSPP-154 decreased while eSTP-154 increased the cooked sample pH by 0.13 and 0.03 unit respectively compared with their unencapsulated cohorts (uSPP = 6.01, eSPP-154=5.88, uSTP = 6.26, eSTP-154=6.29). However, no cooking loss differences ($P > 0.05$) were found between the unencapsulated and encapsulated polyphosphates.

Conclusion: The higher temperature release point likely enables greater thermal input to inactivate phosphatases prior to polyphosphate release. For uncured processed turkey that entails an extended period before thermal processing, encapsulated polyphosphates will greatly limit lipid oxidation during subsequent post-cooked storage.

Keywords: encapsulation, Lipid oxidation, polyphosphates, postmortem age, turkey meat

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ASSESSING ROSEMARY AS AN ANTIOXIDANT IN DUCK BREAST

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Objectives: The ability of rosemary to act as an antioxidant in marinated duck breast was examined. The objective was to measure color (a^*) stability and lipid oxidation products in control and rosemary treated breasts during refrigerated storage under light display.

Materials and Methods: Trial 1 compared control duck breast in a standard marinade to that of duck breast in the same marinade with the addition of rosemary extract (15% rosemary oleoresin/85% maltodextrin). The breast to marinade ratio was 95:5 and rosemary extract was present at 0.8% of the marinade. Breasts were vacuum tumbled in marinade for 8 minutes. Breasts were vacuum packed in high tensile strength bags with low oxygen permeability and stored under light (1615 lux). The treatments were stored skin side-up ($n = 3$ for each treatment at each time point) and breast side up ($n = 3$ for each treatment at each time point). Lipid oxidation was assessed at 2, 7, and 14 days under light at 0-2°C. Color values were assessed at 12 time points during the study using a Minolta colorimeter. Lipid oxidation was assessed using lipid peroxides in raw breast. Hexanal values were obtained using GC-SPME in cooked duck breast. Trial 2 was a replication of trial 1 except that lipid oxidation was assessed at 7, 14, and 21 days under light. Color values were assessed at 12 time points during the study.

Results: Color (a^*) values were stable for the duration of trial 1 and trial 2 in both the control and treatment marinades. In trial 1, lipid peroxides were not detected in either treatment at day 2, suggesting little lipid oxidation occurred early in storage. At day 9 and 14, lipid peroxide values

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increased to 5-7 $\mu\text{mol}/\text{kg}$ in muscle and 22-32 $\mu\text{mol}/\text{kg}$ in skin. Rosemary had no effect on lipid peroxide values compared to control marinade at any time point ($P > 0.05$). Rosemary decreased hexanal values in cooked skin and breast muscle at day 9 and 14. Hexanal values increased with time in control but not in the rosemary treatment ($P < 0.05$). In trial 2, lipid peroxides in muscle declined from 7 to 21 days from 22-24 $\mu\text{mol}/\text{kg}$ to approximately 10-12 $\mu\text{mol}/\text{kg}$ in both treatments. In skin, lipid peroxides in control and treatment ranged from 25-35 and 32-42 $\mu\text{mol}/\text{kg}$ respectively. Rosemary resulted in a significantly greater amount of lipid peroxides compared to control marinade only at day 7 in skin ($P < 0.05$). Rosemary had no effect in hexanal values in product stored breast or skin side up during 21 days of storage under lights. Hexanal values were relatively stable during storage, and were approximately 2-fold greater in muscle than skin.

Conclusion: Overall, rosemary decreased lipid oxidation when compared to the control marinade in trial 1 but not in trial 2. The addition of rosemary oleoresin did not seem to benefit the product in terms lipid oxidation. Better packaging integrity was noted in trial 2, which may partially explain the antioxidant effect of rosemary in trial 1 only. Evaluating sensory attributes of the rosemary treated breast versus control should be done to better understand the potential benefits of rosemary as an added antioxidant.

Keywords: duck, oxidation, rosemary

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OXYGEN SCAVENGERS AFFECT COLOR AND GAS CONCENTRATIONS OF MASTER PACKED GROUND BEEF

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Objectives: For fresh meat packaging a master pack system provides shelf life and economic advantages that contribute to its increased popularity. Various studies have demonstrated the benefits of using a low oxygen atmosphere for improving meat oxidative stability. However, if very low oxygen concentrations are not reached and maintained, color could be impaired. To assure very low oxygen concentrations and avoid formation of metmyoglobin, oxygen scavengers are often utilized in master packs. This study was designed to investigate various aspects of master packed ground beef including color and package gas environment.

Materials and Methods: A series of experiments were performed to show the effect of storage time and presence of oxygen scavengers in 20% carbon dioxide and 80% nitrogen (20/80) and 30% carbon dioxide and 70% nitrogen (30/70) master packed ground beef. Samples stored in the dark at $0.5 \pm 0.5^{\circ}\text{C}$ for time intervals of up to 28 days were evaluated in terms of color, myoglobin forms and CIE $L^*a^*b^*$ values, headspace gas concentration, and lidding film deflation changes.

Results: Our results show that 2-day master packed ground beef that has been allowed to bloom, i.e. exposed to atmospheric oxygen, can reach redness and oxymyoglobin concentration values comparable to fresh meat ($P < 0.05$). However, visual analysis shows that at least 3 days are needed for the entire meat to develop peak red color. Red meat color, as indicated by a^* values, was found to be maintained for up to 28 days in the presence of oxygen scavengers ($P < 0.05$) and to not be affected by

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the difference in master pack headspace gases, 30/70 versus 20/80, ($P = 0.887$). Besides decreasing oxygen concentrations to improve color stability, oxygen scavengers can also affect other headspace gases. Measurements of film deflation and carbon dioxide concentrations during storage were used to calculate carbon dioxide solubility in meat, losses due to package permeability, and absorption by scavengers. Oxygen scavengers alone in 20/80 and 30/70 master packs caused a reduction of over 47% and 31%, respectively, in carbon dioxide concentrations after 14 days of storage. In addition, the presence of an oxygen scavenger contributed to production ($P < 0.05$) of carbon monoxide in the package. Even though oxygen scavengers showed to be the primary source of carbon monoxide, a chemical interaction between meat or microorganisms and the oxygen scavenger cannot be ruled out. Higher carbon monoxide concentrations were found in 30/70 master packs ($P = 0.000$). To account for any pressure differential in trays that could affect measurements, two types of 30/70 master packs, trays versus bags, were used to compare carbon monoxide concentrations during storage. Both types of master packs led to increased carbon monoxide concentrations over time ($P < 0.05$) and showed a Pearson correlation of 0.872 ($P = 0.000$).

Conclusion: Understanding the changes in headspace gases can be essential when considering the initial gas concentrations needed in the package since carbon dioxide is used for its bacteriostatic effect and carbon monoxide is often included to promote formation of the red pigment, carboxymyoglobin. Oxygen scavengers have proven to be beneficial for maintaining a desirable meat color. Nevertheless, their effect on carbon dioxide and carbon monoxide concentrations must be considered as well.

Keywords: Carbon dioxide, Carbon monoxide, Master pack, Myoglobin forms, Oxygen scavenger

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THE EFFECTS OF REPLACING PORK FAT WITH COCONUT OIL ON THE PROPERTIES OF FRESH SAUSAGE

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Objectives: The objective of this experiment was to determine the effects of substituting coconut oil on the chemical composition, microorganism, and sensory properties of fresh sausage.

Materials and Methods: This experiment evaluated three (0, 10%, 20%) levels of coconut oil and pork fat stored at 3°C for 14 days. The following treatments: 1) control (20% pork fat: 0% coconut oil), 2) 0% pork fat: 20% coconut oil and 3) 10% pork fat: 10% coconut oil were replicated three times. Treatments were analyzed for % moisture content, % ash content, pH value, % drip loss, aerobic plate counts, *Escherichia coli*, *Staphylococcus aureus*, lipid stability (thiobarbituric acid-reactive substances TBARS) and sensory testing.

Results: The initial % moisture content and % ash content of fresh sausage in this experiment ranged from 62.53 to 69.25 and 3.30 to 3.36, respectively. The results of this experiment indicated that fresh sausage with 20% coconut oil inhibited the growth of aerobic bacteria and *E. coli* as compared to treatments containing pork fat ($P < 0.05$). However, the TBARS values were higher ($P < 0.05$) in fresh sausage with 20% coconut oil through 14 days at 3°C. In addition, 10% coconut oil combined with 10% pork fat decreased the % drip loss, pH value and obtained the highest overall rating of sensory testing (n = 55). No *S. aureus* were found in this study for 14 d at 3°C.

Conclusion: Replacing pork fat with 20% coconut oil inhibited the growth of aerobic bacteria and *E. coli* of fresh sausages. The combination of 10% coconut oil and 10% pork fat improved the chemical composition

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and sensory properties of fresh sausage. This experiment suggests that coconut oil may be a viable substitute for pork fat.

Keywords: Coconut oil, Properties of fresh sausage

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EFFECT OF MUNGBEAN [VIGNA RADIATA (L.) WILCZEK] PROTEIN ISOLATES ON THE MICROBIAL TRANSGLUTAMINASE-MEDIATED PORCINE MYOFIBRILLAR PROTEIN GELS AT VARIOUS SALT CONCENTRATIONS

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Objectives: This study was performed to investigate the effects of mungbean protein isolate (MPI) as meat and water binders on the microbial transglutaminase (MTGase)-mediated porcine myofibrillar protein (MP) gels at three salt concentrations (0.15, 0.3, and 0.45 M).

Materials and Methods: The general property of MP gel was evaluated by pH, cooking loss (%), and gel strength (gf). Protein-protein interactions among MPI, MTGase, and MP during cooking were assessed using gel electrophoresis, thermal analysis, and microstructure.

Results: When salt content was reduced, gel cooking loss (%) ($P < 0.05$) was increased while pH and gel strength (gf) values were decreased ($P < 0.05$). Addition of MTGase to MP increased pH, cooking loss (%), and gel strength (gf) values, while addition of MTGase and MPI induced synergistic effects on the MP gel strength (gf) (≥ 0.3 M salt concentration) ($P < 0.05$). In scanning electron microscope image, increase of salt concentrations made MP gels more clustered and tighter conglomerated, regardless of treatment.

Conclusion: In conclusion, addition of MPI and MTGase increased gel-forming ability and improved cooking yield of MP gels at salt concentration higher than 0.3 M.

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Keywords: Heat-induced gel characteristics, microbial transglutaminase, mungbean protein isolates, porcine myofibrillar protein, salt concentrations

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COLD-BATTER MINCING OF HOT-BONED AND CRUST-FREEZE-AIR-CHILLED TURKEY BREAST REDUCED SODIUM CONTENT IN PROTEIN GELS

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Objectives: The purpose of this research was to evaluate sodium reduction in the protein gels that were prepared with turkey breasts after hot boning (HB), quarter sectioning (¼), crust freezing air chilling (CFAC), and cold temperature mincing.

Materials and Methods: For each of 4 replications, 36 turkeys were slaughtered and eviscerated. Half of the carcasses was randomly assigned to water immersion chilling (WIC) for chill-boning (CB), whereas the remaining was immediately HB and quarter sectioned/crust freezing air chilled (¼CFAC) in a freezing room (-12°C/1.0 m/s). After deboning, CB fillets were conventionally minced, whereas HB-¼CFAC fillets were cold minced up to 27 min with 1 or 2% salt.

Results: From the beginning of mincing, the batter temperatures of HB-¼CFAC were lower ($P < 0.05$) than those of CB batters up to 12 and 21 min for 2 and 1% salts, respectively. Upon mincing, the batter pH of HB-¼CFAC ($P < 0.05$) rapidly decreased and showed no differences ($P > 0.05$) from the CB batters, except the 1% salt HB-¼CFAC batter after 15 min mincing. The pattern of pH was not changed when the batters were stored overnight. The protein of 2% salt HB-¼CFAC fillets was more extractable ($P < 0.05$) than that of CB fillets at 9, 12, 18 and 24 min. Similarly, the protein of 1% salt HB-¼CFAC fillets was more extractable ($P < 0.05$) than that of CB fillets from 12 min. Stress values

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of 2% salt HB-¼CFAC gels were higher ($P < 0.05$) than those of 1 and 2% salt CB gels, with intermediate values for 1% salt HB-¼CFAC gels. In scanning electron microscope image, pre-rigor batter appears to have more open space, less protein aggregation, and more protein-coated fat particles than those of post-rigor batters.

Conclusion: Based on these results, the combination of HB-¼CFAC and cold-batter-mincing technologies appear to improve protein functionality and sodium reduction capacity.

Keywords: cold mincing, crust-freezing, hot-boning, protein functionality, Sodium reduction

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EFFECTS OF VARIABLE DIETARY LEVELS OF DRIED DISTILLERS GRAINS WITH SOLUBLES ON PORK TRIM FOR USE IN FRESH AND EMULSIFIED SAUSAGE MANUFACTURING

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Objectives:

The inclusion of dried distillers grains with solubles (DDGS) in pig diets is a common practice in the swine industry as it offers alternatives to feeding a high priced corn and soybean meal based diets. However, feeding DDGS to pigs will transition the fatty acid composition to increased levels of unsaturated fatty acids, which has a negative effect on fresh pork quality attributes, but the effects on processing characteristics is less understood. The objective of this study was to include varying levels of DDGS in swine diets to measure the effect on the emulsion stability, batter consistency, fatty acid composition, and palatability characteristics of fresh and emulsified sausage products.

Materials and Methods: Forty-eight crossbred pigs were randomly placed in pens (n=16) and were feed diets containing 0% DDGS (CN), 15% DDGS, 30% DDGS, and 45% DDGS. Pigs were harvested with an average weight of 112±8.1 kg. Pre-rigor trim was removed from the shoulder and pooled by pen for fresh sausage (FS) production. Rigor trim was removed from the shoulder and pooled by pen for bologna production. Fresh sausages were evaluated for subjective sensory color, Minolta L*, a*, and b*, and TBAR absorbance on d 0, 2, 5, 7, 10, 12, and 14 of retail display and fat smearing score on d 0. Bologna was evaluated for subjective sensory color and palatability characteristics, Minolta L*,

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a*, and b*, and TBAR absorbance pm d 0, 2, 5, 7, 9, 12, 14, 17, 19, and 21 of retail display, and compression analysis on d 0. Proximate analysis was conducted to ensure a normal distribution of fat content among pen. Data were analyzed as a completely randomized design with pen used as the experimental unit utilizing the MIXED procedure of SAS.

Results: The FS results show differences in Minolta L* ($P < 0.0001$) and a treatment x day interaction ($P = 0.0113$) of TBAR absorbance between treatments. The change in Minolta L* values indicated differences in fat smearing with DDGS treatments having decreased L* values.

Furthermore, FS from DDGS pigs had an increased amount of lipid oxidation as noted by increased TBARS over time. However, Minolta a*, b*, sensory color, and fat smearing was not different ($P = 0.5822$) for FS. Furthermore, differences were seen in bologna samples for Minolta L* ($P < 0.0001$), a* ($P < 0.0001$), and b* ($P < 0.0001$), sensory discoloration ($P = 0.0189$) and desirability ($P = 0.0301$), and TBARS ($P = 0.0332$) absorbance across treatments. However, there was not a difference in treatment for bologna compression analysis as expressed in force ($P = 0.5484$) and stress ($P = 0.5789$). The trained panelist did not detect differences in bologna lean color ($P = 0.1731$) or palatability characteristics of juiciness ($P = 0.5275$), texture ($P = 0.1133$), rancidity ($P = 0.2633$), off flavor ($P = 0.5278$), or desirability ($P = 0.1055$).

Conclusion: Therefore, for FS and bologna the addition of an increased level of DDGS in pig diets will cause detrimental effects in objective and sensory color scores, with an increased level of oxidation as reflected by increased TBARS absorbance. However, bologna palatability characteristics will not be significantly affected.

Keywords: Bologna, Dried Distiller Grains with Solubles, Fresh Sausage, Unsaturated Fatty Acid

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EFFECT OF AGEING PRIOR TO FREEZING ON FUNCTIONAL AND OXIDATIVE PROPERTIES OF COARSE GROUND LAMB SAUSAGE IN MODEL SYSTEMS

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Objectives: The functional properties of raw meat (such as water-holding capacity (WHC), protein solubility, and oxidation stability) are critical processing components for the final quality attributes of processed meat products. Freezing can induce some adverse impacts on the functional properties of the meat. Substantial meat quality improvements occur during postmortem ageing through endogenous protein degradation. Therefore, it can be hypothesized that ageing meat prior to freezing improves the functional properties for the processed meat. The aim of this study was to determine the effects ageing meat prior to freezing on functional properties of lamb sausage products in model systems.

Materials and Methods: Twenty-five lamb loins (*M. Longissimus dorsi*) were obtained at 2 days postmortem, vacuum packaged, and randomly assigned to one of the five different ageing (-1.5°C) periods prior to freezing (-18°C): 1) frozen at 2 days post mortem (2AF), 2) aged for 7 days (7AF), 3) 14 days (14AF), 4) 21 days (21AF), and 5) 56 days (56AF). After frozen-stored for about 7 weeks, the loins were thawed at 3°C for 24 h, and coarsely ground. The meat was blended with ingredients to give the final formulation of 75% lean, 25% water, 1.5% salt and 0.3% tripolyphosphate. The formulated meat (40g) was stuffed into each 50 ml centrifuge tube, cooked in a water bath and then vacuum packaged. After the display for 3 weeks at 3°C under light, the color, textural properties and lipid oxidation stability were measured. The

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uncooked meat was also assessed for the protein solubility (total, sarcoplasmic, and myofibrillar), expressible moisture, emulsion activity index and stability. The data were analyzed using ANOVA directive of GenStat. Means for all traits of interest were separated ($P < 0.05$) by using least significant differences.

Results: There was no significant difference in pH value and emulsion stability among the treatments. With increasing ageing periods, the higher emulsion activity index and less cook loss were found ($P < 0.05$). Although not significant, there was a trend of an increase in the expressible moisture with the extended ageing confirming the positive effect of ageing on WHC. Furthermore, the protein solubility (total, myofibrillar, and sarcoplasmic proteins) was increased with the extended ageing times ($P < 0.05$). The lipid oxidation of the sausage products was lower in the 21AF and 56AF compared with 2AF, 7AF and 14AF after 3 weeks display, which indicated that ageing meat for more than 21 days prior to freezing could improve lipid oxidation stability of the lamb sausage product. Increasing ageing periods of the raw meat increased lightness and yellowness, while decreasing redness of the final sausage products ($P < 0.05$). The hardness, gumminess and chewiness were ordered as follows: $7AF \geq 14AF \geq 2AF \geq 21AF > 56AF$.

Conclusion: The results suggested that extended ageing periods of raw meat prior to freezing could improve functional properties, particularly for WHC, protein solubility and lipid oxidation stability of the final lamb sausage product.

Keywords: ageing, functional property, processed meat

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MODIFIED ATMOSPHERE PACKAGING AFFECTS GROUND BEEF PATTY COHESIVENESS

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Objectives: Modified Atmosphere Packaging (MAP) of ground beef involves filling the void space in the meat package with a gas mix not typical of air. Two MAP gas environments commonly used with fresh meat are 80% Oxygen: 20% Carbon Dioxide or 80% Nitrogen:20% Carbon Dioxide + 0.4% Carbon Monoxide. When the gas mix includes elevated concentrations of oxygen and carbon dioxide product shelf life may be extended with improved color stability and reduced microbial growth. However, changes in product texture and lipid oxidation may result. This study evaluates the effects of MAP gas environment on ground beef patties.

Materials and Methods: Fresh ground beef patties were packaged in four different MAP environments: High Oxygen (69% Oxygen:16% Carbon Dioxide), Low Oxygen (3% Oxygen:17% Carbon Dioxide), Atmosphere (19% Oxygen), and Vacuum. Ground beef patties were chemically and physically analyzed after 0, 4, and 8 days of storage at 38°F. Parameters measured included pH, color (Hunter L*a*b values), MAP environment gas concentrations, Resistance to Tear and Kramer Shear of cooked patties. The pH and color analysis was conducted on raw product. Resistance to Tear and Kramer Shear were conducted after patties were cooked in clamshell grills to an internal temperature of 72°C.

Results: The pH of the patties declined significantly during storage ($P < 0.01$) (5.47, 5.40, 5.30 at 0, 4, 8 days respectively) but was not affected by the gas environment. Patty color was significantly ($P < 0.01$) affected by both package environment and storage time. It is notable that patties stored in High Oxygen and Atmosphere decreased in the red color

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during 8 days of storage. The a^* values decreased from 17.960 to 2.783 from day 0 to day 8. At day zero patties in Low Oxygen environments tended to exhibit lower redness than those in High Oxygen and redness tended to decline or remain unchanged during storage for 8 days (13.063, 6.567, 9.240 at 0, 4, 8 days respectively). MAP Oxygen concentration did not change during storage ($P = 0.32$). The High Oxygen environment contained 69.5% Oxygen at day 8. There was no significant effect of MAP gas environment on cook loss, but High Oxygen treatment tended to have a lower cook loss ($P = 0.089$). High Oxygen and Low Oxygen Kramer Shear values were not significantly different ($P = 0.69$) (High Oxygen: 140.7, 143.4, 144.4 newton and Low Oxygen: 142.1, 132.7, 139.9 newton at 0, 4, 8 days respectively). Patty cohesiveness (Resistance to Tear) increased during storage for all packaging environments ($P < 0.01$) (4.17, 6.83, 7.95 newton at 0, 4, 8 days respectively). High Oxygen and Atmosphere environments gave the most rapid change with significant ($P < 0.01$) increase after 4 days of storage.

Conclusion: High Oxygen MAP gas environment increases the cohesiveness of the ground beef patty. Further research is needed to determine if protein oxidation is a contributing factor.

Keywords: Cohesiveness, Ground Beef Patties, Modified Atmosphere Packaging

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EFFECTS OF FEEDING HIGH PROTEIN CANOLA MEAL ON DRY CURED AND CONVENTIONALLY CURED BACON

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Objectives: The objective was to compare processing and sensory attributes of dry or conventionally cured bacon from barrows and gilts fed canola meal from high protein (CM-HP) or conventional varieties (CM-CV) of canola seeds in a 3-phase feeding system. Canola meal is generally high in polyunsaturated fatty acids, and these pigs were slaughtered at 114.9 ± 3.23 kg BW; therefore, bellies were expected to be thin and soft. Furthermore, we compared left and right side bellies to determine differences based on carcass side.

Materials and Methods: Seven dietary treatments were fed to test the effects of increasing inclusion rates of CM-HP and CM-CV compared with no canola meal (control). Inclusion rates were 33, 66, or 100% replacement of soybean meal with canola meal for both CM-HP and CM-CV. One hundred forty bellies (2 bellies each from 70 pigs) were used. Left and right side bellies were evaluated for bilateral symmetry of dimensional characteristics and fatty acid profile. Belly fat firmness was evaluated using a Check Line durometer. These data were compared using the paired option of the PROC T Test in SAS. Bellies from the left side of each carcass were randomly assigned to the dry cured or conventionally (wet) cured treatment, and the matching right sides were assigned to the opposite treatment. Conventionally cured bellies were injected with a cure solution to a target of 110% of original weight. Dry cured bellies were cured for approximately 2 weeks for a target of 2.54 cm of sodium migration per week. Bacon slices were evaluated for moisture and extractable lipid content, slice characteristics, and sensory

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attributes. Processing data were analyzed as a general linear mixed model with fixed effects of dietary treatment and sex. Orthogonal polynomial contrasts statements were used to test the linear and quadratic effects of increasing CM-HP and CM-CV on each dependent variable. No comparisons were made between dry cured and conventional cured bellies.

Results: Right side bellies had greater ($P \leq 0.05$) width, flop distance, thickness, belly weight, and fat firmness when compared with left sides. There were no differences ($P \geq 0.12$) in essential fatty acid concentrations (C18:3n-3, C20:5n-3, C22:5n-3, and C22:6n-3) between left and right bellies. There were no differences ($P \geq 0.14$) for fresh belly characteristics among any dietary treatments. There were also no differences ($P \geq 0.24$) for total saturated fatty acids, total monounsaturated fatty acids, and total PUFA among any dietary treatments. However, there was a linear decrease ($P = 0.02$) in total PUFA as CM-HP inclusion increased. There were no differences ($P \geq 0.37$) in iodine value among all dietary treatments. Processing characteristics, bacon slice characteristics, and proximate composition were unaffected ($P \geq 0.15$) by dietary treatments for both conventionally cured and dry cured bellies. Furthermore, sensory panel evaluations of saltiness, flavor intensity, off flavor, and off odor were also similar among dietary treatments in both types of bacon.

Conclusion: Overall, high protein and conventional canola can replace soybean meal in growing-finishing pig diets without any detrimental effects on processing characteristics and sensory attributes of dry cured and conventionally cured bacon.

Keywords: bacon, canola meal, dry cured, pigs

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DEVELOPMENT AND IN VITRO BEAKER SAUSAGE EVALUATION FOR SELECT NATURAL STRAIN FOR PROTEOLYTIC ACTIVITY IN LOW SALT DRY SAUSAGES

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Objectives: Select the best combination of strains *Enterococcus mundtii* CRL35 + *Staphylococcus vitulinus* GV 318 and *Lactobacillus plantarum* CRL 681 + *Staphylococcus vitulinus* GV 318 with proteolytic activity to produce amino acids that affect flavor in an experimental model of low sodium beaker sausage.

Materials and Methods: We grounded the inner portion of muscles Semimembranosus (beef) and *Longissimus dorsi* (pork), in a multiprocessor added with sodium chloride, potassium chloride, and calcium chloride used for low sodium salami production. The sodium nitrite, sodium erythorbate, and sodium nitrate were diluted separately, and subsequently filtered (0.22µm) for sterilization. The meat with the all additives was divided into 3 treatments: (T1) *E. mundtii* CRL35 + *S. vitulinus* GV 318; (T2) *L. plantarum* CRL 681 + *S. vitulinus* GV 318, and Control with antibiotics added. Each strain was inoculated at a concentration of 10⁸ UFC/ml. Each treatment was divided into four tubes (15 g each) for incubation at 22°C, while the control was incubated at 7°C. At 0, 3, 6, and 10 days, we performed readings of the pH, PCA (total bacteria) in the control, MRS (lactic bacterial) and MSA (*Staphylococcus*) for T1 and T2, respectively, and the protein content was determined in all treatments using Bradford and monodimensional

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electrophoresis. Results were statistically analysed using SAS.

Significance of differences between samples was determined ($P \leq 0.05$) using Tukey's test.

Results: The strain concentration of *E. mundtii* in T1 maintains stable after 10 days of incubation vis-a-vis its initial concentration (10^8 at 0 day - 10^8 after 10 days). The results show that the supplement of carbohydrates and the characteristics of low fermentation of *E. mundtii* decreased the pH from 5.8 to 5.1 in 10 days, but the pH did not decrease significantly in the first 3 days. This allowed the count of *S. vitulinus* to decrease only 3 logs (10^8 at 0 day - 10^4 after 10 days). The *L. plantarum* in T2 had a similar behavior to T1, decreasing concentrations in 1 log (10^9 at 0 day - 10^8 after 10 days). However, the *L. plantarum* has quick acidification. The conditions in this experiment acidified quickly the medium and decreased the pH from 5.7 to 4.9 in 3 days. This rapid acidification inhibited *S. vitulinus*, therefore, no counts for this microorganism were observed after 10 days of incubation (10^7 at 0 day - n.d. after 10 days). Regarding the proteolytic activity of the treatments, we found that after 10 days of incubation, consequently T2 had a more intense proteolytic activity than T1 (Fig. 1) evidenced by presence of small bands of 24 kDa. In the control, however, we observed a greater presence of bands above 24 kDa indicating low proteolytic activity. The same was observed in the protein analysis using the Bradford method because T1 had 8.47 mg/ml protein at the beginning of incubation and 4.92 mg/ml after 10 days. This shows that proteins are degraded to amino acids and peptides. In T2, acidification promoted an increased degradation of protein (higher than in T1) started with 6.65 mg/ml and 2.92 mg/ml after 10 days.

Image:

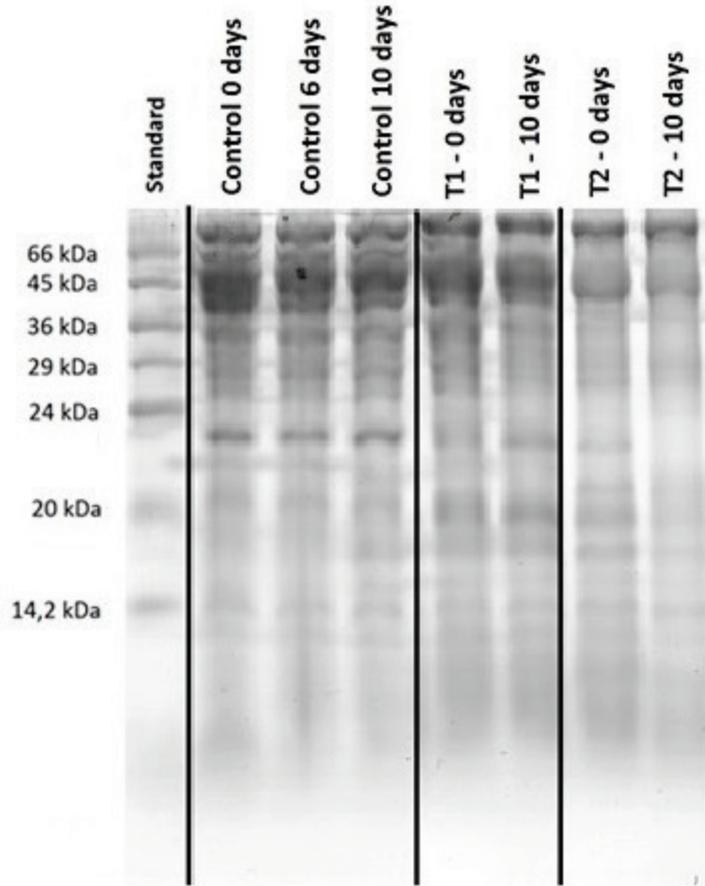


Figure 1 - SDS-PAGE gel electrophoresis of proteins

Conclusion: The combination of microorganisms in T2 has higher proteolysis. Despite growth inhibition of *S. vitulinus* GV 318, this microorganism combination should be considered in the formulation for low sodium salami due to the production of desirable peptides and amino acids.

Keywords: Beaker sausage , Low sodium, Proteolytic activity

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EFFECT OF NATURAL ANTIOXIDANTS AND PHOSPHATE ON LIPID OXIDATION IN A COMMERCIAL DELI TURKEY PRODUCT

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Objectives: Effects of two different natural antioxidants (AO) were investigated in a commercially made deli turkey product with and without phosphate and compared to a control without AO. Objectives were to determine the most effective AO, AO level needed for reduction of lipid oxidation, importance of added phosphate, and to establish a possible correlation between hexanal and off-flavor.

Materials and Methods: The antioxidants examined were Guardian™ 09 and StabilEnhance® OSR D 2.5 at 400 and 600 ppm. Guardian 09 is a water-soluble phenolic antioxidant containing 4% rosemary phenolic diterpenes. StabilEnhance OSR D 2.5 is a water- and oil-soluble deflavored plant extract from rosemary containing 2.5-3.0% carnosic acid, which is a phenolic diterpene. The product was uncured and packaged in an atmosphere of N₂/CO₂ gas. Lipid oxidation was measured after 1, 7, and 13 weeks of refrigerated, dark storage via sensory detection of off-flavor (OF) and headspace hexanal determination by solid-phase microextraction (SPME) gas chromatography (GC) on triplicate of composite samples.

Results: With added phosphate, Guardian 09 at 400 ppm was the most effective treatment (90-96% reduction in hexanal). Without added phosphate, Guardian 09 at 600 ppm was the most effective treatment (38-86% reduction), though much less effective than in the presence of added phosphate. Phosphates can inactivate metals through chelation. If left unchelated by phosphate, those metals can readily oxidize not only

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lipids but also heme proteins, rendering the heme proteins more oxidative towards lipids. Furthermore, polyphosphates increase pH, which decreases the ability of metals and heme proteins to oxidize lipids. Deli turkey with phosphate had an average pH of 6.3, whereas deli turkey without phosphate had an average pH of 6.2. There was no significant interaction between hexanal and storage time ($P = 0.3552$). However, there was a significant effect of storage time ($P = 0.0292$), hence, correlation models were built separately for each week of storage. Correlations between hexanal and OF were statistically significant at each time point ($P < 0.05$). The correlation improved as time of storage increased (R^2 of 0.36, 0.57, and 0.79 for weeks 1, 7, and 13, respectively). **Conclusion:** The correlation models may be improved by repeating the experiment and subjecting samples for sensory- and hexanal analysis to the exact same temperature profile until analysis. The combination of Guardian 09 and added phosphate was particularly effective at inhibiting lipid oxidation during storage.

Keywords: rancidity, rosemary, phenolics, synergy

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IMPACT OF ENCAPSULATION OF SODIUM TRIPOLYPHOSPHATE ON COOK YIELD AND OXIDATIVE QUALITY OF BEEF PATTIES

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Objectives: While being well recognized for moisture retention properties, phosphates such as sodium tripolyphosphate (STPP) and sodium diphosphate also function as antioxidants due to their chelation capacity. However, phosphates are prone to phosphatase enzymes inherent in the muscle. These enzymes catalyze the breakdown of the STPP to mono- and di- (pyro) phosphate components. By increasing the quantity of monophosphates mediated through this enzymatic hydrolysis, the level of antioxidant protection provided by the tripolyphosphate and diphosphates is compromised. To study the impact of such hydrolysis of phosphates on cook yield and oxidation, a comparison was made between STPP, encapsulated STPP and Lem-o-Fos[®] using a grilled beef patty model. Enzyme breakdown (hydrolysis) products of STPP were analyzed after various pre-cooked holding (dwell) times by ion chromatography (IC). The impact of each phosphate and pre-cooked dwell time on cooked beef patty pH, cook yield, and antioxidant properties was evaluated.

Materials and Methods: Three types of STPP (Innophos, Inc) added to a 0.3% level were mixed into 80% lean fresh ground beef. Sea salt was also included in all treatments as such salts may contribute pro-oxidant metal ions. A non-phosphate control with sea salt was included in the design. Beef patties were formed in a hand burger press. For each treatment, 12 patties were formed and cooked on an iron griller at 148°C for 12 minutes until the internal temperature reached 65.5°C.

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Patties with 0, 4 and 24 hours of pre-cook holding time and 1, 6, 12 days of post-storage time were analyzed using wet chemical and chromatographic methods. Cook yield and pH were measured; Ion chromatography was utilized to measure the STPP residue and breakdown products, to investigate the impact of encapsulation on STPP stability. To measure the antioxidant impact of the STPP, 2-Thiobarbituric acid (TBA) values were measured in a UV spectrometer.

Results: Among 4 groups of beef patties, encapsulated STPP showed an improved antioxidant effect. Lemo-fos STPP showed superior cook yield when compared to unencapsulated and encapsulated STPP. Precooked holding times of 4 hour and 24 hour pre-cook holding time differentiated the STPP samples and as such allowed more time for enzyme degradation of the STPP. The advantage of encapsulated STPP on antioxidation effect was showed to be more significant as the post-storage time increase.

	Raw patties: 4 Hr holding time Phosphate residue			Cooked patties: TBA value – after 1 day storage(MDA mg/kg meat)		
	Mono-phosphate	Di-phosphate	Tripoly-phosphate	0 Hr Pre-cook	4 Hr Pre-cook	24 Hr Pre-cook
Control	0.227%	0.010%	0.010%	3.69	3.69	3.86
Un-encapSTPP	0.310%	0.092%	0.015%	3.03	1.36	2.32
Encap-STPP	0.273%	0.113%	0.030%	2.41	1.41	2.17
Lemo-fos STPP	0.307%	0.096%	0.018%	2.84	2.20	2.39

Conclusion: Encapsulation of STPP protected the phosphates from phosphatase hydrolysis, thus maintaining its antioxidant capacity. Ion Chromatorgraphy was effective in detecting functional STPP groups ($P_2O_7^{4-}$ and $P_3O_{10}^{5-}$) thus making it possible to correlate the antioxidant capacity and the tripoly and diphosphate (pyro) content. Holding time before cooking has a greater impact on its antioxidant capacity of STPP. Future tests are planned to determine the optimized ratios of encapsulated and non-encapsultate STPP – levels that would provide maximum water holding capacity (juiciness) and antioxidant properties.

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Keywords: Antioxidant, Encapsulation, Ion chromatography,
Phosphatase, Sodium tripolyphosphate (STPP)

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QUALITY EVALUATION OF LOW-FAT GROUND BEEF PREPARED WITH WHEAT-BASED PROTEIN

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Objectives: Ground beef is an important source of protein in American diets but it can contain animal fat as much as 30%. The objective of this study was to evaluate the quality of low-fat ground beef prepared with wheat-based protein (WP, named Likatein[®]) or starch (ST).

Materials and Methods: Boneless beef round was ground through a 0.48 cm plate to serve as a control (CTR). For three treatments, the beef portion in the control was replaced with starch (ST) for 25%, WP for 25%, and rosemary extract (WPR) for 24.6/0.4%, respectively. Each of the mixtures including CTR was ground again through a 0.32 plate, placed on white polystyrene trays for 450 g, and overwrapped with an oxygen permeable polyvinyl chloride film. The packages of case-ready ground beef were stored for 9 days on shelves (4°C) in a coffin-style retail case under continuous fluorescent light. On each sampling day (0, 1, 2, 3, 5, 7, and 9), two bags of ground beef were taken for color evaluation (CIE L*, a*, and b*), proximate analysis (protein, fat, and moisture), pH, purge, and lipid oxidation (TBARS). Data were analyzed by one-way ANOVA and a post-hoc analysis was performed using Duncan's multiple range test for treatment differences at $P < 0.05$.

Results: During 9 days of storage, the fat contents of WP, WPR and ST ranged from 7 to 10%, which were generally lower ($P < 0.05$) than those (11 to 12%) of CTR. The protein content ($14.5 \pm 1\%$) of ST was significantly lower, regardless of storage day, than those ($20.5 \pm 1\%$) of CTR, WP, and WPR which were not different among each other. After 3 day storage, TBARS values (< 0.11) of WP and WPR were

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significantly lower ($P < 0.05$) than the CTR (0.14 – 0.28), with an intermediate value (0.15 – 0.17) for the ST. The redness (a^* , ~ 25.5) of CTR and ST was initially higher than those (~20) of WP and WPR, which were not different any more after 1 day storage except 2 and 9 days. Regardless of treatment, no significant differences ($P > 0.05$) were seen for pH and purge during the entire storage except 7 days.

Conclusion: Based on these results, the addition of WP to ground beef by 25% significantly reduced fat content and lowered lipid oxidation with the similar product quality as the CTR.

Keywords: ground beef, lipid oxidation, low fat, meat quality

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INFLUENCE OF DROPLET SIZE ON THE ANTIOXIDANT CAPACITY OF ROSEMARY LOADED OIL-IN-WATER EMULSIONS IN DRY-FERMENTED SAUSAGES

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Objectives: We hypothesize that the use of nanoemulsions, which have several advantages compared to conventional macroemulsions, may be more suitable as delivery systems in terms of antioxidant activity due to high surface-to-volume ratio. Therefore, differently sized oil-in-water emulsions stabilized by Tween 80 (2% w/w, pH 5) were fabricated and loaded with rosemary extract (10,000 ppm). 2% of the oil-in-water emulsions ($d_{43} = 150 - 7,200$ nm) were incorporated in dry-fermented sausages to test the antioxidant capacity of rosemary loaded emulsions during ripening and storage.

Materials and Methods: Rosemary loaded emulsions [10% (w/w) Miglyol 812N, 2% (w/w) Tween 80, pH 5] were produced using a high shear blender and high pressure homogenizer. Unloaded oil-in-water emulsions were used as control. The particle size distributions of the emulsions were measured using a static light scattering instrument.

Dry-fermented sausages were manufactured using a typical recipe where lean meat and backfat from pork were added in the ratio 2:1. One batch was salted with sodium chloride only; the other batch with nitrite curing salt (nitrite plus sodium chloride). In both cases, fermentation was controlled by starter cultures. The stuffing was filled in cellulose casings of 60 mm caliber. Sausages were fermented for 21 days in a climate chamber to a weight loss of 27 wt%. After 21 days, the salamis were sliced into 2.0-mm slices and

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stored in sealed trays with 60% oxygen for 49 days at 20 °C in the dark to enhance lipid oxidation. Primary (peroxide value) and secondary (thiobarbituric acid reactive substances) oxidation products were measured during 49 days of storage.

Results: Tween 80 stabilized oil-in-water emulsions were stable over 70 days. The same surfactant concentrations of all emulsions were needed to avoid changes in Tween hydroperoxides content.

Results of primary and secondary oxidation products in dry-fermented sausages have shown that 2% of oil-in-water emulsions loaded with 10,000 ppm rosemary extract could significantly ($P < 0.001$) decelerate oxidation compared to controls without added antioxidant. As expected, control samples with nitrite curing salt had significantly ($P < 0.05$) lower TBARS values than control samples with sodium chloride.

However, no significant differences in antioxidant effectiveness of rosemary extract loaded oil-in-water emulsions were observed in dependence on different droplet sizes and in dependence on the combination with and without nitrite, respectively.

Conclusion: This study has demonstrated that there is no significant difference in the antioxidant effectiveness in terms of droplet size of rosemary extract loaded oil-in-water emulsions in dry-fermented sausages, when 2% of a highly concentrated emulsion was applied. These results are consistent with previous studies. However, as there were slight differences by trend between the differently sized emulsions, further trials will be conducted where 0.5% of oil-in-water emulsions will be incorporated.

Keywords: antioxidant capacity, dry-fermented sausage, lipid oxidation, nanoemulsion, rosemary extract

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EFFECT OF KIWI FRUIT POWDER IN TENDERIZING M. TRICEPS BRACHII FROM MATURE COWS

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Objectives: Chuck muscles from mature cows may be tough. Injection of marinades containing proteolytic enzymes can improve consumer acceptance for this segment. Kiwi fruit contains actinidin, which is a protease that also has activity against collagen. The objective of this study was to evaluate 2 different kiwi-powders with regard to improve palatability of *Triceps brachii* from mature cows.

Materials and Methods: Two different commercial kiwi powders (A and B) were obtained as gifts from the producers. They were claimed to have unequal temperature optima for tenderizing meat. Powder A should have proteolytic activity at 4°C and be inactivated above 40°C. Powder B should have no activity below 10°C but achieve its maximum effect around 50°C. Therefore different test conditions were applied for the beef samples injected with these kiwi substrates. From a commercial abattoir 20 M. *Triceps brachii* were purchased. All muscles were collected from mature cows that were more than 48 months old. After four days ageing the muscles were split at the middle, which gave a total number of 40 samples. Five samples were used as control (C) without injection, five were injected with brine and phosphate only (CS), while 15 samples were injected with each of the kiwi-marinades. Both marinades contained 0.5% kiwi-powder, 3% NaCl and 3% polyphosphate, and the samples were injected to 110% weight. The samples injected with kiwi-powder A were divided into 3 sub-sets, where the enzymes were allowed to work for 24, 48 and 72 hours at 4°C before cooking. The samples injected with kiwi-powder B were also divided into 3 sub-sets, which were held for 0, 30 and 120 minutes at 50°C during the cooking. Except for the

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samples held 30 and 120 minutes at 50°C all samples were immersed into water-bath at 70°C for 50 minutes. The two remaining sub-sets were transferred to 70°C for 30 minutes, after the given period at 50°C. The cooked samples were subjected to Warner Bratzler (WB) shear force and a simplified sensory analysis. Data were analyzed by one-way ANOVA (Minitab 16.1).

Results: There was no difference ($P > 0.05$) in WB shear force between the two control groups, C and CS. For the samples injected with kiwi-powder A there was a significant ($P < 0.05$) decrease in WB shear force accompanying the action time of the kiwi-enzyme. The samples injected with kiwi-powder B showed also a decreasing tendency for the WB shear force, however these values did not differ significantly ($P > 0.05$). Beef off-flavor was evaluated by the sensory assessors. As expected no off-flavor was detected for the control samples (C), while one CS-sample had low but detectable off-flavor. This could probably be ascribed to phosphate from the marinade. The samples marinated with kiwi-powder A had some off-flavor after 24 hours but it disappeared at 48 hours. Contrary, the samples injected with kiwi-powder B obtained increasing score for off-flavor when they were held for 2 hours.

Conclusion: Within the experimental test design of this study kiwi-powder A was better than B in improving the palatability of the chuck muscle. Maybe powder B would have had a better effect if the injected samples had been aged longer before cooking. However, that has to be evaluated in future studies.

Keywords: Actinidin, beef tenderness, Kiwi

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TEXTURE OF RAW AND COOKED CO-EXTRUDED ALGINATE AND MANUFACTURED COLLAGEN SAUSAGE CASINGS OVER STORAGE TIME

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Objectives: The use of co-extrusion casings is on the rise around the world. The approach allows more automation as well as reducing re-work and improving sanitation. During the process a thin layer of casing material (alginate, collagen) is extruded onto the sausage as it is coming from the stuffer. The sausage then goes through a CaCl₂ bath to solidify the alginate. However very little has been published in the scientific literature about the process. The objectives of the work were to compare shear properties in the raw and cooked state over storage of 0, 1, and 2 weeks.

Materials and Methods: Fresh sausages produced under industrial settings were evaluated. A CaCl₂ bath was used for the two alginate treatments. Shear tests were performed (lengthwise and widthwise) on raw and cooked (72 C) sausages using a 9 mm craft knife mounted on a texture analyzer (TA.XT2). Casing thickness was determined with a digital micrometre. Light microscopy of raw casings was used to evaluate microstructure. A mixed linear model with treatment (sausage type), storage time, and their interactions as fixed effects and trial as random effect was used to compare treatments.

Results: There were significant differences ($P < 0.05$) in the work, force and distance (Table 1) needed to shear the raw sausages in the two casing types. Overall, these forces collagen were greater in the collagen casings compared to the alginate casings.

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There were also differences in the distance and work to shear the two raw sausages in alginate casings, which might have been due to meat formulations.

Table 1- Work to shear raw and cooked sausages made with co-extruded alginate or manufactured collagen casings lengthwise, stored for 0, 1 and 2 weeks (n=18).

Casing Type	Weeks	(Raw) Work to	(Cooked) Work to
		Shear (N mm)	Shear (N mm)
Alginate 1	0	2.73 ± 0.59	1.11 ± 0.26
	1	3.03 ± 0.77	1.20 ± 0.56
	2	4.34 ± 2.32	1.50 ± 0.78
Alginate 2	0	4.43 ± 0.59	1.33 ± 0.19
	1	4.23 ± 0.94	1.42 ± 0.69
	2	8.05 ± 3.17	2.11 ± 0.64
Collagen	0	8.72 ± 1.33	4.41 ± 0.73
	1	9.38 ± 0.57	2.81 ± 0.71
	2	9.69 ± 0.66	3.50 ± 0.70

Conclusion: The raw sausages appeared to require more force to shear in the second week after production. There was no difference in the cooked products. The shear properties of the sausages in alginate casings varied with the direction of shear (i.e., lengthwise vs. widthwise).

Keywords: casing, sausage, alginate, collagen, alginate

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SORGHUM BRAN ADDITION IN BRATWURST, PRE-COOKED PORK PATTIES AND PRE-COOKED TURKEY PATTIES

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Objectives: Lipid oxidation in processed meat products results in off-flavors and reduced shelf-life. Sorghum bran has been shown to be an effective antioxidant in pre-cooked beef patties stored at 4°C for up to 5 days under lights. The objective was to examine the effect of sorghum bran addition in bratwursts, pre-cooked pork sausage patties and pre-cooked ground turkey patties on lipid oxidation, color, pH and trained sensory descriptive attribute flavor during 5 d of aerobic storage at 4°C.

Materials and Methods: Sumac or black, high tannin sorghum bran (equivalent mixture of B.05020, B.05029, and B.05023) was added at 0.25%, 0.5% and 0.75% to ground pork sausage, bratwurst, and ground turkey. A negative control (no antioxidants added) and two positive controls of BHA/BHT (0.01% food-grade butylated hydroxyanisole, Sigma-Aldrich, W218208 and 0.01% butylated hydroxytoluene Sigma-Aldrich, W218405, 0.5% ViniferOX™, respectively) and 0.2% rosemary extract (Herbalox® Type HT-25, Kalsec Inc., Kalamazoo, MI) also were included within each product. After the addition of ingredients, bratwursts were extruded into natural casings and two bratwursts per treatment were placed on a Styrofoam tray and over-wrapped with polyvinyl chloride film (PVC). Ground pork sausage patties (hot boned pork sausage at about 48% lipid from a commercial processor; 155 gms; n=20) were formed within treatment. Raw patty moisture and lipid, color and pH were obtained from one patty per treatment within each of three

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replications. Patties were cooked using a convection conveyor oven (XLT 1832E-TS, Wolfe Electric, Inc., Wichita, KS USA) to an internal temperature of 70°C. Patties were cooled to 4°C and placed on Styrofoam trays and over-wrapped with PVC to induce oxidation. Packages were randomly assigned locations in a 4°C cooler under 1600 lx fluorescent lighting and were evaluated after 0, 1, 3 and 5 d. Ground turkey was formed into patties (n=20 per treatment; 115 gm) and cooked as defined for pork sausage patties, packaged and evaluated as previously described. Raw and cooked chemical data was collected as defined for pork sausage patties.

Results: Bratwurst and pre-cooked pork sausage patties containing different antioxidant treatments did not differ ($P > 0.05$) in TBARS, descriptive sensory flavor attributes, color or pH across storage days. However, with storage, control pre-cooked turkey patties increased ($P < 0.05$) in TBARS values. Pre-cooked turkey patties containing 0.5 and 0.75% black, high tannin sorghum bran had similar or lower ($P < 0.05$) TBARS values than pre-cooked turkey patties containing BHA/BHT over 5 days of storage. Brown/roasted, fat-like, and rosemary flavor attributes were not affected ($P > 0.05$) by antioxidant treatments. Cooked turkey patties containing BHA/BHT had less turkey, overall sweet, and salty flavor; and the highest level of bitter and BHA/BHT flavor ($P < 0.05$). Control patties had the highest level of warmed-over, refrigerator stale, and cardboardy flavor ($P < 0.05$). Storage days did not affect ($P > 0.05$) any of the flavor attributes evaluated by the trained, expert flavor descriptive attribute panel.

Conclusion: These results suggest that high tannin sorghum bran can be used as an effective antioxidant without negatively affecting sensory flavor attributes and that sorghum bran was as powerful of an antioxidant as BHA/BHT in pre-cooked ground turkey patties.

Keywords: sorghum

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QUALITY AND SENSORY CHARACTERISTICS OF LOW-FAT HAMBURGER PATTY PREPARED WITH WHEAT-BASED PROTEIN (WP)

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Objectives: The quality of low-fat hamburger patty is primarily affected by the values of raw meat and added ingredients. The objective of this study was to evaluate the quality and sensory characteristics of low-fat hamburger patty prepared with wheat-based protein (WP or Likatein®) or starch (ST).

Materials and Methods: Boneless beef round was ground through a 0.48 cm plate, and mixed with 1.7% salt/15% water to serve as a control (CTR). For three treatments, the beef portion in the control mixture was replaced with starch (ST) for 25%, WP for 25%, and WP/rosemary extract (WPR) for 24.6/0.4%, respectively. Each of the resulting mixtures including the CTR was ground again through a 0.32 cm plate, formed into hamburger patty, placed into Ziploc bags, and stored in a freezer at -15°C for further analysis. On each sampling day (0, 15, 30, 45, 60, 75, and 90), patties were taken for color evaluation (CIE L*, a*, and b*), proximate analysis (protein, fat, and moisture), pH, purge, lipid oxidation (TBARS), and trained sensory evaluation. Data were analyzed by one-way ANOVA with a post-hoc analysis using Duncan's multiple range test for treatment differences at $P < 0.05$. For sensory analysis, a mixed model analysis of variance was used for separation of means.

Results: During 90 days of storage, the fat content of WP, WPR and ST ranged from 3.6 to 8.0%, which were generally lower ($P < 0.05$) than those (8.4 – 10.7%) of CTR. The protein content ($12.5 \pm 0.5\%$) of ST

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was significantly lower, regardless of storage day, than those ($17.5 \pm 0.5\%$) of CTR, WP, and WPR which were not different each other. TBARS values (< 0.11) of WP and WPR were initially lower ($P < 0.05$) than the CTR (> 0.16), with intermediate values (~ 0.13) of the ST, the trend of which was maintained for the rest of storage. Both WP and WPR marked pH values ($5.96 - 6.02$) higher than those ($5.85 - 5.89$) of CTR and ST during the entire storage. In trained sensory evaluation, CTR received a higher redness score, followed by WPR, WP, and ST. Both CTR and WP had higher juiciness and less cohesiveness scores than the ST. In beefy flavor, a greater score was found in CTR than in WPR and WP, which were significantly higher than the ST.

Conclusion: Based on these results, the addition of WP to hamburger patty by 25% significantly reduced fat content, lowered lipid oxidation, and maintained protein level as similar as the CTR, with improved sensory quality over the ST samples.

Keywords: lipid oxidation, hamburger patty, low fat, sensory evaluation

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COOKING LOSS, COOKING TIME, PATTY SHRINK AND COLOR OF NILGAI ANTELOPE PATTIES WITH BEEF OR PORK FAT INCLUSION

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Objectives: Nilgai antelope (*Boselaphus tragocamelus* Pallas) are commercially harvested in South Texas for exotic meat markets. Nilgai are lean, and fat is added to ground nilgai to enhance palatability. The research objective was to determine if the inclusion of beef or pork fat impacts cooking properties, and color of raw and cooked patties. The hypothesis was that inclusion of fat would influence cooking properties, and color of raw and cooked patties, with beef fat having the greatest effect on cooked patty color.

Materials and Methods: There were three treatments: 1) 100% Nilgai (NG), 2) 85% Nilgai-15% Beef Fat (NB), and 3) 85% Nilgai-15% Pork Fat (NP). The raw product was ground through a 9.5 mm plate, mixed, and ground through a 4.8 mm plate. The ground product was formed into 114 g patties using a 12 cm diameter plastic die. There were 11 patties per treatment. The raw patties were crust frozen, vacuum packaged, and frozen (-20°C) until analysis. Frozen raw patties were tempered 24 h before cooking at 4°C. The chilled raw patties were removed from vacuum packages one hour before raw evaluation and cooking. All evaluations of raw patties were conducted immediately prior to cooking, and all cooked evaluations occurred five minutes after patties were removed from the griddle. Prior to cooking, a thermocouple was inserted into the geometric center of the patty. The patties were cooked on an electric griddle until the temperature reached 35.5°C, then flipped over and cooked to 71°C. Once the patties reached 71°C, the patties

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were removed from the griddle. The patties were evaluated for raw and cooked color, cooking time, cooking loss, and surface area shrink during cooking. Three colorimeter scans were taken per sample using a MiniScan EZ Diffuse LAV (20 mm diameter viewed area; 25 mm diameter port size) measuring L^* , a^* , and b^* .

Results: The NB patties had the greatest ($P < 0.05$) cooking loss (34.5%) compared to NG (31.5%) and NP (30.2%) patties. Patties with fat included tended ($P = 0.13$) to take longer to cook compared to NG patties (791 sec., 997 sec., and 957 sec. for NG, NB and NP, respectively). There was no difference ($P > 0.05$) in patty shrink for any of the treatments. Fat inclusion resulted in lighter ($P < 0.05$; L^* : NG 42.3, NB 46.3, NP 48.7) raw patties with NP being the lightest ($P < 0.05$). Raw NG had the greatest ($P < 0.05$) red color as indicated by hue angle (NG 52.9, NB 58.9, NP 56.3), and a^*/b^* ratio (NG 0.76, NB 0.61, NP 0.67). Raw NG had the least ($P < 0.05$) discoloration (a^*/b^*) with raw NB having the greatest ($P < 0.05$). Cooked patties with fat were darker ($P < 0.05$) compared to NG (L^* : NG 43.8, NB 39.9, NP 40.8). Cooked NG had greater ($P < 0.05$) denatured metmyoglobin color compared to NB (hue angle: NG 58.7, NB 53.9). The color change during cooking resulted in patties with fat becoming darker ($P < 0.05$; change in L^* : NG 1.5, NB -6.4, NP -7.9) compared to NG. Patties with fat had a greater ($P < 0.05$) reduction in color intensity during cooking compared to NG (change in chroma: NG -0.2, NB -3.2, NP -3.6).

Conclusion: Thus, inclusion of 15% pork or beef fat into ground nilgai patties had little impact on cooking properties compared to 100% ground nilgai. However, inclusion of beef fat resulted in the darkest cooked color.

Keywords: Antelope, Cooking properties, Nilgai

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EFFECTS OF POSTMORTEM RAPID CHILLING ON SENSORY ATTRIBUTES ON FRESH PORK CUTS FROM THE *LONGISSIMUS DORSI*, *PSOAS MAJOR*, *TRICEPS BRACHII* AND *SEMIMEMBRANOSUS*.

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Objectives: The objective of this experiment was to determine how rapid chilling influences fresh pork quality.

Materials and Methods: Carcasses (n=40); 86 to 91 kg; 54 to 57% fat free lean were selected in groups of ten on four nonconsecutive dates. Carcasses were split approximately 40 minutes postmortem and one side from each carcass was assigned to rapid (RC) or conventional chill (CC) treatment. Loin temperatures were recorded continuously in two sides from each treatment per slaughter date. Tenth rib loin pH and temperature were taken at 40 minutes, 4 and 24 hours postmortem. Aged fresh pork (PM 7 d aging, SM 8 d aging, LD 10 d aging, TB, 13 d aging) was used to determine treatment effects on pH, purge, cook loss, star probe, Warner–Bratzler Shear force (WBS) and sensory quality including color scores, marbling scores and measurements of Hunter L, a* and b* values using a Minolta Chroma Meter fitted with a 50mm aperture and D65 light source with a 0° observer. Chops (LD and SM) were cooked in a clamshell grill and roasts (PM and TB) were cooked in a rotary hearth oven to an internal temperature of 68°C. Data were analyzed using JMP Pro, Version 10 with chilling treatment as a fixed effect and harvest as a block.

Results: Rapid chilling resulted in a mean four hour postmortem loin temperature of 9°C; while mean four hour loin temperature in CC

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carcasses was 13°C. Rapid chilled carcasses had greater four hour loin pH (6.34) than CC carcasses (6.09), indicating a slower pH decline in RC loins. Loins from the RC treatment had increased cook loss (RC=20.60%, CC=18.73%; $P = 0.02$) and greater WBS (RC=3.64 kgf, CC=3.17 kg; $P = 0.05$). Chilling had no other significant effect on quality or sensory measurements in the LD. Rapid chilling resulted in greater purge in the PM (RC=0.75%, CC=0.47%; $P = 0.02$). However, RC resulted in PM chops that were juicier (RC=8.31, CC=7.46; $P < 0.00$), more tender (RC=8.59, CC=7.86; $P = 0.02$), and less chewy (RC=2.09, CC= 2.76; $P < 0.00$). Rapid chilling had no other effect on sensory or quality measurements in the PM. Rapid chilling in the SM was found to have improved color score (RC=3.2, CC= 3.0; $P = 0.04$) but had a lower a^* value (RC=15.30, CC=15.63; $P = 0.05$). Chilling had no further effect in the SM on other measured sensory or quality traits. Rapid chilling had no effect on sensory or quality traits in the TB.

Conclusion: Rapid chilling had a consistent negative effect on LD chop WBS values; this is in agreement with previous reports. However, rapid chilling resulted in juicier, more tender and less chewy sensory scores in the PM. Results indicate that muscle location and fiber type may play a role in the effect of RC on fresh pork quality.

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Keywords: Blast Chilling, Pork, Pork Quality, Rapid Chilling

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COLOR OF MOISTURE ENHANCED NON-INTACT BEEF STEAKS AS AFFECTED BY INTERNAL TEMPERATURE AND MOISTURE ENHANCING RATE BY DOUBLE PAN-BROILING

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Objectives: This study evaluated the efficacy of utilizing color as an indicator of degree of doneness in non-intact beef steaks that were moisture enhanced (10 and 18%) and cooked to internal temperatures of 55°C, 60°C, 65°C and 71.1°C.

Materials and Methods: Fresh 1-kg beef knuckle (IMPS 167A) was processed through a kidney plate and mixed with NaCl+Na-tripolyphosphate solutions to reach a 10 or 18% moisture enhancement rate. Chubs were then frozen (-20°C) for 5 h. Semi-frozen beef were cut into 2.54-cm thick, vacuum-packaged, frozen (-20°C, 96 h), and tempered (4°C, 2.5 h) before double pan-broiling (Farber-ware® griller) to internal temperatures of 55°C, 60°C, 65°C and 71.1°C. Steaks were cooled to approximately room temperature prior to instrument color (HunterLab Miniscan EZ), pH, water activity, and cooking loss measurements. Temperatures of the griller (176°C) and steaks were monitored with thermocouples. Samples were frozen following the above measurements until analysis of fat and moisture content could be conducted. Data (two replicates/three samples each) were analyzed using the GLM procedure of SAS including independent variables and interaction. LS-means were obtained for independent variables and the interaction

Results: As expected, steaks with 18% moisture enhancement had higher analytical moisture values than steaks with 10% moisture

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enhancement. This coincides with cook loss data as steaks with 10% moisture enhancement had a greater (35.61% vs 24.58%; $P < 0.0001$) cook loss percentage than 18% moisture enhanced steaks. Additionally, steaks cooked to 71.1°C had less moisture contents (63.95% vs 66.00%) than steaks cooked to 55°C, 60°C, and 65°C. There were no moisture*temperature interactions for color. However, there were main effects. Semi-frozen steaks with 18% moisture enhancement were more red (21.55 vs 8.91; $P < 0.05$) and more yellow (17.22 vs 13.10; $P < 0.05$) than steaks with 10% moisture enhancement. Furthermore, external color of steaks with 10% moisture enhanced was lighter (48.11 vs 45.83; $P < 0.05$) and less red (3.88 vs 8.28; $P < 0.05$). Steaks with 10% moisture enhancement were lighter (48.56 vs 46.03; $P < 0.05$), less red (7.30 vs 11.37; $P < 0.05$), and more yellow (17.37 vs 15.11; $P < 0.05$) than steaks with 18% moisture enhancement. It is important to note that even with increasing internal temperature, internal color was not different among temperatures.

Conclusion: Internal color is not a good indicator for degree of doneness for restructured steaks. Additionally, moisture enhancement rate affects the internal color of restructured steaks.

Keywords: Color, moisture enhanced, non-intact beef, restructured steaks

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CONSUMER SENSORY EVALUATION OF FORAGE AND CONVENTIONAL FEEDLOT FINISHED BEEF RIBEYE STEAKS

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Objectives: Previously, forage finished beef was rated lower in blind palatability tests. However, many previous comparisons of forage and conventional finished beef were confounded by carcass maturity or degree of marbling. In this study consumers evaluated ribeye steaks of forage and conventional feedlot finished (FL) beef of 'A' maturity having similar ($P > 0.05$) mean numerical marbling scores.

Materials and Methods: Forage diets included a perennial legume, birdsfoot trefoil (*Lotus corniculatus*, BFT), and a grass, meadow brome (*Bromus riparius* Rehmann, GF). Additionally, representative retail forage and conventional beef (USDA Certified Organic Grass-fed, COGF; USDA Top Choice, TC) were evaluated. Ribeye steaks of 2.5-cm thickness were produced from paired ribeye rolls (n=6) aged 14 days postmortem. Prior to consumer evaluation steaks were thawed for 48 hours at 4°C. Steaks were cooked to a medium degree of doneness (71°C), all external fat, connective tissue, and exterior muscles were removed leaving the *Longissimus dorsi*. Consumers were served approximately 2.5-cm³ cubes of steak under red lighting. Consumers (n=120 per replicate) evaluated steaks in 6 replicates for smell, flavor, tenderness, fattiness, juiciness, and overall liking on a nine point hedonic scale (1 = dislike extremely and 9 = like extremely). Each replicate corresponded to one animal. Additionally, a four point hedonic scale of perceived quality was used where 1 = unsatisfactory, 2 = everyday quality, 3 = better than everyday quality and 4 = Premium quality.

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Results: Treatments affected all attributes, with the exception of liking of smell ($P > 0.05$). Flavor of FL and TC steaks were most liked ($P < 0.05$). However, flavor liking of TC steaks was similar ($P > 0.05$) to BFT and GF, while COGF steaks were lower ($P < 0.05$) for flavor liking compared to all beef types, except GF ($P > 0.05$). Liking of tenderness was greatest ($P < 0.05$) among BFT, FL and TC steaks. However, TC was similar ($P > 0.05$) to GF. Steaks of COGF were rated the lowest ($P < 0.05$) in tenderness-liking but were similar ($P > 0.05$) to GF. Steaks from FL, BFT and TC were most ($P < 0.05$) liked for fattiness. However, COGF and TC were similar ($P > 0.05$) with GF steaks which were least liked for fattiness ($P < 0.05$). Liking of juiciness was greatest ($P < 0.05$) for BFT and FL steaks. While TC, GF and COGF were lower ($P < 0.05$) for juiciness liking. Overall liking and perceived quality was greatest ($P < 0.05$) for FL, BFT and TC steaks. However, TC was found to be similar ($P > 0.05$) to GF. Meanwhile, GF was similar ($P > 0.05$) with the COGF receiving the lowest ($P < 0.05$) ranking of overall liking and perceived quality.

Conclusion: These results indicate that beef forage type can impact palatability. Attribute ratings aligned BFT finished beef steaks with FL and retail TC steaks. Meanwhile, GF steaks were aligned with retail COGF steaks being least liked. Further work will be required to extrapolate the mechanisms behind these differences. However, in studies with lamb, tannin content of BFT was an important factor and may similarly impact beef palatability.

Keywords: beef, Birdsfoot trefoil, consumer sensory evaluation, forage-finished, ribeye

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EFFECTS OF TECHNOLOGY USE IN BEEF PRODUCTION SYSTEMS ON MEAT QUALITY AND CONSUMER PALATABILITY RATINGS

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Objectives: The objectives of this study were to examine the effects of beef production systems with and without the use of a β -adrenergic agonist on strip loin quality and consumer acceptance compared to an all-natural production system. The treatments consisted of all-natural production (NAT), conventional production (CONV), and conventional production with the addition of the beta-agonist, zilpaterol hydrochloride (CONV-Z).

Materials and Methods: Crossbred beef steers (n = 336) were randomized to one of the three treatments. NAT cattle received no growth promoting technologies. The CONV and CONV-Z steers were implanted with 40 mg of estradiol and 200mg of trenbolone acetate on d 0, and were fed 33 and 9 mg/kg of monensin and tylosin daily, respectively. The CONV-Z steers were fed a diet 6.76 mg of ZH/kg for 20 d before slaughter with a 3 d withdrawal. Forty-four carcasses that graded USDA Low Choice were identified for each treatment and strip loins were collected. Loins were fabricated into 2.54-cm thick steaks and steaks from each loin were aged for 14 d and 21 d. Steaks for sensory analysis and instrumental tenderness (Warner-Bratzler shear (WBSF), slice shear (SS) [Shackelford, 1999]) were thawed at 2°C for 24 h and cooked on an impingement oven to an internal endpoint temp of 71°C. Consumers (n = 400) and trained panelists (n = 8) evaluated each sample for tenderness, juiciness, flavor and overall liking. A consumer taste panel

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was conducted prior to an OSU football game in Stillwater, OK. Consumers were fed one 21 d aged sample from each treatment; groups of 100 consumers tasted samples from 27 steaks from the three treatments within similar WBSF groups to reduce variation. Shear and panel data were analyzed in the MIXED procedure of SAS and considered significant at $P < 0.05$.

Results: Analysis of WBSF showed at 14 d aged both NAT and CONV steaks had lower shear values compared to CONV-Z. At 21 d, WBSF values were different with NAT steaks having the lowest value and CONV-Z the highest ($P < 0.01$). Slice shear values from steaks aged 14 d, were different with NAT having the lowest SS value and CONV-Z, the highest ($P < 0.01$). Of steaks aged 21 d, average SS values of NAT and CONV steaks were lower compared to CONV-Z ($P < 0.01$). The consumer panel found strip steaks from NAT and CONV-Z steaks similar for tenderness, juiciness, flavor and overall liking with CONV steaks ranked lowest in all attributes ($P < 0.05$). Trained panelists ranked NAT and CONV steaks similar for juiciness and tenderness at 14 d aged with CONV-Z rated less juicy and tender compared to NAT and CONV. By 21 d aged NAT were ranked as more tender and juicy compared to CONV, but both were rated higher than CONV-Z steaks ($P < 0.05$). No differences in beef and metallic flavors were observed ($P > 0.05$) at any aging \times treatment combination.

Conclusion: Consumers were unable to detect tenderness or palatability differences found by WBSF, SS and trained panelists. Consumers rated steaks from cattle supplemented with zilpaterol hydrochloride similar to steaks from all-natural cattle and higher than steaks from conventionally managed cattle. The conflicting consumer vs. trained panel results indicate consumers do not describe palatability differences in the same manner as trained panelists.

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None Declared

Keywords: beef cattle, palatability, tenderness, zilpaterol hydrochloride,
 β -adrenergic agonist

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IMPACT OF MULTIPLE ANTIMICROBIAL INTERVENTIONS ON GROUND BEEF QUALITY

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Objectives: To determine if antimicrobial interventions, when applied in various combinations to beef carcasses and/or beef trimmings, impacted color and consumer and trained panel characteristics of ground beef patties.

Materials and Methods: Trimmings subgroups ($n = 40$) were derived from beef forequarters ($n = 10$). In addition to a control (hot carcass lactic acid spray only), four antimicrobial treatment combinations were used in this study: (1) hot water (82.2 °C or higher) applied to hot carcass followed by hot carcass lactic acid application; (2) hot water applied to hot carcass followed by hot carcass lactic acid application, followed by a pre-fabrication cold forequarter lactic acid spray; (3) hot water applied to hot carcass followed by hot carcass lactic acid application, followed by a pre-fabrication cold forequarter acidified sodium chlorite spray and (4) hot water applied to hot carcass followed by hot carcass lactic acid application, followed by a pre-fabrication cold forequarter Beefxide (lactic acid and citric acid mixture) spray. Following carcass treatments, trimmings were assigned to one of four treatment groups: (1) acidified sodium chlorite, (2) Beefxide, (3) lactic acid or (4) control. Where they were sprayed following forequarter fabrication and were subsequently held in cold storage for 48 h before grinding. Ground beef patties were produced from each trimming subgroup and were designated for shelf-life, consumer panel, or trained panel evaluation. Beef patty temperature, pH and color (L^* , a^* , b^*) measurements were taken on the day of patty production, in addition to daily color measurements taken over the 5 d shelf-life period.

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Results: While some visual darkening of patty color occurred by the completion of the shelf-life period, few significant changes were seen in color space values for each treatment combination. Consumer scores for overall liking, flavor liking, and beefy flavor liking were impacted ($P < 0.05$) by combined antimicrobial treatment effects. Although there were some significant interactions reflected in consumer panel scores, there was no clear trend describing interaction effects and consumer ratings. Of the 32 attributes outlined in the trained panel ballot, panelists detected 18 attributes with only scores for sour milk/dairy ($P = 0.0132$) and cardboardy ($P = 0.0014$) being impacted by treatment combination effects. Again, no clear trends were seen related to any single or combined antimicrobial treatment for these scores.

Conclusion: Beef safety and quality are continuous challenges for the meat industry. With foodborne pathogens being of upmost concern, antimicrobial interventions are commonly used as a method to reduce the prevalence of pathogenic bacteria throughout the beef production process. Multiple hurdle antimicrobial intervention strategies are commonly employed in all facets of beef product manufacturing to ensure the highest level of food safety possible. In general, findings from this study support that food safety interventions, while effective in reducing microbiological counts on product surfaces, do not negatively impact beef patty quality.

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Keywords: Ground beef, Intervention, Quality

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EFFECTS OF CRYSTALLINE AMINO ACID SUPPLEMENTATION OF REDUCED CRUDE PROTEIN (RCP) DIET ON NET ENERGY BASIS ON *LONGISSIMUS* MUSCLE (LM) QUALITY OF GROWING-FINISHING SWINE

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Objectives: Barrows and gilts (n=210) were used to test the effects of crystalline amino acid (AA) supplementation of reduced crude protein (RCP) diets formulated by net energy basis on quality characteristics of the LM from growing-finishing pigs.

Materials and Methods: Pigs were blocked by BW, and pens (3 barrows and 3 gilts/pen) within each block were assigned randomly to either corn-soybean meal diets (C) or 1 of 3 RCP diets (reduced dietary CP and added crystalline lysine levels for the dietary treatments during each feeding phase are presented in the accompanying table). Additionally, synthetic isoleucine, valine, tryptophan, threonine and methionine were added to diets to meet amino acid requirements of growing-finishing pigs. During the last 3-wk feeding phase, 10 ppm of ractopamine were included in all diets. At slaughter and a 24-h rapid chilling period a subsample of whole pork loins (3/pen) was captured during carcass fabrication and further processed into LM chops for quality data (fresh, visual and instrumental color, water holding capacity, Warner-Bratzler shear force) collection.

Results: As CP decreased in pig diets, Japanese ($P < 0.01$), American ($P = 0.032$), and fat color scores decreased ($P = 0.017$) linearly. LM drip loss (linear, $P = 0.015$) increased with decreasing CP diets. Lightness (L^*) value increased ($P = 0.015$) linearly with decreasing CP diets; yet, neither a^* nor b^* values were affected ($P \geq 0.414$) by RCP treatments.

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Furthermore, marbling, firmness scores, cooking loss, and shear force values were not affected ($P \geq 0.503$) by dietary CP levels.

CP (added L-Lysine-HCL) of experimental diets for each feeding phase (% as fed)				
Phase	C	RCP1	RCP2	RCP3
1	20.640 (0.350)	18.825 (0.512)	18.433(0.549)	16.678 (0.716)
2	19.382 (0.334)	16.852 (0.558)	16.498(0.590)	14.697 (0.763)
3	16.755 (0.285)	14.683 (0.468)	14.079(0.523)	12.482 (0.675)
4	14.994 (0.253)	13.051 (0.424)	12.611(0.464)	11.109 (0.607)
5	17.981 (0.300)	16.596 (0.424)	16.198(0.462)	14.599 (0.614)

Conclusion: Results indicate that color was detrimentally affected by reducing dietary CP and adding crystalline AA in diets formulated on a net energy basis.

Keywords: color , pork, reduced CP

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EFFECTS OF DIETARY LEVELS OF DRIED DISTILLERS GRAINS WITH SOLUBLES ON BONELESS HAM QUALITY AND SHELF-LIFE

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Objectives: Including dried distillers grains with solubles (DDGS) in swine diets provides alternatives to feeding corn and soybean meal based diets that can be higher in price. However, previous research has shown feeding swine diets with increased levels of DDGS can result in negatives effects on fresh pork quality, yet limited data is available to evaluate further processed pork products. Therefore, the objective of this study was to include varying levels of DDGS in swine diets to measure the effect on the boneless ham quality and shelf life.

Materials and Methods: Forty-eight crossbred pigs were randomly placed in pens (n=16) and were fed diets containing 0% DDGS (CN), 15% DDGS, 30% DDGS, and 45% DDGS. Pigs were harvested with an average weight of 112±8.1 kg and boneless, two-piece hams were fabricated and pooled by pen. Ham pieces were injected with a standard brine cure to 115% green weight and vacuum tumbled for four hours. Hams were stuffed into fibrous casings, smoked to an internal temperature of 66°C for 30 min, and allowed to cool for 12 h before processing. Hams were sliced to 1.27 cm with one slice placed on a Styrofoam tray and stored under cool florescent light for 0, 7, 14, 21, and 28 d. On each day of retail storage, ham slices were evaluated for subjective sensory color, Minolta L*, a*, and b*, TBAR absorbance. One slice per pen was analyzed for crude moisture and fat content. Data were analyzed as a completely randomized design using the MIXED procedure of SAS, to evaluate the main effects of treatment, storage day,

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and treatment x storage day, using pen as the experimental unit, storage day as a repeated measure, and crude fat content as a covariate for TBARS.

Results: As expected, storage day was significant for all quality and shelf-life measurements ($P < 0.05$). No significant differences were found for any of the quality or shelf-life measurements for the main effect of treatment or the interaction of treatment x storage day ($P > 0.05$).

Conclusion: With the addition of DDGS an increase in unsaturation of fats is expected which can increase the incidence of lipid oxidation and decrease shelf-life of fresh and processed meat products. However, as boneless hams have significantly less fat content ($< 5\%$ crude fat) compared to sausage products it is not unexpected that few or no differences would be observed in shelf-life measurements. These data indicates the inclusion of DDGS does not significantly impact boneless ham quality or shelf-life.

Keywords: Boneless Ham, Dried Distiller Grains with Solubles, Pork Quality, Shelf-life

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LOW ENERGY-HIGH FIBER DIETS INCREASE IODINE VALUES IN PIGS IRRESPECTIVE OF RESIDUAL FEED INTAKE SELECTION

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Objectives: The project objective was to determine the effect of feeding a high energy, low fiber (HELF) or low energy, high fiber (LEHF) diets on the fatty acid composition and iodine value in pigs divergently selected for residual feed intake (RFI). RFI is a measure of a pig's feed efficiency given growth rate and backfat; low RFI (LRFI) pigs are generally more feed efficient than high RFI (HRFI).

Materials and Methods: Barrows (n=76) and gilts (n=81) from the 9th generation of the Iowa State University RFI selection project were used (LRFI (42 HELF and 41 LEHF; HRFI: 39 HELF and 35 LEHF). Pigs were randomly assigned to mixed line and sex within pens, with 6 pens on the HELF diet (3.32 Mcal ME/kg; 9.5% NDF) and 6 pens on the LEHF diet (2.87 Mcal ME/kg; 25.9% NDF). Pigs were slaughtered (2 groups) at a mean BW of 128.4 ± 8.0 kg. Immediately after exiting the slaughter floor, adipose tissue cores were collected as a 2.54 cm diameter core over the clear plate. Samples were placed in re-sealable plastic bags and held at 4 °C for 2 d and then frozen at -20 °C until analysis. A core of the adipose tissue sample (containing all layers) was homogenized in 4:1 methanol:hexane and then spiked with the internal standard heptadecanoic acid. Fatty acid methyl esters were then analyzed by gas chromatography (flame ionization detector). Fatty acids were identified by their retention times on the column as judged from

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appropriate standards. Iodine value (IV) was calculated as $IV = \%C16:1 (0.95) + \%C18:1 (0.86) + 18:2 (1.732) + \%C18:3 (2.616) + \%C20:1 (0.795) + \%C20:2(1.57) + \%C20:3(2.38) + \%C20:4(3.19) + \%C20:5(4.01) + \%C22:4(2.93) + \%C22:5(3.68) + \%C22:6(4.64)$. Data were analyzed using the MIXED procedure in SAS (v. 9.3, SAS Institute Inc., Cary, NC). The model included the fixed effects of line, diet, sex, line by diet, and interactions of line, sex, and diet that were $p \leq 0.10$; random effects of slaughter group, pen, litter, and sire; and the covariate of off-test BW for all traits.

Results: Feeding the HELF diet resulted in a greater adipose tissue IV ($P < 0.01$; 72.63 vs. 68.74) as a result of a greater percentage of C18:2n6c ($P < 0.01$; 16.34% vs. 13.76%), C18:3n3 ($P < 0.01$; 0.85% vs. 0.60%), and a lower percentage of C16:1 ($P < 0.01$; 1.57% vs. 1.70%) and C18:1n9c ($P < 0.05$; 43.29% vs. 44.63%). Line selection had no effect on IV ($P > 0.05$), however the percentage of C16:1 was greater in adipose tissue from animals of the LRFI line ($P < 0.01$; 1.73% vs. 1.54%). Within the LRFI line, gilts had adipose tissue with greater IV and C18:2 than adipose tissue from barrows ($P = 0.01$). Within each sex, pigs fed the LEHF diet had a greater percentage of C18:2n6c ($P < 0.05$) in their adipose tissue and greater IV ($P < 0.01$) than adipose from HELF fed pigs. Adipose tissue from LRFI pigs fed the HELF diet had a greater percentage of C18:3n6.

Conclusion: Regardless of selection for efficiency, feeding pigs diets low in energy and high in fiber resulted in an increase in carcass fat IV.

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Keywords: energy, fiber, iodine value, residual feed intake

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EFFECT OF DIET AND SELECTION FOR RESIDUAL FEED INTAKE ON SENSORY QUALITY AND POSTMORTEM PROTEOLYSIS OF PORK LOIN

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Objectives: The project objectives were to determine if feeding either a low energy, high fiber (LEHF) diet or a high energy, low fiber (HELF) diets would affect pork sensory characteristics and postmortem desmin degradation of loins from pigs divergently selected for residual feed intake (RFI). RFI is the difference in an animal's observed and expected feed intake given their actual growth and backfat. The LRFI line is generally more feed efficient than the HRFI line.

Materials and Methods: Pigs [LRFI (80 barrows, 75 gilts), HRFI (76 barrows, 77 gilts)] from the 8th and 9th generation of the Iowa State University RFI selection project were randomly assigned to 12 mixed line and sex pens per generation. Within each generation, 6 pens were put on the HELF diet (3.32 Mcal ME/kg; 9.5% NDF) and 6 pens were put on the LEHF diet (2.87 Mcal ME/kg; 25.9% NDF). Pigs were slaughtered at a mean BW of 122.5 ± 8.0 kg (generation 8) and 128.4 ± 8.0 kg (generation 9). Boneless loins were removed 24 hours postmortem. Day 2 postmortem, 2.54 cm chops were cut. Sensory evaluation chops were aged for 7 d in vacuum package bags at 0°C prior to being frozen at -20°C. Chops were then thawed at 4°C for 48 h and cooked to 68°C. Cook loss was determined on a chop used for sensory. A trained sensory panel (n=8) evaluated samples for juiciness, tenderness, chewiness, pork flavor, and off-flavor on a 15.0 point

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unstructured scale with larger numbers indicting a higher degree of that attribute. To measure star probe, 1 chop from each animal was punctured 3 times at a crosshead speed of 3.3 mm/s. Chops aged 2, 5, and 7 d postmortem were also used to determine desmin degradation. A polyclonal rabbit anti-desmin antibody diluted at 1:40,000 was used as the primary. Data were analyzed using the MIXED procedure in SAS (v. 9.3, SAS Institute Inc., Cary, NC). The model included the fixed effects of line, diet, sex, generation, line by diet, and other interactions of line, sex, and diet if $p \leq 0.10$; random effects of slaughter group, pen, litter, sire, and sensory day (for sensory traits, star probe, and cook loss); and covariate of off-test BW for all traits.

Results: There was no line by diet effect on pork loin sensory chewiness, tenderness, star probe and intact 55kDa desmin degradation measures at all time points, or 38 kDa degraded desmin amount 7 d postmortem ($P > 0.05$). However, chops from pigs of the LRFI line had greater sensory juiciness ($P < 0.05$; 9.80 vs. 9.34), less 38kDa desmin degradation product at 5 d ($P = 0.05$; 1.55 vs. 1.82) postmortem, and tended to have a lower cook loss ($P < 0.10$; 15.73% vs. 16.44%) than chops from pigs of the HRFI line. Loins from pigs fed the LEHF diet also tended to have decreased drip loss ($P = 0.09$; 0.36% vs. 1.36%) and lower off flavor sensory ratings ($P = 0.08$; 0.42 vs. 0.31). Within the LRFI line at 2 d postmortem, loins from pigs fed the LEHF diet had greater 38 kDa degradation product than loins from pigs fed the HELF diet ($P < 0.01$). On day 5 postmortem, gilts fed the LEHF diet had loins with greater 38 kDa degradation product than those from HELF fed gilts ($P < 0.01$).

Conclusion: While line and diet impacted sensory characteristics and postmortem protein proteolysis, it is unlikely that these effects are large enough to be detected by the consumer. Supported by USDA-AFRI Grant #2011-68004-30336.

Keywords: desmin, energy, fiber, residual feed intake, sensory

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BELLY QUALITY OF IMMUNOLOGICALLY CASTRATED PIGS FED DRIED DISTILLERS GRAINS WITH SOLUBLES

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Objectives: Immunologically castrated (IC) pigs can be harvested 3 to 10 wk after the second Improvest dose (*gonadotropin releasing factor analog - diphtheria toxoid conjugate*; Zoetis, Inc., Florham Park, NJ). Increasing the time between second Improvest dose and harvest increases backfat thickness. In lean pigs, fatty acid composition of adipose tissue reflects dietary fatty acid composition. Feeding unsaturated fat sources, such as dried distillers grains with solubles (DDGS), results in soft pork fat in barrows and gilts. Therefore, the objective was to evaluate the effects of DDGS feeding strategy and timing of second Improvest dose on belly quality.

Materials and Methods: At 8 wk of age (WOA) entire male pigs (n = 863) were assigned randomly to dietary and Improvest treatments in a 4 x 3 factorial arrangement. Dietary treatments were fed in 4 phases (Phases 1 to 4 were fed for 3, 4, 4, and 5 wks) and treatments included: positive control (PCon; 0% DDGS fed in all phases), DDGS stepdown (SD; 40%, 30%, 20%, 10% DDGS fed in 4 phases), DDGS withdrawal (WD; 40% DDGS fed in phases 1 to 3 and 0% DDGS fed in phase 4), and negative control (NCon; 40% DDGS fed in all phases). The first Improvest dose was given to all pigs at 11 WOA and the timing of the second dose (TD) occurred at 9 (TD9), 7 (TD7), or 5 (TD5) wks before harvest. Pigs (n = 2 per pen) were selected randomly at 13 WOA for harvest at 24 WOA and belly quality assessment. Belly thickness (n = 8 locations per belly), length, width, and flop distance

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were determined, and belly flop angle was calculated. Subcutaneous belly fat samples were collected to determine objective Hunter color values, subjective Japanese color score (JCS), fatty acid profile, and calculated iodine value (IV; AOCS, 1998).

Results: There were no diet x TD interactions ($P > 0.32$) for any measures of belly quality. Belly thickness was reduced ($P < 0.05$) in pigs fed NCon compared to pigs fed PCon and WD (2.80 vs. 2.97 and 2.98 ± 0.19 cm) and tended to be reduced ($P < 0.10$) compared to pigs fed SD (2.95 ± 0.19 cm). Belly thickness tended to be reduced ($P < 0.10$) in TD5 pigs compared to TD9 pigs (2.86 vs. 2.99 ± 0.19 cm). Objective belly fat color (a^* and b^*) were not different ($P > 0.05$) among Improvest or dietary treatments. However, L^* of belly fat was lower ($P < 0.05$) and subjective JCS was higher ($P < 0.05$) in pigs fed NCon compared to pigs fed PCon and SD ($L^* = 76.53$ vs. 78.56 and 78.13 ± 0.57; JCS = 1.33 vs. 1.08 and 1.15 ± 0.07). Belly flop angle was less ($P < 0.05$) in pigs fed NCon compared to pigs fed SD, WD, and PCon (10.3 vs. 14.0, 13.4, and 16.4 ± 1.4°). Flop angle was not different ($P > 0.05$) between pigs fed SD and WD. However, flop angle was not different among any Improvest treatments. Pigs fed SD and WD had lower ($P < 0.05$) IV compared with pigs fed NCon (65.6 and 66.7 vs. 74.9 ± 1.56), but pigs fed PCon (59.4 ± 1.56) had lower ($P < 0.05$) IV compared to all other dietary treatments. Belly fat IV of TD5 pigs was greater ($P < 0.05$) than for TD9 and TD7 pigs (67.7 vs. 66.0 and 66.3 ± 1.56).

Conclusion: Dietary DDGS feeding strategy and timing of the second Improvest dose affected belly quality independently. Belly quality was reduced in TD5 pigs due to thinner bellies and greater IV compared to TD9 pigs. Feeding SD and WD improved belly fat quality compared to feeding NCon, but neither SD nor WD fully restored belly quality compared with pigs fed PCon.

Keywords: belly quality, DDGS, Improvest

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QUALITY ATTRIBUTES OF READY TO EAT BISON MEAT SNACK DURING 40°C ACCELERATED STORAGE

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Objectives: The market for bison meat products is increasing as a result of consumer interest in meat from animals that are primarily grass fed, raised without hormones, and are generally produced in small herds on pastures. Quality attributes of a bison meat snack containing cranberry and apple pieces and formed into a bar or bite were evaluated during 18 weeks of storage in a 40°C accelerated shelf life cabinet to simulate an ambient shelf life of 18 months.

Materials and Methods: The products were formulated at a commercial facility; bars were packaged into a vacuum package, while bites were packaged in a sealed bag with an oxygen absorber. External color, pH, sensory attributes, Warner-Bratzler shear force (WBSF), water activity (a_w), and yeast and mold counts were determined. External color, pH and a_w were evaluated on weeks 0, 3, 5, 11 or 12, 14, and 18 of accelerated storage. Sensory attributes, WBSF shear force and yeast and mold counts were evaluated on weeks 0, 3, 5, 11 or 12, and 18. Additionally, fruit pieces were separated from the bites for a_w measurement. A complete randomized block design with bars and bites as experimental units were used. The data was blocked by replication and time was a treatment with seven levels. ANOVA was performed using the PROC MIXED procedure in SAS.

Results: At week 0 and week 18, external L^* for the bars and bites were similar ($P > 0.05$); however, trained panelists observed both products becoming visually darker ($P < 0.05$) by weeks 11 and 12 for bars and bites, respectively. For bars and bites, a^* values remained constant ($P < 0.05$) until week 5, then became less red ($P < 0.05$) by week for bars and week 12 bites, and bites continued to become less red ($P < 0.05$) by week

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18. Baseline water activity of bars and bites were 0.84 and 0.88, respectively, and pH was 4.63 for bars and bites. The bar a_w remained constant ($P > 0.05$) through week 14, and then declined ($P < 0.05$) to 0.77 at week 18. The bites a_w remained constant through week 5, and then declined to a mean a_w of 0.83 for the remainder of accelerated storage. When fruit pieces were separated from the bites, it was found that cranberry water activity declined ($P < .05$) from 0.88 at week 0 to 0.82 by week 18, and apple pieces declined ($P < .05$) from 0.88 at week 0 to 0.83 by week 18. The bar pH remained constant ($P > 0.05$) through week 11, and then declined ($P < 0.05$) to 4.32 at week 18. The bites pH remained constant ($P > 0.05$) through week 14, and then declined ($P < 0.05$) to 4.22 at week 18. Yeast and mold counts were non detectable throughout storage for either product. WBSF did not change ($P > 0.05$) as a result of accelerated storage; however panelists found that bars became harder and less tender ($P < 0.05$) while bites became softer and more tender ($P < 0.05$) during storage. Bar and bites sweetness and fruit flavor intensity declined ($P < 0.05$) and off-flavors increased ($P < 0.05$) by the end of storage. Panelists did not perceive a change ($P > 0.05$) in salt intensity from week 0 to 18 for bars or bites.

Conclusion: Changing product size from bars to smaller bites and using a vacuum bag versus a sealed bag with an oxygen absorber influenced product characteristics during accelerated storage.

Keywords: Accelerated Storage, Bison Meat Snack, Quality of Bison Meat Snacks

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ANTIMICROBIAL TREATMENT EFFECTS ON GROUND BEEF INSTRUMENTAL AND SENSORY COLOR, SENSORY AROMA AND TASTE CHARACTERISTICS

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Objectives: Because ground beef is produced from trimmings from different animals and locations from a carcass, antimicrobials are often necessary to combat any contamination that may have occurred. However, the impact of antimicrobial on ground beef quality and color are also important. Therefore the purpose of this research was to determine the impact of sodium benzoate, sodium propionate, potassium-L (+) lactate/potassium diacetate blend and propionic acid on ground beef patty color, odor and sensory characteristics. All the antimicrobials used in this study are approved for use in meat and poultry products by the Food and Safety Inspection Service (FSIS) of the US Department of Agriculture and food products by the FDA.

Materials and Methods: Beef trimmings (80/20) were sprayed (n = 2/treatment) with treatment solution at a rate of (~0.1 ml/g) until meat surfaces were saturated. The treatments included sodium benzoate (0.1% w/v; BEN), sodium propionate (0.3% w/v; PROP), potassium-L (+) lactate/potassium diacetate blend (3% w/v; POT) and propionic acid (0.35% w/v; PROPA) and a control (CON). Treatments were replicated twice. Next, beef trimmings were ground, processed into meat patties (150 g), placed on plastic foam trays and over wrapped with polyvinyl chloride film. The packages were displayed under simulated retail conditions (4°C). Trained panelists evaluated meat sensory color, odor and processing abilities on days 0, 1, 2, 3 and 7 of display. For sensory taste panel analysis, ground beef patties were cooked in a Blodget/Zephaire forced air convection oven at 163 °C until an internal temperature of 71°C was reached. Patties were cut into squares (2.54cm

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x 2.54cm), wrapped in foil and kept in a commercial food warmer (49°C) until served to panelists. The CIE L*, a* and b* instrumental color measurements (n = 3/sample) were obtained using a HunterLab Mini Scan, using Illuminant A/10° observer on days 0, 1, 2, 3 and 7 of display. Data were analyzed using the General Linear Model procedure and least squares means were separated using the Probability of Difference procedure of SAS.

Results: The PROPA and POT treatments significantly increased the overall meat color redness ($P < 0.05$) and reduced the percentage of discoloration ($P < 0.05$) compared to CON on days 0 and 1 of display. The BEN and PROP treatments significantly increased the overall color redness ($P < 0.05$) on day 2 of display compared to CON while POT showed no significant difference ($P > 0.05$) compared to CON. The BEN, POT and PROP treatments showed no difference ($P > 0.05$) in overall meat color redness compared to CON on days 3 and 7 of display. Redness (a*) between the BEN, PROP and POT treatments on days 1, 2, 3 and 7 of display was not different ($P > 0.05$) from CON. All of the treatments presented a similar beef odor ($P > 0.05$) compared to CON on days 0, 1, 2 and 3 of retail display. The BEN, PROPA and PROP treatments showed no significant difference ($P > 0.05$) in beef flavor compared to CON.

Conclusion: The results suggest that the use of propionic acid and sodium propionate as antimicrobials on beef trimmings prior to grinding may improve sensory retail display properties such as meat color without affecting aroma and flavor of ground beef patties.

Keywords: antimicrobials, beef trimmings, ground beef, meat safety, organic acids

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LONG CHAIN ORGANIC ACID EFFECTS ON GROUND BEEF INSTRUMENTAL COLOR AND SENSORY COLOR, TASTE AND AROMA CHARACTERISTICS.

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Objectives: The use of antimicrobials in beef decontamination is a good alternative to improve microbial safety of the products. Any adverse effects of these antimicrobials on meat sensory properties such as color, odor and taste can pose a challenge for customer's perception. Therefore the purpose of this research was to determine the impact of fumaric, malic, octanoic and decanoic acids on ground beef patty color, odor and sensory characteristics. All the antimicrobials used in this study are approved for use in meat and poultry products by the Food and Safety Inspection Service (FSIS) of the US Department of Agriculture and food products by the FDA.

Materials and Methods: Beef trimmings (80/20) were sprayed (n = 2/treatment) with organic acid antimicrobial treatment solutions at a rate of (~0.1 ml/g) using an electrostatic spray system until meat surfaces were saturated. The treatments included fumaric acid (F), malic acid (M), octanoic acid (O) and decanoic acid (D) all at 3% (w/v) versus control (C). Treatments were replicated twice. Next, beef trimmings were ground, processed into meat patties (150 g), placed on plastic foam trays and over wrapped with polyvinyl chloride film. The packages were displayed under simulated retail conditions (4°C). Trained panelists evaluated meat sensory color, odor and processing abilities on days 0, 1, 2, 3 and 7 of display. For sensory taste panel analysis, ground beef patties were cooked in a Blodget/Zephaire forced air convection oven at 163 °C until an internal temperature of 71°C was reached. Patties were cut into squares (2.54cm x 2.54cm), wrapped in foil and kept in a commercial food warmer (49°C) until served to panelists. The CIE L*, a* and b*

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instrumental color measurements ($n = 3/\text{sample}$) were obtained using a HunterLab Mini Scan Illuminant A/10° observer on days: 0, 1, 2, 3 and 7 of display. Data were analyzed using the General Linear Model procedure and least squares means were separated using the Probability of Difference procedure of SAS.

Results: The D, F and O treatments significantly increased sensory evaluated overall meat color redness ($P < 0.05$), reduced percentage of discoloration ($P < 0.05$) and showed higher a^* values ($P < 0.05$) compared to C on days 0 and 1 of display. Malic acid showed no difference ($P > 0.05$) in overall color and percentage of discoloration compared to C on days 3 and 7 of display. There were no significant differences in beef odor ($P > 0.05$) between C and the rest of the treatments on days 0 to 3 of display, except for M on day 0 ($P < 0.05$). Treatments F and D showed greater beef odor ($P < 0.05$) compared to C and the rest of the treatments on day 3 of display. Fumaric acid presented a more intense beef odor ($P < 0.05$) compared to C and the rest of the treatments on day 7 of display. There were no significant differences ($P > 0.05$) in beef flavor between C and the rest of the treatments.

Conclusion: The results suggests that the use of solutions containing fumaric, malic, octanoic and decanoic acid as antimicrobials on beef trimmings prior to grinding may improve sensory retail display properties such as meat color and odor without affecting beef flavor of ground beef patties.

Keywords: antimicrobials, beef trimmings, Ground beef, meat quality, organic acids

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IMPACT OF USING REDUCED-FAT DISTILLERS GRAINS IN BEEF FEEDLOT DIETS ON CARCASS AND MEAT QUALITY.

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Objectives: The objective of this study was to evaluate the impact of using reduced-fat distillers grains (DG; 8.5%) in beef feedlot diets on carcass and meat quality.

Materials and Methods: Purebred Jersey steers (n = 12) and LimousinXJersey crossbred steers (n=24) were blocked by breed, randomly assigned to one of four dietary treatments (Table 1) and fed individually utilizing a Calan gate feeding system for 93 d. Cattle were harvested at a commercial abattoir. Strip loins (IMPS 180) were removed from the right side of each carcass 48 h postmortem, vacuum packaged, and transported to the University of Minnesota Meat Science Laboratory. Strip loins were weighed while inside and immediately after removal from the package to determine purge loss. Ultimate pH was collected from strip loins 5 d post-mortem. Six 2.54-cm steaks were cut serially from the anterior end of each strip loin. Steaks (n = 2 per loin) were placed on polystyrene trays, overwrapped with PVC film, and stored at 4°C under cool, white fluorescent lighting. Strips steaks were used to determine objective color (L*, a*, and b*; Hunter Miniscan EZ) for six consecutive days. Subjective evaluation was conducted by seven trained panelists for lean color (1=extremely brown, 8=bright cherry red), surface discoloration (1=91-100% discoloration, 11=0% discoloration), and overall appearance (1=extremely undesirable, 8=extremely desirable). Warner-Bratzler shear force (WBSF) was determined from two steaks, cooked to 71°C, and cooled for 24 h. At room temperature, six 2.54-cm cores were excised parallel to muscle fibers and sheared (Shimadzu, EZ-SX) to determine objective tenderness. Data were analyzed using the

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Mixed procedure of SAS 9.3; statistical significance was declared at $P < 0.05$ and trends discussed at $0.10 > P > 0.05$. HCW was used as a covariate for analyzing REA. Fixed effects include dietary treatment and breed, ID classified as random effect. Individual animal is the experimental unit.

Results: Hot carcass weight (HCW) was greater ($P = 0.02$) in RF-Low compared to CON (390 vs. 335 ± 13.53 kg). Back fat depth was unaffected ($P = 0.81$) by dietary treatment but tended ($P = 0.06$) to be less in Jersey steers (7.36 vs. 9.65 ± 2.79 mm). Ribeye area (REA) was not impacted ($P = 0.48$) by dietary treatment. However, Jersey steers had smaller ($P = 0.02$) REA (88.74 vs. 97.83 ± 2.27 cm²). Yield grade (YG) was not influenced ($P = 0.73$) by dietary treatment, but Jersey steers had lower ($P = 0.02$) YG (2.69 vs. 2.90 ± 0.06). Steers fed CON tended ($P = 0.09$) to have greater WBSF compared to steers fed RF-CO (3.00 vs. 2.24 ± 0.20 kg). Steak objective color (L^*) was greater ($P = 0.03$) in steers fed RF-Low than steers fed CON (31.23 vs. 27.04 ± 0.95).

Table 1.		
Dietary treatments and inclusion by replacement of dry rolled corn (DRC)-silage-based control (CON) ¹ diets		
Treatment	Dietary inclusion ¹	Crude Fat%
Control (CON)	Dry rolled corn (DRC)/silage	3.3
Reduced fat low (RF-Low)	20% Reduced fat distillers grains	4.1
Corn oil (RF-CO)	20% Reduced fat distillers grains plus 1% corn oil to simulate full-fat DG	5.1
Reduced fat (RF-High)	46% Reduced fat distillers grains at same dietary fat as RF-CO	5.0

Conclusion: In conclusion, JerseyXLimousin crossbred steers had greater REA and HCW but no difference in carcass or meat quality. Feeding reduced-fat distillers grains in replacement of dry-rolled corn did not affect carcass characteristics or meat quality of strip loins.

Keywords: beef, color evaluation, distillers grains, Jersey, tenderness

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EFFECT OF BONE IN VS. BONELESS AGING ON EATING QUALITY OF MIDDLE MEATS.

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Objectives: The objective of this study was to determine the effect of bone-in vs. boneless aging on eating quality of middle meats.

Materials and Methods: Ten USDA Choice carcasses ($n = 10$) with small marbling scores were randomly selected from a commercial packing facility. From each carcass, one tenderloin (IMPS #189A), one short loin (IMPS #174), one bone-in rib (IMPS # 109A), one boneless strip loin (IMPS # 180) and one boneless ribeye roll (IMPS # 112A) were collected. All products were cut into 2.54-cm thick steaks and frozen at -20°C at the end of the appropriate postmortem aging period. Two steaks were allocated to one of four postmortem aging periods, 7, 14, 21 or 28 d. One steak was used for Warner-Bratzler shear force (WBSF) determination and the other was used for sensory analysis. Warner-Bratzler shear force was not conducted on bone-in or boneless tenderloin steaks. Each steak for WBSF determination and sensory analysis was thawed under refrigerated temperatures ($4^{\circ}\text{C} \pm 1^{\circ}\text{C}$) and then cooked to an internal temperature of approximately 70°C .

Results: There were no differences ($P > 0.05$) in WBSF values between bone-in and boneless strip loin steaks and bone-in or boneless ribeye roll steaks at each postmortem aging period, excluding ribeye roll steaks at 14 d. Boneless ribeye steaks were more tender ($P = 0.0394$) according to WBSF values than bone-in ribeye steaks at 14 d postmortem aging. Trained panelists found bone-in ribeye steaks more juicy ($P < 0.0001$) than boneless ribeye steaks at 21 d of age. Generally, trained panelists found bone-in ribeye steaks to be overall more tender ($P < 0.05$) than boneless ribeye steaks. Bone-in ribeye steaks were more buttery ($P < 0.05$) than boneless steaks at 14 and 21 d of aging. Additionally, boneless

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ribeye steaks at all aging periods were more metallic in flavor than there bone-in aged counterparts. Similar to bone-in ribeye steaks, bone-in strip steaks were more buttery than boneless strip steaks at 7, 14 and 28 d. Boneless strip steaks were more metallic in flavor than bone-in steaks at 14, 21 and 28 d. Bone-in tenderloin steaks were initially more tender and overall more tender than boneless steaks at 14, 21 and 28 d. Unlike bone-in and boneless ribeye and strip steaks, no differences ($P > 0.05$) in buttery or metallic were found between bone-in and boneless tenderloin steaks at each aging period excluding metallic flavor at 28 d. Boneless tenderloin steaks at 28 d were more metallic ($P = 0.0145$) to a trained panel than bone-in steaks. Results from this study show bone-in ribeye and strip steaks to be more buttery and less metallic than boneless ribeye and strip steaks at 7, 14, 21 and 28 d.

Conclusion: There were minimal to no effects of aging low choice middle meats bone-in or boneless on WBSF determination. However, bone-in ribeye, strip loin and tenderloin steaks were generally more tender to a trained panel than boneless ribeye, strip loin and tenderloin steaks. These results can substantiate claims of bone-in steaks being somewhat more tender and flavorful.

Keywords: aging, Beef, bone-in, Sensory

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EFFECTS OF AGING MIDDLE MEATS AS STEAKS VS. INTACT WHOLE MUSCLES ON EATING QUALITY.

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Objectives: Ten USDA Choice carcasses ($n = 10$) with small marbling scores were randomly selected to evaluate the effects of wet aging ribeyes (RE) and strip loins (SL) as individual steaks vs. whole muscles on tenderness and eating quality.

Materials and Methods: From each carcass side, a boneless SL (IMPS # 180) and boneless ribeye roll (IMPS # 112A) were collected. Product was assigned to either whole muscle or individual steak aging treatments and was alternated between sides. Product designated to be aged as steaks were immediately sliced into 2.54 cm steaks and aged for one of the following aging periods: 7, 14, 21 or 28 d and frozen at -20°C . Product designated to be aged as whole muscles was aged until the end of each individual aging period (7, 14, 21 and 28 d) and then two 2.54 cm steaks sliced. Two steaks were allocated to each aging period, one for Warner-Bratzler shear force (WBSF) determination and one for trained sensory analysis. For each sensory panel, at least 8 panelists were used. Each steak was thawed under refrigerated temperatures ($4^{\circ}\text{C} \pm 1^{\circ}\text{C}$) and cooked to an internal temperature of approximately 70°C .

Results: No difference ($P > 0.05$) in WBSF was found between RE samples aged as steaks or whole muscles for 7, 21 and 28 d. However, RE samples aged as whole muscles for 14 d had a lower WBSF value ($P = 0.03$) than samples aged as steaks. Similarly, WBSF showed no difference ($P > 0.05$) between SL samples aged as steaks vs. whole muscles at 7, 14, 21 and 28 d. No differences ($P > 0.05$) were found between initial and sustained juiciness of RE aged as individual steaks vs. whole muscles at 7 and 21 d. Ribeye samples aged as steaks for 14 d were initially more juicy ($P = 0.0008$) as well as higher ($P = 0.0006$) in

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sustained juiciness than ribeye samples aged as whole muscles for 14 d. Ribeye samples aged as steaks for 28 d were initially more juicy ($P = 0.0112$) and higher ($P = 0.0010$) in sustained juiciness than ribeye steaks aged as whole muscles for 28 d. No differences ($P > 0.05$) were found in initial tenderness, overall tenderness and connective tissue between RE aged as individual steaks and whole muscles at 7, 14, 21 and 28 d. No differences ($P > 0.05$) were found in beef, buttery and livery flavor between RE aged as individual steaks and whole muscles at 7, 14, 21 and 28 d. No differences ($P > 0.05$) were found in metallic flavor between RE aged as individual steaks and whole muscles at 7, 14 and 21 d. However, RE aged as individual steaks were more ($P = 0.0074$) metallic in flavor than RE aged at whole muscles at 28 d. No differences ($P > 0.05$) were found in initial or sustained juiciness between SL aged as individual steaks or whole muscles at 7 or 14d. However, SL aged as individual steaks were higher ($P < 0.05$) in initial and sustained juiciness than SL aged as whole muscles at 21 and 28 d. No differences ($P > 0.05$) were found in initial tenderness, overall tenderness, and connective tissue along with beef, buttery, metallic and livery flavors between SL samples aged as individual steaks or whole muscles at 7, 14, 21 and 28 d (excluding initial tenderness at 21 d and metallic flavor at 14 d).

Conclusion: Overall, there were minimal to no effects of aging RE and SL as individual steaks vs. whole muscles on tenderness and sensory characteristics at 7, 14, 21 and 28 d.

Keywords: aging , Beef, Sensory, tenderness

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APPLICATION OF "TENDERCUT" WITH ADDED WEIGHT AND "TENDERSTRETCH" TO GOAT CARCASSES

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Objectives: Recently, a "Tenderstretch" (TS) technique was demonstrated to improve tenderness in goat carcasses; however, a "Tendercut" technique proved to be ineffective at reducing Warner-Bratzler shear force (WBSF) values, perhaps due to the lack of stretching because of the relatively light weights of goat carcasses. Therefore, the objective of this study was to compare tenderness of goat carcasses resulting from the application of prerigor "Tendercut" with added weight (TCW) and TS techniques.

Materials and Methods: Mixed-breed wethers (n = 30; 25 ± 1.3 kg live weight) were transported approximately 450 km (4.5 h) from Lincoln University to the University of Arkansas abattoir and were slaughtered after overnight lairage with water. At approximately 30 min postmortem, 1 of 3 treatments were applied randomly to each carcass: control (C; n = 10), TS (n = 10), and TCW (n = 10). Briefly, TS carcasses were suspended from the pelvic bone with both front and hind legs tied together with string, whereas TCW carcasses were suspended conventionally and cut between 12th and 13th thoracic vertebrae, with the *Longissimus* muscle (LM) as the only attachment between the fore- and hindsaddles. Additionally, a 2.3-kg weight was attached to the neck of each TCW carcass. After a 48-h chill at 1°C, the LM and semimembranosus (SM) were removed from each carcass for cooking loss (SM only), WBSF, and sarcomere length determinations.

Results: There were no differences ($P \geq 0.74$) for final weight, carcass weight, or dressing percentage across all treatments. Cooking loss for

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SM was lower ($P < 0.10$) for TS than TCW and C. Also, WBSF from LM was less ($P < 0.10$) for TS than TCW and C, but LM WBSF did not differ ($P > 0.10$) between TCW and C. Semimembranosus WBSF differed ($P < 0.10$) across all treatments with TS being the lowest. *Longissimus* muscle and SM sarcomeres were longer ($P < 0.10$) for TCW and TS than C.

Conclusion: These results confirm that the application of “Tenderstretch” can be a viable technique to improve LM and SM tenderness in goat carcasses. Although, adding weight to the “Tendercut” treatment lengthened sarcomeres, improvements in shear force values were inconsistent and depended on muscle.

Keywords: "Tendercut", "Tenderstretch", carcass, goat

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COMPARISONS OF LIPID OXIDATION PRODUCTS OF THREE BEEF RETAIL CUTS FROM CATTLE FINISHED ON FORAGE AND CONVENTIONAL FEEDLOT DIETS

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Objectives: This study assessed the development of lipid oxidation products during simulated retail display of beef retail cuts (ribeye, top sirloin, arm/ranch steak) from cattle finished on three different diets (birdsfoot trefoil, *Lotus corniculatus*, BFT; meadow brome, *Bromus riparius* Rehmann, GF; conventional feedlot, FL).

Materials and Methods: Carcasses (n=6 per diet) of similar maturity and mean numerical marbling scores were obtained from cattle on each diet. Subprimals (ribeye roll, top sirloin butt, and shoulder clod) were collected in pairs from both sides of each carcass, and portioned into 2.5-cm thick retail steaks. Steaks were aged 14 days postmortem (2-4 °C) and frozen. Prior to retail packaging, frozen steaks (n = 3 per diet muscle combination) were thawed for 24 hours (2-4 °C). Each steak was packaged on a foam tray with an absorbent pad and overwrapped with gas permeable polyvinyl-chloride film. Lipid oxidation products were evaluated by measurement of thiobarbituric acid reactive substances (TBAR, mg/g) on days 0, 3, and 7 of simulated retail display (2-4 °C).

Results: Interactions were found between day × diet and diet × cut ($P < 0.05$). Initially (day 0), TBAR values were similar ($P > 0.05$) for BFT and FL steaks, while GF were lower ($P < 0.05$). The TBAR values of GF steaks were similar ($P > 0.05$) between day 0 and day 3, but increased ($P < 0.05$) at day 7. Overall TBAR values were greater ($P < 0.05$) for BFT steaks compared with GF. A pattern similar to GF was observed for

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BFT steaks where day 0 and day 3 did not differ ($P > 0.05$) and day 7 was greater ($P < 0.05$). The TBAR values of FL steaks were greater ($P < 0.05$) than BFT and GF steaks at both day 3 and 7. Additionally, FL TBAR values increased more ($P < 0.05$) between each sampling period. With regard to diet and cut, TBAR values of GF cuts did not differ ($P > 0.05$). The TBAR values for top sirloin and ribeye of BFT and FL were similar ($P > 0.05$), but less ($P < 0.05$) than ranch steaks of BFT and FL.

Conclusion: These results indicate that finishing diet and muscle can impact oxidation of lipids. These impacts are of importance to multiple meat quality factors including: shelf-life, color, odor, and flavor. Further analysis will be required to determine the mechanisms behind these interactions. However, based on previous research it may be speculated that retention of dietary antioxidants and muscle characteristics (pH, fiber type, energy metabolism, lipid content) contribute to the observed differences.

Keywords: beef, finishing diet, Lipid oxidation, Retail cut, Retail Display

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CONCENTRATIONS OF DISSOLVED O₂ AND CO₂ IN PURGE OF VACUUM-PACKAGED PORK CHOPS AND RELATIONSHIP TO MICROBIAL POPULATION AND SHELF LIFE

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Objectives: The objectives of this study was to determine the dissolved CO₂ and O₂ concentrations in the purge of vacuum-packaged (VP) pork chops over 60 days of storage and how they relate to microbial populations and shelf life.

Materials and Methods: Forty-eight bone-in pork chops were purchased from a retail store and the bones removed at the lab. Surface pH was measured twice on each pork chop (pre-package pH) before 3 chops were placed into one VP bag. Before sealing, a Teflon stand with two 22x3 cm glass tubes were placed into the package to collect the purge and the packages were stored at 4°C for 60 days. Sampling was performed on 0, 5, 15, 30, 45, and 60 days of storage, where two packages were sampled per day. The packages were aseptically opened to allow a Hach LDO101 probe in one tube and a CO₂ ion selective electrode into the other tube. After measuring the gas concentrations, 1 mL of purge from the O₂ tube was collected for microbiological analysis. Then the package was completely opened and the surface pH of each chop was measured 3 times and averaged to find a post-packaging pH. Four core samples were taken from each chop, placed into a Whirl-pak bag filled with 90 mL 0.1% peptone solution, and stomached for 30 s. Appropriate serial dilutions for core and purge samples were made using 0.1% peptone. Aerobic plate counts (APC) were determined on tryptic soy agar at 22°C for 72h, Enterobacteriaceae counts (EB) on violet red bile glucose agar at 35°C for 48h, lactic acid bacteria (LAB) on Man, de Rogosa, Sharpe agar anaerobically at 32°C for 48h, and *Brochothrix thermosphacta* on

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streptomycin-thallos acetate-actidione agar at 22°C for 48h. Bacterial counts were log transformed and reported as colony forming units (CFU) per cm² or mL. All microbiological analyses were conducted in duplicate and the data analyzed after averaging the duplicates. The experiment was repeated three times.

Results: No differences were found between microbial numbers of core and purge samples ($P > 0.1885$) but there was a significant difference for sampling day ($P < 0.0001$). APC and LAB counts increased to log 8 CFU/cm², while EB and *B. thermosphacta* had lower counts of log 6 and log 4, respectively, after 60 days. The pre-package pH did differ significantly throughout the storage period ($P < 0.0489$) but post-package pH did not ($P < 0.1423$). The dissolved O₂ concentrations decreased to around 0.10 mg/L and there was no difference between sampling days. Dissolved CO₂ concentrations did change significantly due to sampling day ($P < 0.0001$), and over 60 days, CO₂ increased from 0 to 3000 mg/L. The bacteria in vacuum-packaged pork increase the dissolved CO₂ and decrease the O₂ concentrations over time.

Conclusion: This relationship between dissolved CO₂ concentrations and the microbial population can be described using a quadratic equation: \log_{10} microbial population = $4.105 + 0.0027(\text{dissolved CO}_2) + [(-4.458 \cdot 10^{-7})(\text{dissolved CO}_2)^2]$ (adjusted R² value = 0.95). This equation demonstrates that the microbial population, and therefore the remaining shelf life, could be estimated using dissolved CO₂ concentrations, a rapid instrument measurement, by approximating a microbial population.

Keywords: dissolved carbon dioxide, dissolved oxygen, microbiology, pork, SHELF LIFE

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A BASIC MECHANISM OF BEEF TENDERIZATION: FEEDING WET DISTILLERS GRAINS PLUS SOLUBLES CONTRIBUTES TO SARCOPLASMIC RETICULUM MEMBRANE INSTABILITY

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Objectives: Muscle is an elegant biological system with mechanisms in place to control calcium. At death, calcium ions slowly diffuse from the sarcoplasmic reticulum (SR) to the sarcoplasm where they activate the calcium-dependent calpain system and enhance tenderness. It is well-known that feeding high levels of wet distillers grains plus solubles (WDGS) increases polyunsaturated fatty acid (PUFA) levels in beef. It is possible that WDGS in feedlot diets could increase PUFA concentration in the SR membrane, thereby altering membrane integrity, resulting in more rapid calcium leakage and improving tenderness. The objective of this study was to evaluate this hypothesis.

Materials and Methods: Steers were fed on two treatments (corn or 50% WDGS) with eight per pen and six replications for a total of 96 steer. Fifteen striploins (*Longissimus lumborum*) from each treatment (n=30; 2-3 per pen) were collected and aged for 2, 7, 14, or 21 d. Steaks were removed at each aging period and placed under retail display condition for 0, 4, and 7 d. Steaks were used to measure tenderness (via Warner Bratzler Shear Force), proteolysis (via immunoblotting to quantify troponin-T degradation), free calcium concentrations (via inductively coupled plasma spectroscopy), lipid oxidation (via *thiobarbituric acid reactive substances assay*), and SR fatty acid (via gas chromatography), lipid and phospholipid (via thin-layer chromatography) profile. Data were analyzed by GLIMMIX procedure of SAS (version 9.2, Cary, NC, 2009) as a split-split-plot design with dietary treatments as the whole-

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plot, aging period as the sub-plot and retail display time as the repeated measures. Separation of means was conducted using LSMEANS procedure with PDIFF or SLICEDIFF options at $P \leq 0.05$.

Results: Compared to steaks from steers fed corn only, steaks from steers fed WDGS were more tender ($P < 0.01$) and had higher sarcoplasmic free calcium concentration ($P < 0.01$) at 2 d aging. In addition, feeding WDGS decreased C15:1 ($P < 0.05$), C16:1 ($P < 0.01$), C17:1 ($P < 0.01$), C18:1 ($P < 0.05$), C18:1V ($P < 0.01$) and total monounsaturated fatty acids ($P < 0.01$) concentrations, but increased C18:0 ($P < 0.05$) and C18:2 ($P < 0.05$) in SR membrane. Feeding WDGS also tended to decrease phospholipid concentration ($P < 0.1$) while tended to increase neutral lipid concentration ($P < 0.1$) in SR membranes. Also, feeding WDGS increased phosphatidylcholine ($P < 0.01$), but decreased phosphatidylethanolamine ($P < 0.05$) percentages in SR phospholipids. There were no differences in troponin-T degradation at any of the aging periods. Steaks from corn-fed steers had higher lipid oxidation values compared to steaks from steers fed WDGS ($P < 0.05$) at 21 d aging.

Conclusion: This study confirmed that feeding WDGS tended to increase tenderness and early postmortem calcium release. However, the true mechanism that contributes to SR membrane instability is still unclear. Additional research is needed to clarify the impact of feeding WDGS on the mechanism of tenderization.

Keywords: calcium, fatty acid profile, phospholipid, sarcoplasmic reticulum, WDGS

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THE EFFECTS OF CORN GLUTEN FEED ON PERFORMANCE, CARCASS CHARACTERISTICS AND SENSORY OF FEEDER LAMBS

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Objectives: Use of corn gluten feed (DCGF) in the cattle industry has resulted in positive effects on cattle performance; however, research is needed to determine its effects in small ruminants. The objective of this study was to determine if corn gluten feed consumption affected performance, carcass characteristics and meat quality of lambs.

Materials and Methods: In this study, 80 multiple sire Rambouillet lambs of similar weight were sorted into group pens, and pens were randomly assigned to one of four treatments (5 pens/ treatment) in a completely randomized design. Prior to treatment, lambs were hand fed the control diet (0% dry corn gluten feed) for 14 days of adjustment; after which time, the adjustment diet was replaced with one of the dietary treatments. Treatments included 0% (control), 10%, 20%, or 30% dry corn gluten feed supplemented to a standard iso-nitrogenous and iso-caloric finishing diet. Pen weights were recorded at receiving, on initial day of treatment, and every 14 days thereafter in order to monitor average daily gain until animals reached target finished weight (50 kg). Feed refusals were collected to determine dry matter intake and gain efficiency. The first ten lambs/treatment/pen (n=40) that met the target finished weight were humanely harvested at the Angelo State University Food Safety Product Development Laboratory. Hot carcass weight was recorded at harvest and flank streaking, leg circumference, body wall thickness, loin eye area and back fat measurements were recorded by trained personnel following a 24 hour chill. Carcasses were fabricated and the lamb loin (NAMP #232A) was removed for trained sensory

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panel testing following 14 days of postmortem aging. Average daily gain, intake and feed efficiency were analyzed using repeated measures analysis of variance with individual animal as the experimental unit, treatment as the main effect and pen as replicate. Carcass analysis was assessed using analysis of variance with treatment as the main effect and animal within treatment as replicate. Means were separated using Tukey's LSD test ($P < 0.05$).

Results: Average daily gain fluctuated depending on treatment within date ($P < 0.05$), with no clear pattern evident. Intake due to treatment varied by date ($P < 0.05$) with 20% and 30% DCGF treatments consuming less than lambs receiving the control diet in the last four weeks of the trial period. Feed efficiency due to treatment was reliant on date ($P < 0.05$). In week 12 (completion of trial), body weight did not differ due to treatment as weight ranged from a minimum of 52.5 kg to a maximum 54.1 kg; correspondingly, hot carcass weight, dressing percentage, loin eye area, body wall fat thickness, leg circumference and flank streaking did not differ ($P > 0.05$). Lamb yield grades ranged from 2.4 – 3.0, loineye area from 3.5 cm² – 3.8 cm² and flank streaking scores ranged from Small³⁶ – Small⁹⁵. Moreover, sensory attributes (initial and sustained juiciness, initial and sustained tenderness, flavor intensity and off-flavor) were similar between treatments ($P > 0.05$).

Conclusion: The results of this study indicate that livestock producers can effectively use corn gluten feed as a component of lamb finishing diets without producing adverse effects on carcass weight, carcass quality, or sensory attributes.

Keywords: corn gluten feed, lamb

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INFLUENCE OF EXTENDED AGING ON WARNER-BRATZLER SHEAR FORCE AND SENSORY PERCEPTION OF FOUR BEEF MUSCLES

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Objectives: Our objective was to determine the influence of post-fabrication aging (2, 14, 21, 42, and 63 days) on Warner-Bratzler shear force (WBSF) and consumer sensory perception of top loin, top round, top sirloin, and bottom round steaks.

Materials and Methods: At 48 h post mortem (day 0), beef strip loin (IMPS 180), top (inside) round (IMPS 168), top sirloin butt (IMPS 184), and outside round (IMPS 171B) from the left side of USDA Select carcasses (n=12) were purchased from AB Foods (Toppenish, WA) and transported to the University of Idaho Meat Science Laboratory. The *Longissimus lumborum* (LL), *semimembranosus* (SM), *gluteus medius* (GM), and *biceps femoris* (BF) were removed from their respective wholesale cuts for aging and subsequent analysis. On day 2, muscles were cut into five sections at least 5.1 cm-thick. Each section was randomly assigned to one of the five aging periods (2, 14, 21, 42, and 63 days post-fabrication). Sections were vacuum shrink packaged and subsequently aged at 0°C. At the end of each aging period, two 2.54 cm-thick steaks were cut from designated sections. Steaks were placed in white styrofoam trays, overwrapped with an oxygen permeable PVC film, and displayed in a glass-fronted retail display case at 3°C. One of the steaks was displayed for 4 days then cooked to 71°C and allowed to cool before WBSF was performed. The other steak was displayed for one day and subsequently vacuum packaged and frozen for later sensory panel analysis. Four consumer panels (n=60 per muscle) evaluated cooked

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steaks from each aging time for overall acceptability, tenderness, juiciness, and flavor. Data were analyzed using the Mixed Model procedure of the Statistical Analysis System (SAS Institute, Inc., Cary, NC) and significance was determined at $P < 0.05$.

Results: Warner-Bratzler shear force values decreased ($P < 0.001$) from day 2 to 14 of aging and then from day 21 to 63 of aging for the LL, while SM WBSF values were lower ($P < 0.001$) on days 42 and 63 than days 2 and 14 of aging. Interestingly, no differences were observed in WBSF values between aging periods for the BF or GM. Overall acceptability of SM steaks aged for longer than 21 days was greater ($P < 0.05$) than steaks aged for 2 days. There were no differences in overall acceptability between aging periods for the BF, GM, or LL. Tenderness scores for the BF were greater ($P < 0.05$) for steaks aged 21 days or longer than steaks aged for 2 days. *Gluteus medius* tenderness scores increased ($P < 0.01$) from day 14 to 42 of aging. Furthermore, LL sensory tenderness scores increased ($P < 0.05$) from day 2 to 14 of aging, while SM sensory tenderness scores were greater ($P < 0.001$) on days 42 and 63 than days 2 and 14 of aging. Juiciness of the SM tended to improve ($P = 0.07$) with longer aging periods. There were no differences in juiciness between aging periods for the BF, GM, or LL. Furthermore, there were no differences in flavor between aging periods for any of the muscles examined.

Conclusion: In conclusion, WBSF improved for the LL and SM, but did not change for the BF and GM over time. Additionally, extended aging is an effective method to improve consumer sensory perception of tenderness of all muscles as well as juiciness and overall acceptability of the top round without affecting the flavor of beef.

Keywords: Aging, Beef, Sensory Perception, Tenderness

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METAGENOMICS OF (COOKED) MEAT SPOILAGE AND CULTURE DEPENDENT METHODS: PRESENTING THE TOP 5 USUAL SUSPECTS.

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Objectives: Lactic acid bacteria are well known spoilers of meat. They are responsible for off taste, off flavors and visual defects in many meat products and dominate cooked meat products like ham and hot dogs. Several reports on identification of these spoilers are present in literature, but it is difficult to extract a general picture. Nothing is known about regional and product variability and how large the variations are. The objective of this study is to determine the dominant spoilers and to assess the variability within and between regions with metagenomics and traditional methods

Materials and Methods: We applied metagenomics to ten samples of spoiled cooked meat, like hot dogs from two geographical regions and compared the results with culture dependent isolations from exactly the same product. For this purpose the V3-V5 hyper variable region of the 16S rDNA gene was amplified and sequenced with an Illumina Sequencer yielding 250 bp reads that were aligned against the Silva 16S rRNA database and further analyzed with MEGAN software.

At Corbion, we additionally isolated and identified more than 100 dominant isolates by 16S RNA sequence analysis over many years from different spoiled (cooked) meat products from various regions in the world. We established a top five of most isolated species by counting and compared it to the counts per region.

Results: Metagenomics was applied successfully to cooked meat as was validated with traditional isolation and identification.

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Combining the results of the metagenomics study with the large set of previous isolation of dominant spoilers, a clear limited set of usual cooked meat spoilers could be identified. *Leuconostoc mesentroides*, *Leuconostoc carnosum*, *Lactobacillus plantarum*, *Lactobacillus sakei* and *Lactobacillus curvatus* are (by far) the most isolated species, in decreasing order. This top 5 dominates spoiled cooked meat all over the world. The results also clearly show that a dominant flora in spoiled cooked meat products emerges from a much more diverse flora present at the beginning of the shelf life.

Conclusion: To our knowledge this is the first report of applying metagenomics in cooked meat. This is also the first time that a research based on so many isolates, identified with 16S RNA analysis, and culture independent methods is presented, making it unique in research on microbial spoilage in meat. In conclusion, variation in spoilage flora of cooked meat is limited but present.

Keywords: cooked meat, lactic acid bacteria, spoilage

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TRAINED SENSORY PANEL EVALUATION OF BEEF STRIP STEAKS OF VARYING MARBLING AND ENHANCEMENT LEVELS COOKED TO THREE DEGREES OF DONENESS

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Objectives: With increasing beef prices and quality demands, the need for maximizing the palatability of lower quality cuts is higher than ever before. Enhancement offers beef producers a means to add value to lower quality cuts. The purpose of this study was to compare the palatability traits of enhanced USDA Select beef strip steaks with those of higher USDA quality grades across three degrees of doneness.

Materials and Methods: Strip loins (n = 48; 12/grade) were selected to represent USDA Prime, Top Choice (upper 2/3 Choice), Low Choice (lower 1/3 Choice), and Standard. Moreover, 36 USDA Select strip loins were selected, of which 24 [12/enhancement level; High Enhanced (HE; 12% injection) or Low Enhanced (LE; 7% injection)] were injected with a water, salt, and alkaline phosphate solution. The remaining 12 USDA Select strip loins were used as a non-enhanced Select treatment.

Treatments were aged 21 d in vacuum bags at 2 to 4°C. Strip loins were cut into 2.5 cm thick steaks and stored at -20°C until analysis. Thawed samples were evaluated by a trained panel for initial juiciness, sustained juiciness, initial tenderness, sustained tenderness, beef flavor ID (beef-like to unbeef-like), beef flavor intensity, and off-flavors. Each trait was rated on a 10 cm, verbally anchored line scale. Steaks were cooked on a belt grill to three temperatures; 60°C (rare), 71°C (medium), and 77°C (well-done). Steaks had a 3 min rest period prior to cutting. Each panelist was served two, 1 cm x 1 cm pieces per sample. Thirty-six

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(12/degree of doneness) panels of at least 7 panelists were conducted. Panelists were served one sample randomly from each treatment. Data were analyzed with a split-plot arrangement, with the fixed effect of degree of doneness as the main plot factor and treatment as the subplot factor.

Results: A treatment by degree of doneness interaction was found for initial and sustained juiciness ($P < 0.05$). Select HE, Select LE and Prime samples were rated higher ($P < 0.05$) than all other treatments for initial and sustained juiciness for medium and well-done degrees of doneness. However, when cooked to rare, both enhanced treatments, Prime and Top Choice samples rated similar ($P > 0.05$) for sustained juiciness, with Top Choice also rating similar ($P > 0.05$) to Standard. Also, Select HE samples rated higher ($P < 0.05$) for initial juiciness than Low Choice, Select, and Standard samples cooked to rare. Select HE samples rated highest ($P < 0.05$) for initial and sustained tenderness across all degrees of doneness. Prime steaks received the highest ($P < 0.05$) scores for beef flavor intensity. Prime and Top Choice samples rated highest ($P < 0.05$) for beef flavor ID. Panelists rated Select HE and Select LE the lowest ($P < 0.05$) for beef flavor ID and beef flavor intensity. The two enhanced treatments rated higher ($P < 0.05$) than all other treatments for salty off-flavor. Rare samples scored highest ($P < 0.05$) for initial and sustained tenderness. Beef flavor ID and beef flavor intensity were rated similar ($P > 0.05$) across all internal cook temperatures.

Conclusion: Enhanced USDA Select strip loins were rated higher for tenderness and juiciness than non-enhanced steaks from higher USDA quality grades; indicating an opportunity for adding value to lower quality beef while concurrently improving palatability through enhancement.

Keywords: beef, degree of doneness, enhancement, quality grade, sensory

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EFFECTS OF TOPICAL SPRAY OF NATURAL ANTIOXIDANTS ON OXIDATIVE STATUS AND FATTY ACID COMPOSITION OF BEEF STRIP STEAKS

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Objectives: Natural antioxidants have become a desirable mean for meat preservation because of their similar effectiveness and greater appeal compared with their synthetic counterparts. The objective of this study was to evaluate the effects of natural antioxidants applied through topical spray on the shelf life of beef strip steaks.

Materials and Methods: Nine USDA Select beef strip loins of A maturity carcasses were collected from a commercial processing facility in Texas. The subprimals were stored in the absence of light under vacuum at 2°C for 72 h before fabrication. The subprimals were sliced subsequently into 2.54-cm thick steaks and trimmed to 0-cm external fat thickness. Nine steaks within each subprimal were randomly assigned to nine (3×3) factorial combinations of treatment including a control (CON, deionized water), a spearmint extract (TRT1), and a rosemary/green tea powder (TRT2) at 500 ppm of steak weight and retail display time points of d 0, d 3, and d 5. Steaks were placed on black styrofoam plates and overlapped with PVC packaging film. Steaks from four randomly selected strip loins were used for chemical analyses (n = 4 steaks per treatment×day combination) of thiobarbituric acid reactive substances (TBARS, mg malondialdehyde/kg raw meat), trolox equivalent antioxidant capacity (TEAC, μmol trolox/g raw meat), and

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fatty acid composition (percentage of total fatty acids). Statistical analysis followed a general linear mixed model with antioxidant treatment and day serving as fixed effects and subprimal serving as a random effect in a randomized block design with a factorial arrangement. Statistical significance was determined at $P \leq 0.05$.

Results: In general, there was no treatment effect on either oxidative status (TBARS and TEAC) or fatty acid composition of steaks ($P > 0.05$). As expected, the length of retail display (day) increased TBARS value ($P < 0.01$) and decreased TEAC value ($P = 0.01$) of steaks. Changes occurred from d 0 to d 3 and from d 3 to d 5 for TBARS ($P < 0.01$), however, was not observed for TEAC from d 3 to d 5 ($P = 0.95$). Neither day effect on fatty acid composition ($P > 0.05$) nor treatment \times day interaction in oxidative indications and fatty acid composition ($P > 0.05$) was observed.

Conclusion: These results indicate that the topical spray application used in this study may not be as suitable for steaks as reported for ground meat products. Further research is needed to determine an appropriate antioxidant delivery technique for whole muscle products.

Keywords: beef, Fatty Acid, natural antioxidant, oxidation, topical spray

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ORGANOLEPTIC QUALITY AND COOKED FLAVOR VOLATILES OF BEEF STRIP STEAKS TOPICALLY SPRAYED WITH NATURAL ANTIOXIDANTS

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Objectives: Natural antioxidants provide a more appealing alternative for meat preservation. However, they are extracted from herbs and spices and can alter the sensory characteristics of meats. The objective of this study was to evaluate the sensory attributes and cooked volatiles of beef strip steaks treated with topical spray of natural antioxidants.

Materials and Methods: Nine USDA Select beef strip loins of A maturity carcasses were collected from a commercial processing facility in Texas. Subprimals were stored under vacuum and in the absence of light at 2°C for 72 h before fabrication. Subprimals were sliced into 2.54-cm thick steaks and trimmed of external fat. Nine steaks within each subprimal were randomly assigned to nine (3×3) factorial combinations of treatment including a control (CON, deionized water), a spearmint extract (TRT1), and a rosemary/green tea powder (TRT2) at 500 ppm of steak weight being combined with retail display time points of d 0, 3, and 5. Five randomly selected strip loins were used for sensory evaluation by trained panelists and cooked volatile analysis (n = 5 steaks per treatment × day combination). Subjective color was evaluated daily from d 0 to 5 on the same steaks by untrained panelists. Objective color (CIE L*, a*, b*, reflectance at 473, 525, 572, and 700 nm) was measured using a spectrophotometer with the illuminant A, a 2.5-cm aperture size, and a

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10° observer angle. Steaks were cooked on an electric clam shell grill to the medium degree of doneness (71°C), cut into 2.54-cm cubes, and placed in an aluminum foil pouch until being served to a 7-member trained panel for evaluation of juiciness, tenderness, flavor, and flavor intensity using an 8-point hedonic scale. A general linear mixed model was used to analyze the variances with treatment and day serving as fixed effects and subprimal serving as a random effect in a randomized block design. Subjective and objective color data were analyzed in a split-plot design in time with day being the repeated factor. Statistical significance was determined at $P \leq 0.05$.

Results: There was no treatment effect ($P > 0.05$) on objective color, forms of myoglobin, sensory attributes, and cooked volatiles. There was no day effect ($P > 0.05$) on sensory attributes, except for a slight increase in initial tenderness ($P = 0.04$) and flavor intensity ($P = 0.05$) on d 5. Steaks were darker and discolored ($P < 0.01$) as retail display progressed. Moreover, more volatiles associated with lipid oxidation were found in steaks on d 3 and d 5, such as heptanal ($P = 0.03$).

Conclusion: These results suggest that either topical spray may not be the appropriate delivery technique or 500 ppm may not be enough to prevent oxidation in whole muscle products, although such a concentration has been reported to be effective in ground meats. Natural antioxidants used in this study caused no adverse effects on flavor of beef steaks.

Keywords: beef, beef color, beef flavor, natural antioxidant, oxidation

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BEEF FLAVOR AND CONSUMER PERCEPTION

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Objectives: Our objectives were to create varying levels of positive and negative beef flavor attributes by selecting beef cuts that varied in quality grade, pH, and amount of connective tissue, and then prepare them utilizing three different methods of cooking to manipulate the extent of browning and degree of doneness. Steaks and roasts were evaluated by an expert, descriptive attribute flavor sensory panel, consumers for overall liking, GC-O volatile compounds and chemical analyses (fatty acid composition, non-heme iron and myoglobin content, pH, and fat and moisture analysis). The main objective was to understand factors, either chemical, volatile, or trained flavor descriptive attributes, that drive consumer liking.

Materials and Methods: Beef subprimals (n=20; Choice (Ch) top loins, high pH top loins), Ch top sirloin, Se bottom rounds (BR), and Ch BR) were obtained and cut into steaks or roasts. Steaks were cooked either on a George Forman grill (GF) at 190°C or flat top grill at 232°C to 58 or 80°C internal temperatures. Roasts were cooked in a crock-pot on the high setting to 58 or 80°C. Steaks and roasts were evaluated by an expert trained beef flavor descriptive attribute panel and by consumer sensory panels (n=80 each) in Philadelphia PA, Houston TX, Portland OR, and Olathe KS. Cooked chemical flavor volatile analysis and raw chemical fat/moisture, pH, non-heme iron, myoglobin, and fatty acid analyses were conducted on the same samples.

Results: As degree of doneness increased, beef identity increased. High pH *M. Longissimus lombarum* (LM) steaks had less beef identity than Ch LM steaks cooked on the GF to 58 or 80°C or on the grill to 58 °C.

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Choice 58°C RF roasts cooked to 58 °C had a higher beef identity compared than Se BR roasts cooked to 58 °C. Brown/roasted was lower and bloody/serumy was higher when steaks or roasts were cooked to lower internal temperatures. Fatty acid composition accounted for variation in beef flavor ($P < 0.05$). Volatile compounds ($n=149$) were identified. Fifteen volatiles accounted for 55% of variation in consumer overall liking. Principal component analysis showed lower temperatures and/or shorter cooking times favored the generation of lipid-degradation products, while higher temperatures and/or longer cooking times favored production of Maillard reaction products. Regression equations using volatile aromatic compounds accounted for 77, 50, 51, 52, 77, 82, and 79% ($P < 0.15$) of the variability, respectively in beef flavor identity, brown/roasted, bloody/serumy, fat-liking, metallic, liver, and umami. Overall flavor, grill flavor and beef flavor accounted for 90% of the variation in overall consumer liking.

Conclusion: Different aromatic volatiles and beef flavor lexicon attributes can be manipulated by muscle, quality grade, pH level, cooking method and final internal temperature endpoint. Beef flavor lexicon attributes can be predicted using volatile aromatic compounds. Likely Maillard reaction and lipid degradation compounds were responsible for specific beef flavor components and were related to consumer sensory attributes. High heat cookery increased the production of Maillard reaction products and improved consumer overall liking.

Keywords: beef flavor, Consumer Perception, consumer sensory evaluation, descriptive sensory evaluation, gas chromatography

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EFFECT OF ZINC SULFATE OR ZINC SULFITE MARINATION ON COLOR OF RAW AND COOKED MEAT

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Objectives: Pork ham redness has been shown to result from zinc incorporation during processing, leading to increased acceptability of such a product. Zinc can replace iron in the heme group leading to a bright red color that remains after cooking. Increasing redness of meat also improves acceptability of beef but is considered a quality defect in chicken. This study was conducted to evaluate the effect of marination with either zinc sulfate ($ZnSO_4$) or zinc sulfite ($ZnSO_3$) on color stability of raw and cooked meat from chicken, pork, and beef.

Materials and Methods: Boneless chicken breast, pork butt steaks, and beef loin steaks were obtained fresh from a retail store. Meat from each species was randomly assigned (4 pieces/treatment) to one of three marination treatments; control (water), sulfite (1% $ZnSO_3$), or sulfate (1% $ZnSO_4$). Color measurements of lightness (L^*) and redness (a^*) were taken before and after marination, and each day for 7 days while meat was refrigerated. On d 7, meat was cooked in a bag immersed in a 92°C water bath to an endpoint of 74°C. Meat was then refrigerated and color was measured each second day until d 14 after cooking. Data were analyzed using General Linear Models procedure of SAS, with marinade treatment (water, 1% $ZnSO_3$, or 1% $ZnSO_4$) and species (poultry, pork, or beef) as the main effects.

Results: Within each meat species, marination using 1% $ZnSO_4$ increased ($P < 0.05$) L^* of raw meat (d 1-7) but had no effect on cooked meat (d 1-14). The 1% $ZnSO_3$ marinade increased raw beef a^* measured at d 7 (21.88, 13.21, and 10.81) compared to water and 1% $ZnSO_4$ marinade, respectively. This effect persisted until day 14 after cooking in

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beef; values were 4.88, 6.36, and 2.57 for water, 1% ZnSO₃, and 1% ZnSO₄, respectively. Raw pork *a** measured at d 7 was also increased when marinated with 1% ZnSO₃; *a** values were 11.81, 13.70, and 8.96 for water, 1% ZnSO₃, and 1% ZnSO₄, respectively. Marination had no effect on *a** of raw chicken, however, *a** of cooked chicken meat measured at d 14 was reduced when marinated with 1% ZnSO₄ (-0.07, 1.11, and 0.47) compared to water and 1% ZnSO₃ marinade, respectively.

Conclusion: Using ZnSO₃ at 1% of initial meat weight increased and maintained redness of raw and cooked beef for 7 d of refrigeration and 14 d after cooking, respectively. The variation in meat species response to marinade solutions could be attributed to variation in myoglobin content.
Keywords: Beef, Chicken, Marination, Pork, Zinc

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MULTIFACTORIAL APPROACH TO MEASURE SHELF LIFE OF MEAT PRODUCTS

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Objectives: Beef prices are volatile and depend on multiple factors. To accommodate for that instability, product formulations depend on different raw materials and storage ages. The objective of this test was to use a Response Surface Design to evaluate the effect of different factors and their interaction on the shelf life of beef patties.

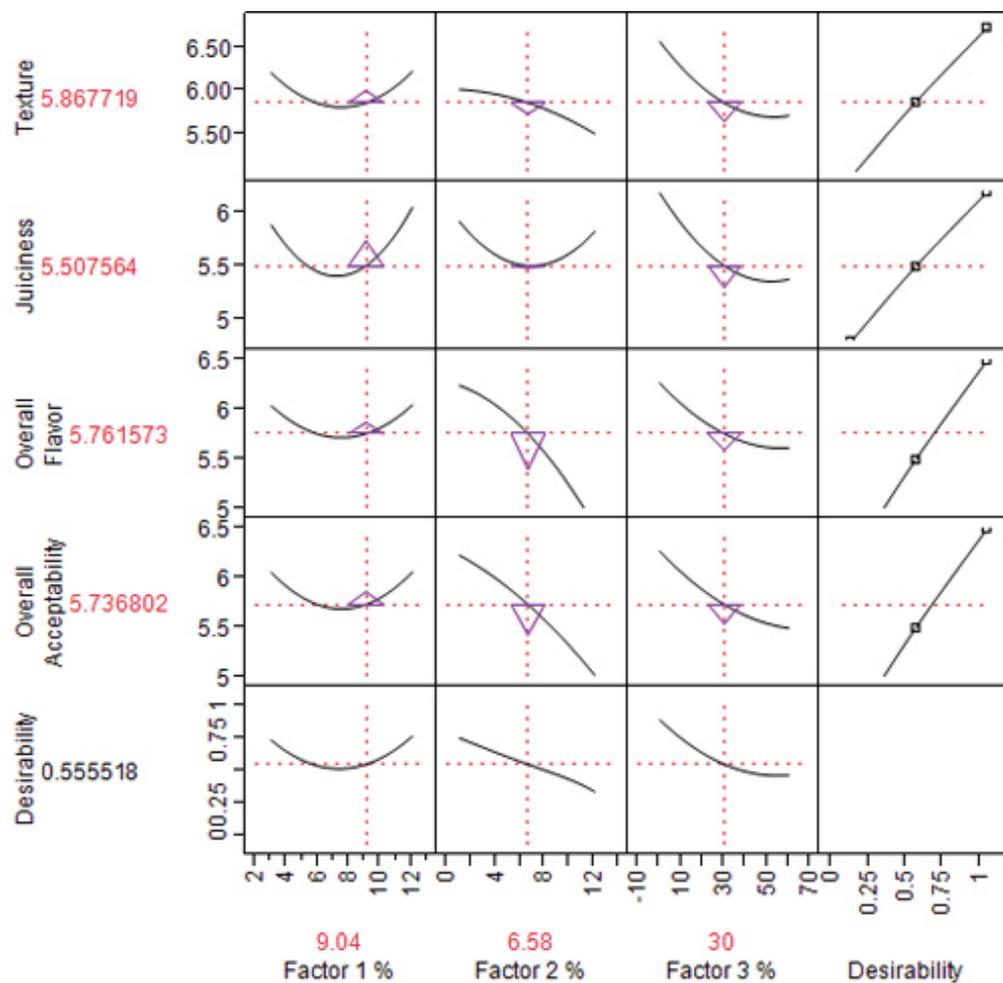
Materials and Methods: A rotatable inscribed central composite design with $\alpha=1.414$ was employed to formulate beef patties using a mixture of frozen and fresh raw materials with different ages and several inclusion rates. The design consisted of nine full factorial points, six axial points and five center points. Twenty treatments were formulated into patties and frozen. From frozen, patties were cooked to 160F and served to panelists. Samples were presented simultaneously and judges were instructed to cleanse their palate with unsalted crackers and water before and in between samples. A total of five panels were conducted. Samples were randomly distributed across panels with the exception of the center points, which were evaluated at the same time. Independent variables analyzed consisted of "Factor 1" (X1), "Factor 2" (X2) and "Factor 3" (X3). The dependent variables investigated were 1-9 Structured Hedonic Scales for texture, juiciness, overall flavor and product overall acceptability. Data was blocked by day and mathematical models containing only the significant terms were generated for each response parameter using multiple linear regression analysis and analysis of variance. A desirability function was calculated to simultaneously optimize Hedonic scores.

Results: Based on a minimum score of 5.5 which is at least a "slight liking" for hedonic consumer acceptance, maximum ages of raw materials

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at specific levels of inclusion were determined depending on a targeted shelf life. Figure 1 shows a desirability function with a minimum of 5.5 for texture, juiciness, flavor and overall acceptability at a given factor combination. The statistical program used (JMP® 10.0, SAS Institute Inc., 2012) allowed for an interactive profiler graph where the consumer acceptance was predicted based on a function that included only the significant terms affecting the shelf life for this product. As a result, the shelf life of beef patties was calculated based on a multifactorial analysis of the sensory characteristics over time.

Image:



Conclusion: Response Surface Methodology allowed for a better understanding of the simultaneous effect of multiple factors on the shelf life of beef patties.

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Keywords: RESPONSE SURFACE MODEL DESIGN, SHELF
LIFE

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EFFECTS OF IMMUNOLOGICAL CASTRATION MANAGEMENT STRATEGY ON LIPID OXIDATION AND SENSORY CHARACTERISTICS OF BACON DURING SIMULATED FOOD SERVICE STORAGE

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Objectives: The objective was to determine the effect of Improvest[®] (*gonadotropin releasing factor analog-diphtheria toxoid conjugate*, Zoetis) management strategies (age at slaughter, wk after second dose (ASD)), on lipid oxidation and sensory characteristics of bacon packaged for food service (without an O₂ barrier). To mimic conditions of a normal belly supply chain, all immunological castrates (IC) were pooled to compare bacon from IC, regardless of management strategy, to physical castrates (PC) and gilts (G) for the same traits.

Materials and Methods: Bacon was manufactured under commercial conditions from bellies (n=129) from 2 slaughter dates. Management strategies of IC pigs included 24 wk old IC pigs 4, 6, 8, or 10 wk ASD, 26 wk old IC pigs 6 wk ASD and 28 wk old IC pigs 8 wk ASD. To compare IC with PC and G, all IC treatments were pooled. Gilts and PC were slaughtered at 24, 26, and 28 wk of age and pooled across wk. Center-cut bacon was layered on parchment paper, packaged in oxygen-permeable poly-vinyl lined boxes, and frozen (-33°C) for 1, 4, 8, or 12 weeks to simulate food service conditions. At the end of each storage period, bacon was evaluated for saltiness, oxidized odor, oxidized flavor, and off flavor on a 15-cm line scale (0 cm indicated none and 15 cm indicated extreme intensity for each characteristic). At similar time points, lipid oxidation (TBARS) and proximate analysis were determined. Both data sets (IC management strategies and IC compared

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with PC and G) were analyzed using the MIXED procedure in SAS with belly as experimental unit. Model included fixed effects of treatment, week, and their interaction, with kill date as a block and week as a repeated measure. Least square means were separated using PDIFF option with a Tukey-Kramer adjustment.

Results: Overall, as storage time increased, saltiness decreased 1.5 units from 1 to 12 wk ($P < 0.01$), oxidized odor and oxidized flavor increased ($P < 0.01$), and TBARS increased by 0.23-0.30 mg MDA/kg meat from 1 to 12 wk ($P < 0.01$), but moisture and lipid content did not change ($P > 0.11$). There was no interaction of treatment and week within IC treatments or within sex classes ($P > 0.11$). Oxidized odor and flavor were unaffected by IC management strategy ($P > 0.21$) or sex class ($P > 0.31$). Amid IC bacon, TBARS were increased in bacon from 28 wk old 8 wk ASD IC pigs compared with bacon from 24 wk old 4 and 6 wk ASD IC pigs ($P < 0.01$) with other treatments being similar to both extremes. Lipid content was increased and moisture reduced ($P < 0.01$) in bacon from IC pigs 8 and 10 wk ASD compared with IC pigs at 4 and 6 wk ASD, regardless of age. When IC bacon treatments were pooled, TBARS tended to be increased ($P = 0.06$) by 0.03 mg MDA/kg meat from IC compared to G, with PC bacon not differing from either sex. Bacon from PC contained less ($P < 0.01$) moisture and more ($P < 0.01$) lipid than bacon from IC and G, which were similar.

Conclusion: Regardless of IC management strategy or sex, bacon became more oxidized with storage. Within IC treatments, lipid oxidation and lipid content increased as time after second dose increased, regardless of age. Lipid oxidation tended to be increased in IC compared with G. However, regardless of treatment, there were no differences in sensory attributes of bacon. Therefore, reductions in bacon shelf life due to the use of bellies from IC pigs should not be expected.

Keywords: bacon, Improvest, Lipid oxidation, storage

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EFFECTS OF ANTIMICROBIALS ON SHELF LIFE CHARACTERISTICS OF GROUND BEEF

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Objectives: The control of shiga toxin-producing *E. coli* is of major concern for non-intact beef products such as ground beef. As novel antimicrobials are developed to reduce these pathogens, it is critical to understand their impact on meat quality. Thus, the objective of this research was to evaluate the effects of pathogen interventions on quality characteristics of ground beef.

Materials and Methods: Beef trim (85/15) was produced from whole boneless chuck rolls to ensure known source and packaging date. Beef trim was treated with 4.5% lactic acid (LA), 200 ppm peroxyacetic acid (PAA), 50 ppm electrolyzed oxidizing water (EO), or 2.0% levulinic acid plus 0.2% sodium dodecyl sulfate (LVA-SDS) compared to an untreated control (CON). Beef trim from all chucks were combined so treatment was not confounded by source. Fifteen kilograms of trim per treatment were individually placed on the spray cabinet conveyor (360 degree 6 nozzle sprayer, 275 kPa) for treatment application. The beef trim was ground through a 12.7-mm plate followed by a 6.4-mm plate. After grinding, patties (150±2 g; 13 mm thick) were produced (Patty-O-Matic Protégé). Approximately 100 patties were made per treatment, 30 patties were randomly selected and assigned to a retail display for 0, 1, 2, 3, 4, or 5 d. An additional 5 patties were individually vacuum packaged and frozen for Kramer shear force analysis. Retail display patties were individually packaged in Styrofoam trays and wrapped with polyvinyl chloride film. Patties were placed in a coffin style retail display case at 3±2°C under 24 h florescent warm white lighting at 1851 lx. On their respective day patties were collected for psychotropic bacteria, pH, purge,

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and lipid oxidation analysis. Objective and subjective color was measured daily on d 5 patties. This was replicated three times. Data was analyzed by PROC MIXED (SAS Inc). If a treatment by day interaction occurred, the model was reanalyzed by day. Sample within treatment by replication was considered the random term. Comparisons were considered significant at $\alpha \leq 0.05$.

Results: Psychotropic bacteria counts increased as time on display increased for all treatments ($P < 0.05$). After d 5 of display LA inhibited the growth of psychotropic bacteria compared to all other treatments ($P < 0.05$). Percent purge increased as time on display increased and LA had a greater percent purge compared to all other treatments ($P < 0.05$). After d 1 of shelf life PAA lipid oxidation was lower than EO and LA ($P < 0.05$) and similar to CON ($P > 0.05$). For a^* and hue, redness decreased for all treatments as time on display increased and PAA retained greater redness after d 5 compared to all other treatments ($P < 0.05$). Delta E increased as time on display increased and the reflectance ratio of 630nm/580nm decreased over time for all treatments ($P > 0.05$). Initial color revealed that as time on display increased all treatments became darker red ($P > 0.05$). After d 2 of display the discoloration of LA and LVA-SDS maintained a lighter color compared to all other treatments ($P < 0.05$). After d 4, CON, LA, and LVA-SDS had a lower percent discoloration and after d 5 LA and PAA had less discoloration compared to all other treatments ($P < 0.05$). Kramer shear was similar for all treatments ($P > 0.05$).

Conclusion: The use of EO and LVA-SDS would maintain acceptable color for ground beef. Overall, EO and LVA-SDS can be used without negatively affecting quality compared to industry standards.

Keywords: Antimicrobial, ground beef , Quality

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BEEF (LD MUSCLE) SARCOMERE LENGTH MEASURED BY LASER DIFFRACTION OR PHASE CONTRAST MICROSCOPY. IS THERE A DIFFERENCE?

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Objectives: Variations in the myofibrillar protein structure can have significant effects on tenderness. Muscle sarcomere length (SL) has been exhaustively evaluated in experiments to determine whether tenderness was affected by cold shortening. Two methods are very much cited in the literature for measuring SL, laser diffraction and phase contrast microscopy. However, there are only a few scientific works that present a comparison between measurements obtained with these methods, being difficult to explain some low values obtained with laser diffraction in the absence of cold shortening. The purpose of this research was to compare the SL of *Longissimus dorsi* muscle (LD), measured by the two methods.

Materials and Methods: Two experiments were carried out. Trial 1 - LD samples from F1 crossbreeds (Angus x Nelore) 18 months old heifers (n = 7) and young bulls (n = 13). Trial 2 - LD samples from 24-36 months old *Bos indicus* (BI) bulls (n = 16). The LD muscle (12th rib), from both trials, was evaluated for ultimate pH (pH_u), cooking loss (CL), Warner Bratzler shear force (WBSF) and sarcomere length. The pH_u and SL were measured on fresh samples 4 days post mortem, while CL and WBSF were evaluated after 14 days of aging. For laser diffraction, samples were fixed in glutaraldehyde and small fibers bundles were passed through the helium-neon laser. For microscopy, myofibrillar extract, was obtained by grinding and centrifugation to evaluate sarcomeres by phase contrast. The statistical analyses were performed separately for both trials, and the results expressed as mean±SEM.

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Results: The results were: trial 1 - pH (5.53 ± 0.03), SL ($2.05 \pm 0.02 \mu\text{m}$ and $1.80 \pm 0.03 \mu\text{m}$, for SL by microscopy and laser, respectively), CL (23.25 ± 0.69) and WBSF (3.63 ± 0.11) were not affected by gender ($P > 0.05$). There was a positive correlation ($r = 0.88$; $P < 0.001$) from SL measured by microscopy and laser, while the correlation between SL and WBSF was not significant ($P > 0.05$). Regarding the regression procedures, it was found a linear trend for SL measured by microscopy and laser ($r^2 = 0.78$; $SL_{\text{laser}} = 1.3165 * SL_{\text{microscopy}} - 0.9049$). In laser diffraction the SL ranged from 1.48 to $2.23 \mu\text{m}$, while in microscopy the SL ranged from 1.81 to $2.32 \mu\text{m}$. Trial 2 – the mean values for pH, WBSF and CL were 5.58 ± 0.03 , 6.12 ± 0.39 and 23.52 ± 0.72 , respectively. Different from trial 1, there was a significant ($P < 0.001$) negative correlation ($r = -0.70$) between WBSF and SL for both laser and microscopy methods in the BI samples. It was found a correlation ($r = 0.80$; $P < 0.001$) and linear regression ($r^2 = 0.64$; $SL_{\text{laser}} = 1.2137 * SL_{\text{microscopy}} - 0.7608$) between SL by laser and microscopy. In laser diffraction the SL ranged from 1.31 to $2.03 \mu\text{m}$, while in microscopy the SL ranged from 1.80 to $2.17 \mu\text{m}$.

Conclusion: These data suggest instrumental tenderness is correlated with sarcomere length regardless of sarcomere length method, however the methods influenced sarcomere length, and, generally, the diffraction method results in shorter sarcomere length values.

Keywords: beef tenderness, cold shortening, sarcomere length, Warner-Bratzler shear force

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EFFECT OF RACTOPAMINE HYDROCHLORIDE AND ZILPATEROL HYDROCHLORIDE ON TENDERNESS OF *LONGISSIMUS* STEAKS OF *BOS TAURUS* STEERS

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Objectives: Three experiments were conducted to determine 1) the interaction of ractopamine hydrochloride (RH) inclusion rate (0 or 300 mg·hd⁻¹·d⁻¹ for last 30 to 34 d before harvest) and dietary protein level (13.5 or 17.5% CP) on LM slice shear force (SSF) at 14 d postmortem (Exp. 1); 2) the interaction of zilpaterol hydrochloride (ZH) inclusion rate (0 (ZH0) or 84 (ZH84) mg·hd⁻¹·d⁻¹ for 21 d with 3 to 5 d withdrawal before harvest) and dietary WDGS level (0 vs 30%) on LM SSF at 14 d postmortem (Exp. 2); 3) the interaction of ZH, dietary WDGS level, and postmortem aging period (7, 14, 28, or 42 d) on LM SSF (Exp. 3).

Materials and Methods: Calf-fed *Bos taurus* crossbred steers (Exp. 1, n = 448; Exp. 2, n = 438) were harvested at a large-scale Midwestern commercial beef processing plant and then carcasses were chilled conventionally and graded at approximately 37 h postmortem. Subsequently, a LM steak (2.54 cm thick) was obtained from the anterior end (i.e., 13th rib) of the strip loin of the left side of each carcass, aged (1°C) until 14 d postmortem, cooked to an internal temperature of 71°C, and sampled for SSF. For Exp. 3, a subsample of U.S. Choice carcasses (n = 100) were selected from each of the four dietary treatment combinations (n = 25 per treatment combination) of Exp. 2. The strip loin was obtained from the left side of each carcass and aged (1°C). Subsequently, a steak was obtained from each strip loin at each postmortem aging period (7, 14, 28, or 42 d) and LM SSF was determined.

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Results: °In Exp. 1, LM SSF increased with RH inclusion rate ($P < 0.03$; 15.4 vs 14.1 kg). But, LM SSF was not affected by dietary protein level or the interaction of RH with dietary protein level ($P > 0.10$). In Exp. 2, LM SSF increased with ZH inclusion rate ($P < 0.0001$; 24.2 vs 16.2 kg). But, LM SSF was not affected by WDGS level or the interaction of ZH with WDGS level ($P > 0.10$). In Exp. 3, ZH and postmortem aging period interacted to affect LM SSF ($P < 0.0001$). The LM SSF of ZH84 was higher than that of ZH0 at 7 (28.4 vs 19.8 kg; $P < 0.0001$), 14 (22.0 vs 15.1 kg; $P < 0.0001$), 28 (16.4 vs 12.3 kg; $P < 0.0001$), and 42 (13.9 vs 10.9 kg; $P < 0.01$) d postmortem. The LM SSF of ZH84 at 14 d postmortem was greater than the LM SSF of ZH0 at 7 d ($P < 0.05$). Inclusion rate of ZH and postmortem aging period interacted to affect the level of LM postmortem proteolysis as assessed with western blotting for desmin (Figure 1; $P < 0.01$). The amount of desmin degraded was lower for LM of ZH84 than that of ZH0 at each aging time but the magnitude of the effect decreased with aging. The amount of LM desmin degraded for ZH84 at 14 d postmortem was lower than the amount of LM desmin degraded for ZH0 at 7 d ($P < 0.05$). Extrapolation between observations made at 28 and 42 d postmortem, suggests that 34 and 33 d of postmortem storage are required for LM of ZH84 to achieve the same SSF and level of postmortem proteolysis, respectively, as LM of ZH0 at 14 d postmortem.

Conclusion: These data show that β -agonists, particularly ZH, can negatively impact beef tenderness and that significant lengthening of aging protocols would be required to overcome the negative effect of ZH on beef LM tenderness.

Keywords: beef, β -agonist, zilpaterol, ractopamine, slice shear force

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INSTRUMENTAL COLOR AND VISUAL EVALUATION OF THREE BEEF RETAIL CUTS FROM CATTLE FINISHED ON FORAGE AND CONVENTIONAL DIETS OVER TIME

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Objectives: Retail cuts (ribeye, top sirloin, arm/ranch steaks) from cattle finished on three diets, conventional feedlot (FL), grass (meadow brome, *Bromus riparius* Rehmman, GF), and birdsfoot trefoil (*Lotus corniculatus*, BFT), were evaluated under retail display.

Materials and Methods: Carcasses (n=6 of each diet) having similar maturity and marbling were utilized. Ribeye roll, top sirloin butt, and shoulder clod pairs were collected and portioned into 2.5-cm thick steaks. Product was frozen after 14 d postmortem aging (2-4°C). Prior to packaging, steaks (n=3 per diet muscle combination) were thawed (2-4°C) for 24 hr. Steaks were packaged on foam trays with absorbent pads and overwrapped with gas permeable polyvinyl-chloride film. Simulated retail display occurred for 7 d (2-4°C). Instrumental color (L*, a*, b*) assessment of steaks occurred at 24 hr intervals (n=8). Trained panelists (n≥8) evaluated steaks for redness (8-point hedonic scale, 1 = very bright red and 8 = tan to brown) and discoloration (6-point hedonic scale, 1 = none, 0 % and 6 = extensive discoloration, 81-100%).

Results: Lightness (L*) showed a day × diet interaction ($P < 0.05$). Steaks of FL beef had greater ($P < 0.05$) L* followed by BFT and GF having the lowest ($P < 0.05$). Lightness of cuts was dependent on diet ($P < 0.05$), where GF ribeyes were darkest while ribeyes from BFT and FL were lightest ($P < 0.05$). Redness (a*) interactions included: day × diet, day × cut, and diet × cut ($P < 0.05$). Overtime a* decreased ($P < 0.05$) for all diets, however, GF had greater ($P < 0.05$) a* at day 7. Likewise, as the

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trial progressed a^* decreased ($P < 0.05$) in each cut. Ranch steaks had greater ($P < 0.05$) a^* . Top sirloin steaks initially had greater ($P < 0.05$) a^* than ribeyes but ended with the least ($P < 0.05$). Ribeye a^* were similar ($P > 0.05$) to FL ranch steaks. Ribeyes from GF and BFT had lower ($P < 0.05$) a^* . A diet \times cut interaction was determined for yellowness (b^* ; $P < 0.05$). The b^* of FL cuts did not differ ($P > 0.05$). Within GF and BFT b^* was greatest ($P < 0.05$) in top sirloin and ranch steaks. Steak redness and discoloration, evaluated by panelists, had interactions including: day \times diet, day \times cut, and diet \times cut ($P < 0.05$). As day increased, steak redness of each diet was reduced ($P < 0.05$) and discoloration increased ($P < 0.05$). The BFT and FL steaks were similar ($P > 0.05$) in redness and discoloration up until d 6, where BFT steaks possessed the least ($P < 0.05$) redness and greatest ($P < 0.05$) discoloration. Top sirloin steaks were found to have the least ($P < 0.05$) initial and final redness and greatest ($P < 0.05$) discoloration. Ribeye and ranch steaks were initially similar ($P > 0.05$), ribeye steaks maintained greater ($P < 0.05$) redness and less ($P < 0.05$) discoloration. Within BFT the ribeye and ranch steaks discoloration did not differ ($P > 0.05$), but top sirloin steaks had greater ($P < 0.05$) discoloration. Within FL and GF each retail cut differed ($P < 0.05$) where top sirloin had the most discoloration followed by ranch steaks and ribeyes.

Conclusion: Further investigations will be **required** to elucidate the basic mechanisms contributing to the observed differences. This study reveals that not all forage finishing diets have equal impacts on appearance of cuts. Practical findings of this study may be used to optimize selection and utilization of beef cuts from multiple finishing programs.

Keywords: beef, Color, forage finishing, Retail Display, Shelf-life

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PRODUCING PREMIUM GRINDS WITH BRISKET TRIMMINGS

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Objectives: Ground beef is naturally enriched with oleic acid (18:1 n-9) which may reduce risk factors for cardiovascular disease, and higher concentrations of oleic acid are positively correlated with overall palatability. We hypothesized that unique, premium ground beef products could be formulated from lean and fat trim of the brisket, flank, and plate, each with its own positive attributes.

Materials and Methods: The carcasses graded USDA Select and represented a variety of *Bos taurus* breed types and backgrounds. Primals were collected from both sides of the carcass and included the brisket, flank, and plate. The study was carried out as a randomized complete block design in a 3 × 3 factorial arrangement. Lean and fat trims were separated by dissection, and the fat content of each fat and lean trim from all primals for each carcass was measured by gravimetric chloroform:methanol lipid extraction. Lean and fat trims from each primal were formulated to contain 10, 20, or 30% total fat. Once formulated, lean and fat trim were combined, coarse ground (1.27 cm) and a final grind (0.32 cm) was performed and patties were formed into 136g patties. Total lipids of cooked patties and drippings were extracted and a fatty acid composition was analyzed. Melting points of the subcutaneous adipose tissue lipids were approximated by determining slip points. Consumer sensory analysis was conducted in which panelists evaluated samples using a descriptive flavor analysis. Once samples were cooked, they were placed in a glass jar with a Teflon piece under the metal lid and then placed in a water bath at 60°C, where the headspace was collected with a solid-phase micro-extraction to determine volatiles. Fatty acid data were analyzed by single-factor analysis of variance by the

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Super Anova program with treatment group as the main effect, means were separated by the Fisher's Protected LSD. For sensory data were analyzed using the Proc GLM procedure of SAS. Volatiles were analyzed using JMP® Software.

Results: Brisket patties contained higher proportions of monounsaturated fatty acids 16:1n-7 ($P = 0.001$), 18:1n-9 ($P = 0.001$) and less saturated fatty acids 16:0 ($P = 0.04$), 18:0 ($P = 0.001$) than the flank or the plate. After cooking, brisket patties had higher Bloody ($P = 0.02$) and Fat ($P = 0.006$) descriptor values than flank patties. Plate patties generated higher amounts of lipid-derived volatiles compared to patties from the brisket or flank. Brisket patties generally had higher amounts of furancarboxaldehyde (a meaty, caramel aroma), 1-(1H-pyrrol-2-yl)-ethanone, benzene ethanol, and 3-hydroxy, 2-butanone (buttery) volatiles ($P < 0.05$) and relied more heavily on Maillard-derived volatiles than the other treatments. Consistent with our hypothesis, the results indicate that individual primal lean and fat trims can be used to formulate ground beef with unique characteristics.

Conclusion: Consistent with our hypothesis, the results indicate that individual primal lean and fat trims can be used to formulate ground beef with unique characteristics.

Keywords: Adipose Tissue, Bovine, Fatty Acid, Growth

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IN UTERO HEAT STRESS ALTERS OBJECTIVE COLOR MEASURES AND CONSUMER PERCEPTION OF CURED HAMS ON DAYS 30, 60, 90, AND 120 OF A SHELF LIFE STUDY

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Objectives: Muscle development in the pig occurs from day 25 to 90 of gestation and is susceptible to developmental programming events, such as heat stress. This work investigates the quality of cured hams from pigs heat stressed *in utero*.

Materials and Methods: Seventy-nine barrows were used for this work. At 25 kg, barrows born to control (TN; n=40) or heat stressed (HS; n=39) dams were individually housed and fed a corn soybean meal diet. At this time, barrows were equally and randomly assigned to receive a diet that met (100% NRC; n=20) or exceeded (110% NRC; n=20) NRC lysine recommendation. In the last 30 days of finishing, barrows were again equally and randomly assigned to a diet containing 0 (CTL; n=10) or 7.4 ppm ractopamine HCl (PAY; n=10). Barrows received diets until 121 kg of weight was attained, at which time all barrows were slaughtered at the University of Missouri abattoir. Hams from these barrows were deboned and knuckles were cured and smoked. Wet, pumped, and cooked weights, as well as brine uptake, were recorded for each ham. Cook loss and percent yield were calculated. Hams were sliced at a thickness of 2.5 cm, vacuum sealed for storage, and displayed under fluorescent lights for 120 days. Ham slices were analyzed on days 30, 60, 90, and 120 for objective color by Minolta Chromameter and TBARS measurements. A sensory panel consisting of consumers was conducted on day 30 for overall liking, tenderness, juiciness, and flavor using a measured line ballot, using a 10 cm line. Statistical analysis was performed using the GLM procedure of SAS.

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Results: Ham weights effected by HS where wet weight (1408.22 ± 25.55 vs 1239.96 ± 25.90 g; $P < 0.0001$), pumped weight (1737.48 ± 30.21 vs 1528.71 ± 30.63 g; $P < 0.0001$), cooked weight (1375.75 ± 27.70 vs 1144.13 ± 28.08 g; $P = <0.0001$), brine uptake (329.26 ± 10.06 vs 288.75 ± 10.20 g; $P = 0.006$), and percent yield (79.07 ± 0.46 vs 74.61 ± 0.47 %; $P < 0.0001$) were increased in HS barrows. Cook loss was reduced as a result of HS (20.93 ± 0.46 vs 25.39 ± 0.47 %; $P < 0.0001$). Objective color was altered by HS. HS barrows had increased L^* on day 60, 90, and 120 (61.98 ± 0.48 vs 56.47 ± 0.49 ; 61.27 ± 0.50 vs 56.23 ± 0.51 ; 58.06 ± 0.27 vs 56.70 ± 0.27 ; $P < 0.05$) and b^* on day 90 (8.08 ± 0.18 vs 7.36 ± 0.18 ; $P < 0.0001$), but reduced a^* on day 60, 90, and 120 (13.45 ± 0.17 vs 14.99 ± 0.18 ; 12.03 ± 0.26 vs 14.19 ± 0.27 ; 11.92 ± 0.28 vs 13.03 ± 0.28 ; $P < 0.05$) and b^* on day 60 (7.80 ± 0.14 vs 6.93 ± 0.14 ; $P < 0.0001$). PAY increased b^* on day 120 (8.16 ± 0.17 vs 7.66 ± 0.17 ; $P = 0.04$), but decreased a^* on day 120 (12.06 ± 0.28 vs 12.89 ± 0.28 ; $P = 0.04$). TBA value was increased on day 90 as a main effect of 110% (0.17 ± 0.01 vs 0.15 ± 0.01 mg malonaldehyde/g ham; $P = 0.01$). Sensory perception of hams was affected by HS where on day 30, overall liking (3.54 ± 0.17 vs 4.32 ± 0.17 cm; $P = 0.001$), tenderness (3.29 ± 0.19 vs 4.44 ± 0.19 cm; $P < 0.0001$), juiciness (3.63 ± 0.21 vs 5.06 ± 0.21 cm; $P < 0.0001$), and flavor (3.78 ± 0.18 vs 4.26 ± 0.18 cm; $P < 0.0001$) were reduced in HS barrows.

Conclusion: This study demonstrated that cured hams from barrows heat stressed during critical periods of muscle development were significantly heavier, but lighter in color, and consumer acceptability of hams was reduced.

Keywords: Cured Hams, Heat Stress, SHELF LIFE

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REDUCED OBJECTIVE COLOR IN FRESH GROUND PORK AND PORK SAUSAGE PRODUCT FROM BARROWS SUBJECTED TO IN UTERO HEAT STRESS

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Objectives: Muscle development in the pig occurs from day 25 to 90 of gestation and is, therefore, susceptible to developmental programming events, such as heat stress. This work investigates the quality of fresh ground pork and pork sausage from barrows heat stressed *in utero*.

Materials and Methods: Seventy-nine barrows were used for this work. At 25 kg, barrows born to control (TN; n=40) or heat stressed (HS; n=39) dams were individually housed and fed a corn soybean meal diet. At this time, barrows were equally and randomly assigned to receive a diet that met (100% NRC; n=20) or exceeded (110% NRC; n=20) NRC lysine recommendation. In the last 30 days of finishing, barrows were again equally and randomly assigned to a diet containing 0 (CTL; n=10) or 7.4 ppm Paylean (PAY; n=10). Barrows received diets until 121 kg of weight was attained, at which time all barrows were slaughtered at the University of Missouri-Columbia abattoir. Picnics from these barrows made into fresh ground pork patties and pork sausage patties. Patties were placed on Styrofoam trays, overwrapped with polyvinyl chloride and displayed under fluorescent lights for six days to determine oxidative color stability. Raw patties of each type were analyzed for objective color by Minolta Chromameter on days 0, 2, 4, and 6; oxymyoglobin concentrations on days 2 and 4; and TBA values on days 1 and 6. Statistical analysis was performed using the GLM procedure of SAS.

Results: In the fresh ground pork patties from HS barrows, L* tended to be reduced on day 0 (55.79 ± 0.29 vs 56.55 ± 0.30 ; $P = 0.07$) and was

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reduced on days 2, 4, and 6 (55.61 ± 0.40 vs 57.30 ± 0.41 ; 56.00 ± 0.35 vs 57.09 ± 0.36 ; 56.32 ± 0.33 vs 57.40 ± 0.34 ; $P < 0.05$). HS reduced a^* on day 0 (18.51 ± 0.13 vs 19.10 ± 0.13 ; $P < 0.05$), but increased a^* on day 6 (14.83 ± 0.30 vs 14.08 ± 0.30 ; $P < 0.05$). b^* was reduced on days 0, 2, and 4 (8.96 ± 0.10 vs 9.48 ± 0.10 ; 8.64 ± 0.10 vs 9.27 ± 0.11 ; 8.52 ± 0.10 vs 8.84 ± 0.11 ; $P < 0.05$) in fresh ground pork patties from HS barrows. There were no differences observed in oxymyoglobin concentrations or TBA value for fresh ground pork patties. In the pork sausage patties, HS reduced L^* values on days 0 and 6 (53.47 ± 0.26 vs 54.64 ± 0.26 ; 53.78 ± 0.27 vs 54.67 ± 0.28 ; $P < 0.05$); a^* values on days 0 and 2 (15.66 ± 0.15 vs 16.62 ± 0.15 ; 13.39 ± 0.13 vs 13.89 ± 0.13 ; $P < 0.05$); and b^* values were reduced on days 0, 2, 4, and 6 (8.21 ± 0.10 vs 9.12 ± 0.10 ; 7.25 ± 0.09 vs 7.95 ± 0.09 ; 6.91 ± 0.09 vs 7.39 ± 0.10 ; 6.48 ± 0.10 vs 6.73 ± 0.10 ; $P < 0.05$). Oxymyoglobin concentrations on day 2 in pork sausage patties were increased in product from HS barrows (1.39 ± 0.03 vs 1.30 ± 0.03 mg/kg; $P < 0.05$). Pork sausage product from 110% barrows tended to have greater a^* values on days 0 and 2 (15.95 ± 0.15 vs 16.33 ± 0.15 ; 13.47 ± 0.13 vs 13.81 ± 0.13 ; $P < 0.10$) and did have a greater a^* value on days 4 and 6 (12.11 ± 0.13 vs 12.56 ± 0.13 ; 10.45 ± 0.14 vs 10.89 ± 0.14 ; $P < 0.05$). Feeding PAY resulted in a reduced a^* value for pork sausage patties on days 0 and 2 (16.35 ± 0.15 vs 15.94 ± 0.15 ; 13.81 ± 0.13 vs 13.47 ± 0.13 ; $P < 0.05$).

Conclusion: Product from barrows subjected to heat stress during critical periods of muscle development was overall darker in color.

Keywords: Ground pork, Heat Stress, SHELF LIFE

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EFFECTS OF FAST FREEZING ON MEAT QUALITY ATTRIBUTES OF PRE-AGED BEEF LOINS

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Objectives: The freezing process, and particularly the freezing rate, has substantial impacts on quality attributes of frozen/thawed meat products. Studies have shown that the meat quality gaps, such as tenderness, color and water-holding capacity (WHC), between chilled (never frozen) and frozen/thawed meat can be greatly reduced as long as the meat is sufficiently aged prior to freezing. Therefore, the objective of the present study was to determine the effects of different freezing rates on meat quality attributes of pre-aged beef loins.

Materials and Methods: Both loins (*M. Longissimus*) from 12 steers (around 2 years old) were obtained from a local meat processing plant at 24h postmortem. The loins were divided into four different sections, vacuum packaged, and randomly assigned to four different ageing/freezing periods (no ageing – frozen only control, 3 or 4 weeks ageing at -1.5°C then frozen, and never frozen – aged only (4 weeks) control). Two different freezing methods (Fast freezing – using cryogenic calcium chloride immersion or Slow freezing using air freezer at -18°C) were applied to the sub-loin sections after each assigned pre-ageing period. The freezing rate was monitored by inserting thermocouples in a center of each loin section. After the assigned ageing/freezing and/or thawing at 2°C for 24 h, each loin section was further measured for pH, WHC (purge and drip loss), shear force, and surface meat color. The experimental design was a split plot with the four ageing/freezing periods allocated to the four sub-sections from both sides of each carcass in a saturated arrangement. Within each sub-section, two sub-cuts from each

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sub-section were randomly assigned to two different freezing treatments (either Fast or Slow freezing). The data were analyzed using the REML directive of GenStat.

Results: Different freezing methods substantially influenced the freezing rate of the loins. The Fast freezing method took less than 6 hours to reach the final ultimate freezing temperature at -18°C , whereas the Slow freezing took more than 35 hours to get below -15°C . The Fast freezing resulted in lower purge and drip loss of the loins ($P < 0.05$) compared to the slow-frozen counterpart ($P < 0.05$), regardless of the length of ageing periods prior to freezing. As expected, ageing meat prior to freezing significantly improved WHC of the frozen/thawed meat, where the frozen only loins had the highest purge/drip loss followed by the loins aged 3 weeks and aged 4 weeks prior to freezing, while the aged only (never frozen) loins had the lowest water loss ($P < 0.05$). Different freezing methods did not affect shear force values of the loins ($P > 0.05$). However, ageing-then-freezing significantly improved shear force values of the loins compared to both the aged only and frozen only loins, where the aged/frozen/thawed loins had even lower shear force values (5.9 kgF) than the aged-only loins (7.5 kgF; $P < 0.05$). Meat color was not affected by the different freezing/thawing methods ($P > 0.05$).

Conclusion: These observations suggest that the Fast freezing of previously aged meat will minimize the amount of water-loss due to the freezing/thawing process, and subsequently will add more value of the aged/frozen/thawed meat products by improving the appearance through less drip, as well as minimizing the loss of soluble nutrients.

Keywords: beef, freezing rate, tenderness, water-holding capacity

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EFFECT OF DIFFERENT FREEZING/THAWING METHODS ON MEAT QUALITY CHARACTERISTICS OF PRE-AGED LAMB LOINS

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Objectives: The rate of freezing and thawing plays a crucial role in determining quality attributes of frozen/thawed meat products by impacting the size and location (or distribution) of ice crystals within the frozen meat tissue. Recent studies found that differences in meat quality attributes including tenderness, color stability and water-holding capacity (WHC) between chilled and frozen meat can be diminished, if the meat is sufficiently aged prior to freezing. However, there has been no research undertaken on how different freezing/thawing methods influence the efficacy of ageing/freezing on meat quality attributes. Therefore, the objective of this study was to determine effects of different freezing/thawing methods on quality characteristics of pre-aged lamb loins.

Materials and Methods: A randomized block design with a 2 x 3 factorial arrangement, where there were 2 freezing (fast and slow) x 3 thawing (-1.5, 4 and 15°C) methods plus non-frozen (aged only) control, was applied to the lamb loins (*M. Longissimus dorsi*; n = 105) obtained at 24 h postmortem. After 2 weeks of ageing at -1.5°C under vacuum packaging, the loins were assigned to each freezing/thawing combination or non-frozen control, and then pH, WHC (drip and cook loss), surface color (CIE $L^*a^*b^*$), and shear force were measured. The data were analyzed using the ANOVA directive of GenStat. Means for all traits of interest were separated (F test, $P < 0.05$) by using least significant differences.

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Results: Fast freezing significantly decreased the amount of drip loss of the aged/frozen/thawed loins regardless of thawing methods. A significant freezing by thawing interaction on cook loss was found, where the cook loss was not influenced by different thawing methods ($P > 0.05$), when the fast freezing was applied to the pre-aged loins. However, when the slow frozen loins were assigned to the fast thawing (15°C), the highest cook loss was observed compared to other treatments ($P < 0.05$) indicating that the combined condition of both slow freezing and fast thawing (15°C) would result in the highest water loss during cooking. Regardless of different freezing/thawing methods, the aged/frozen/thawed loins had equivalent shear force values to the non-frozen control (3.85 kgF and 3.80 kgF; $P > 0.05$), confirming the positive effect of ageing prior to freezing on meat tenderness. The different freezing/thawing methods had no impacts on pH, L^* , a^* and chroma values on the aged/frozen/thawed loins.

Conclusion: The data from the current study indicate that fast freezing significantly improved WHC of the aged/frozen/thawed lamb loins by minimizing drip and cook loss. Further, this study confirmed that ageing meat for 2 weeks prior to freezing would improve quality attributes (WHC and shear force) of the frozen/thawed meat products.

Keywords: freezing rate, lamb, meat quality, thawing rate

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EFFECT OF TECHNOLOGY USE IN BEEF PRODUCTION SYSTEMS ON MUSCLE CONFORMATION OF *LONGISSIMUS LUMBORUM*

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Objectives: The objectives of this study were to examine the effect of beef production systems with and without the use of a β -adrenergic agonist on muscle conformation of strip loins compared to an all-natural production system. The treatments consisted of all-natural production (NAT), conventional production (CONV), and conventional production with the addition of the beta-agonist, zilpaterol hydrochloride (CONV-Z).

Materials and Methods: Crossbred beef steers (n = 336) were randomized to one of the three treatments. NAT cattle received no growth promoting technologies. CONV and CONV-Z steers were implanted with 40 mg of estradiol and 200mg of trenbolone acetate on d 0, and were fed 33 and 9 mg/kg of monensin and tylosin daily, respectively. CONV-Z steers were fed 6.76 mg of ZH/kg of diet for 20 d before slaughter with a 3 d withdraw. Forty-four carcasses that graded USDA Low Choice were identified for each treatment and strip loins were collected. Loins were fabricated into 2.54-cm thick steaks, and the anterior end of each steak was pictured for muscle dimension measurements. Objective measurements were taken using image analysis software. Measurement data were analyzed in the MIXED procedure of

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SAS with steak number as a repeated measure and were considered significant at $P < 0.05$.

Results: Muscle dimension analysis indicated that *M. Longissimus lumborum* (LL) area was increased in CONV-Z steers compared to CONV steers ($P < 0.01$) and CONV were increased compared to NAT steers ($P < 0.01$). No difference ($P = 0.11$) was detected in medial-lateral LL width between CONV-Z and CONV steers, but both showed an increase compared to NAT steers ($P < 0.01$). Maximum dorsal-ventral depth of LL at 25, 50 and 75% length of LL was increased in CONV-Z steers compared to CONV ($P < 0.01$) and NAT steers ($P < 0.01$), with the greatest increases at 25 and 75% depth. *M. gluteus medius* (GM) area was decreased in NAT steers compared to CONV-Z and CONV ($P < 0.01$). CONV-Z steers trended toward an increased percentage of vein-steaks (strip steaks containing both LL and GM), compared to NAT ($P = 0.06$), although CONV-Z had a numerically greater percentage of vein-steaks compared to CONV steers, they did not differ statistically ($P = 0.18$). No difference in average number of steaks yielded from each loin was detected between treatments ($P = 0.31$).

Conclusion: Results show improvement in muscle conformation creating a more usable center of the plate steak from the use of efficiency improving technologies. CONV and CONV-Z production practices result in larger LL areas, mainly shown through increased dorsal-ventral muscle depth economically important to the steak cutting industry.

Disclosure of Interest: B. Harsh: None Declared, G. Mafi: None Declared, D. VanOverbeke: None Declared, R. Ramanathan: None Declared, J. Hodgen Grant / Research Support from: Merck Animal Health, J. Finck Grant / Research Support from: Merck Animal Health, C. Maxwell: None Declared, C. Richards: None Declared, C. Krehbiel: None Declared

Keywords: beef cattle, conformation, natural, zilpaterol hydrochloride, β -adrenergic agonist

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EFFECT OF FEEDING DISTILLER'S GRAINS IN DIFFERENT PHASES OF PRODUCTION ON THE FATTY ACID PROFILE IN BEEF AND LIPID OXIDATION OF FROZEN, COOKED BEEF LINKS

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Objectives: The objective of this trial was to evaluate the impact of feeding modified wet distiller's grains during different production phases on the fatty acid profiles of beef, and on the oxidation of cooked beef links during frozen storage.

Materials and Methods: Heifers were randomly assigned to a 2 X 2 factorial design that included 0.91 or 2.27 kg/hd/d supplementation of wet distiller's grains during the winter backgrounding phase and either 40% dietary inclusion (DM basis) of sweet bran or modified wet distiller's grains during the finishing phase. During the summer months, all cattle were supplemented with modified wet distiller's grains at a rate of 0.6% of BW. A total of 16 clods representing four carcasses from each dietary treatment group were collected. Lean, fat, and composite samples from each clod were taken for fatty acid analysis. Each clod was independently ground, and 0.75% salt and 0.25% sodium phosphate were added. The mixture was formed into skinless links using a piston stuffer. Links were placed in individual foil trays for each clod and cooked to an internal temperature of 71°C. The links were placed in zip-top bags and placed in frozen, dark storage. Lipid oxidation was evaluated on days 0, 28, 56, 84, 112, 140, and 168 using the thiobarbituric acid reactive substances (TBARS) analysis. Fatty acid composition was analyzed on lean, fat, and composite samples from each clod.. Data were analyzed as a

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2 X 2 factorial of backgrounding supplementation and finishing diet using the PROC MIXED procedure of SAS and with repeated measures (day) for TBARS.

Results: For the lean, fat, and composite portion fatty acid analysis, a finishing diet effect was observed where beef from cattle finished on modified distiller's grains (MDGS) had greater amounts of C18:2 ($P = 0.0076, 0.0221, 0.0046$, respectively) and total polyunsaturated fatty acids ($P = 0.0021, 0.0283, 0.0283$ respectively). The composite sample also had a finishing diet effect where cattle finished on MDGS had greater amounts of C16:1 ($P = .0425$) and lesser amounts of C17:0 and C17:1 ($P = .0018$ and $.0064$, respectively). The fat portion had a backgrounding diet effect where there was a greater amount of unsaturated fatty acids, fewer amount of C18:0, and a lower unsaturated fatty acid to saturated fatty acid ratio ($P = .0045, .0060, \text{ and } .0139$ respectively) in beef from cattle supplemented with more MDGS. Lipid oxidation in frozen beef links was not impacted by dietary treatments ($P > 0.05$) Lipid oxidation increased over storage time ($P < 0.0001$). Samples from 0d were less oxidized than all other sampling times, and 168d were more oxidized than 28d and 56d.

Conclusion: Even though feeding MDGS resulted in a fatty acid profile making the beef more susceptible to lipid oxidation, no dietary differences were found among treatments.

Keywords: distillers grains, Fatty Acid Profile, Lipid oxidation, Ready-to-Eat Beef, TBARS

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MEAT COLOR ASSESSMENT USING A STRUCTURED LIGHT IMAGING SYSTEM

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Objectives: Color is one of the most important meat quality attributes, and thus developing precise and consistent assessing techniques is critical. The typical instrumental measurement using a colorimeter is performed by random spot assessments, which may not accurately evaluate the whole surface meat color. In that regard, a computer vision system (CVS) and image analysis can be an effective technique to overcome this limitation. Therefore, the objective of the current study was to investigate the efficacy of the CVS for obtaining color attributes from the diffuse scattered light in the assessment of color stability of beef muscles during retail display.

Materials and Methods: Three beef muscles (*Longissimus dorsi* (LD), *semimembranosus* (SM), and *psoas major* (PM)) from eight beef carcasses were obtained (USDA Select; A maturity) at 1 day postmortem. Two steaks (2.54 cm thick) were cut from each muscle, vacuum packaged and assigned to two ageing periods (2 and 9 days postmortem). After the assigned ageing time, each steak was placed on Styrofoam trays, overwrapped with PVC film, and displayed for 7 days at 3°C under continuous fluorescent natural white light. The surface colors of the steaks were evaluated using a Minolta CR400 colorimeter (D65, 1 cm diameter aperture, and 2° standard observer; 3 spot measurements), the trained color panel (n = 10; lean color and discoloration based on AMSA

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color guidelines) and the CVS on day 1, 4 and 7. The CVS consists of a RGB camera (8M pixels) and a projector. By acquiring a sequence of images with shifted checkerboard patterns, the diffuse and specular components of the samples were obtained. The RGB images of the diffuse component were transformed to CIE XYZ, and then to CIELAB values, which were used for the calculation of hue angle, chroma, and a^*/b^* ratio.

Results: In general, the color attributes of beef muscles assessed by the CVS were highly correlated to the sensory lean color scores ($r = 0.90$ for chroma and $r = 0.91$ for a^*/b^*), which is higher than the Minolta at a 7% and 4% level significance level. Correlations relating to discoloration scores and hue angle values were not statistically different. Between the muscle types, the color attributes generated from the CVS showed statistically stronger correlations to the sensory lean color scores ($r = 0.76$) for the LD muscle compared to the results from the colorimeter ($r = 0.56$) at a 5% significance level, and no substantial differences were found for SM and PM. Between display days, the CVS appears to outperform the colorimeter evaluating both lean color and discoloration at 1 day display - all statistically different at a 0.01% level - whereas for the later days the two instruments performed at the same level based on the correlation to the sensory color. The ageing treatments did not seem to effect correlation differences.

Conclusion: These results indicate that a CVS with computing a diffuse component showed a strong correlation to the trained panel color evaluation, and thus can be used for the meat color assessment with improved precision and accuracy over a colorimeter.

Keywords: beef, image analysis, meat color assessment

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CHANGING BEEF STRIP STEAK VOLATILE AROMA CHEMICAL PRODUCTION BY DIFFERING STEAK THICKNESS AND COOK SURFACE TEMPERATURE

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Objectives: Our objectives were to determine the quantity of volatile aroma compounds from thin-, medium-, or thick-cut strip steaks using low, medium, or high cook surface temperature.

Materials and Methods: USDA Select top loin steaks were cut 1.3 cm, 2.5 cm, or 3.8 cm thick and nine each of these steak thicknesses were cooked on a flat iron skillet with a surface temperature of 177°C, 204°C, or 232°C. All steaks were cooked to 71°C turning the steak once (35°C). Each steak was cut into pieces (1.3 cm x 1.3 cm cubes), and placed in a 750mL glass jar in a water bath held at 60°C. Headspace volatile compounds were collected with solid-phase micro-extraction (SPME) for 2 h. The SPME was then desorbed on a multi-dimensional gas chromatograph/mass spectrometer for quantification (measured and reported as total ion counts) and identification of volatile aroma compounds. A 3 x 3 factorial ANOVA and stepwise regression were used to determine the relative contribution of thickness and cooking traits to volatile production (alpha = 5%).

Results: The high cook temperature produced higher ($P < 0.05$) amounts of 1-hexanol, 2-ethyl-5-methyl-pyrazine, 2,5-dimethyl-pyrazine, phenyl-acetaldehyde, and trimethyl-pyrazine. The thinnest steaks had highest ($P < 0.05$) quantities of lipid degradation volatiles including E-2-decenal, 1-hexanol, 1-octanol, 2-heptanone, 2-pentyl-furan, decanal, ethyl-benzene, heptanal, nonanal, and octanal. The 3.8-cm-thick steaks had

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more ($P < 0.05$) Maillard products 2-ethyl-3-methyl-pyrazine, 2-ethyl-3,5-dimethyl-pyrazine, 2-ethyl-5-methyl-pyrazine, 2-ethyl-6-methyl-pyrazine, 2-methyl-butanal, butanedione, 2,5-dimethyl-pyrazine, 3-methyl-butanal, and methyl-pyrazine. About two-thirds of the variation in 2,4-nonadienal could be explained by skillet temperature at the beginning and end, steak surface temperature at the flip and at the end, steak internal temperature at the end of cooking, and cook loss percentage ($P < 0.05$). Twenty-four percent of 2-methyl-furan from is solely from the steak surface temperature ($P < 0.05$) at the end of cooking. Beginning steak internal temperature and ending steak internal temperature accounted for 35.8% of the variation ($P < 0.05$) in heptanal. A total of seven variables entered the equation ($P < 0.05$) for nonanal and accounted for almost 29% of the variation. Nonenal was described ($P < 0.05$) by beginning internal steak temperature, ending steak surface temperature, and cooking loss. Four temperature variables combined to account for more than 35% of the variation in octanal ($P < 0.05$). Just more than 12% of the variation in octane and 6% of the variation in 2-ethyl-3,5-dimethyl-pyrazine could be accounted for by cooking temperature measurements ($P < 0.05$). The three Maillard products 2,3-dimethyl-pyrazine, 2,5-dimethyl-pyrazine, and trimethyl-pyrazine could be described by the ending surface temperature, and when combined with other cooking temperature and time measurements, accounted for 22.2, 49.5, and 21.4% of the variation ($P < 0.05$), respectively. Additionally, all three of these compounds were positively affected ($P < 0.05$) by both time and temperature which would be characteristic of Maillard products.

Conclusion: This research suggests that steak thickness and cook surface temperature significantly impact the quantity and composition of volatile aroma compounds.

Keywords: beef flavor, cooking properties, temperature, volatiles

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ASSESSMENT OF BULL AND COW MEAT INCLUSION LEVEL ON THE PALATABILITY OF AMERICAN WAGYU GROUND BEEF PATTIES

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Objectives: Bull and cow meat can be added to ground beef blends as an affordable source of lean. Bull or cow meat from Wagyu-Angus crossbred cattle (American Wagyu) was added to conventional young American Wagyu ground beef blends to determine the maximum level of inclusion without affecting palatability.

Materials and Methods: Cow or bull meat was included in pre-formulated frozen ground beef patties at 6 inclusion levels (10, 20, 30, 40, 50, and 100%) for each gender. Proximate analysis was performed on 4 patties from each of the 12 blends to determine fat, protein, and moisture values. Trained panelists (6 to 7) were used to determine the palatability of cooked patties. After cooking, each patty was cut into 6 equally sized portions and served to panelists to be evaluated on an 8-point scale for juiciness, cohesiveness, hardness, beef flavor intensity, and beef flavor. Off flavor was scored on a 5-point scale. Finally, shear force (SF) values were determined using representative samples from each treatment. One strip (2.5 cm wide) was cut from the center of each patty for SF analysis and sheared 3 times. Data were analyzed using the mixed procedure of SAS. The experimental design was a 2 x 6 factorial with gender, inclusion level, and their interaction as fixed effects.

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Results: An interaction between inclusion level and gender was detected ($P < 0.01$) for fat, protein, and moisture contents. Proximate analysis of bull patties showed moisture and protein levels increased with inclusion level, while fat content decreased. As inclusion level of cow meat increased, fat content of patties generally increased; however, there was no clear pattern for moisture or protein content. Juiciness was affected only by inclusion level ($P = 0.04$), resulting in decreased juiciness ratings as inclusion level increased. An interaction between gender and inclusion level was observed ($P < 0.04$) for hardness, cohesiveness, texture, beef flavor, and off-flavor. Hardness of both bull and cow patties increased with inclusion levels ($P < 0.05$); however, patties with 10 and 20% bull meat had lower ($P < 0.05$) hardness scores than any other treatment. Differences in cohesiveness were observed, although no clear trends were present. The only blends rated as coarse textured were 100% cow and 30% bull; however, 50% cow was similar ($P > 0.05$) to these blends. All other treatments were considered moderately to slightly fine textured. Only 100% cow patties resulted in a decrease ($P < 0.05$) in beef flavor and an increase ($P < 0.05$) in off-flavor detection compared to other samples. No differences ($P > 0.05$) in beef flavor intensity were noted. Shear force was impacted only by inclusion level ($P = 0.02$). For both bull and cow patties, SF values were higher at 100% than any other inclusion level. In bull patties, desirable palatability characteristics appeared to be directly related to fat content of the blends. No such trend was observed in cow patty blends suggesting gender differences in the relationship between proximate and sensory characteristics. Gender and blend level had only minimal effects on the flavor of patties, with the only decrease in flavor and off flavor presence linked to 100% cow patties.

Conclusion: In conclusion, sensory traits were affected by inclusion level and gender; however, regulating fat content of blends in future studies could more accurately explain these variations.

Keywords: bull meat, cow meat, ground beef, sensory, Wagyu beef

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A PROTEOMIC APPROACH FOR THE IDENTIFICATION OF SMALL PEPTIDES IN DRY-CURED HAM AS MARKERS OF TIME OF PROCESSING

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Objectives: This work has been focused on the use of advance proteomic tools for the identification of small peptides generated as a consequence of proteolysis phenomena up to 9 months processing of Spanish dry-cured ham. The quality of such type of product is usually considered as acceptable when 9 months of processing are achieved. The final goal is the identification of some small peptides as potential markers of the time of processing which is correlated to the quality of the product.

Materials and Methods: Peptides have been extracted from samples of dry-cured ham at 2, 3.5, 5, 6.5, and 9 months of processing. Peptides were extracted and deproteinized followed by gel filtration chromatography through a sephadex G-25 gel, The eluted fraction containing the target peptides was collected and further analyzed by nanoliquid chromatography and mass spectrometry in tandem (nESI-LC-MS/MS, model Eksigent of AB Sciex, CA, USA). The identification of protein origin of the peptides was done using the tool BLAST (Basic Local Alignment Search Tool) from UniProt protein database. with a FDR of 0.5 and a significance threshold $P < 0.05$. The tolerance on the mass measurement was 0.3 Da in MS mode and 0.3 Da for MS/MS ions. The alignment of protein sequences was also carried out using the Uniprot protein resource.

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Results: A large number of peptides have been identified by mass spectrometry in tandem, which proves the intense activity of muscle endopeptidases, mainly cathepsins, in the generation of polypeptides as well as the activity of exopeptidases in the generation of small peptides. Myofibrillar proteins are the origin for most of the identified small peptides. In some of them, methionine oxidation has been observed towards the end of the process (6.5 and 9 months of processing). The search was focused on those peptides exclusively present at 9 months of curing discarding those peptides appearing at previous times. So, peptides PAPPKEE, APAPPKEE and KKDVKKPA from myosin light chain and RKKPLNI and KEEEEELVAL from troponin T were found only at 9 months of processing. Thus, these peptides could be good markers for a minimum processing time of 9 months which is associated to a good quality of the ham.

Conclusion: The use of proteomic tools like nESI-LC-MS/MS constitutes a powerful resource to study the generation of peptides in meat products and thus evaluate the potential of the identified small peptides PAPPKEE, APAPPKEE and KKDVKKPA from myosin light chain and RKKPLNI and KEEEEELVAL from troponin T as natural markers of processing time for dry-cured ham.

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Keywords: dry-cured ham, peptides, proteomics, quality prediction

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RELATIONSHIPS BETWEEN VOLATILE FLAVOR COMPOUNDS AND BEEF FLAVOR DESCRIPTIVE ATTRIBUTES USING PRINCIPAL COMPONENT ANALYSIS

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Objectives: The flavor of beef has been shown to be an important factor in consumer demand. A dynamic group of attributes contribute to beef flavor that are described in the beef flavor lexicon. These flavors are derived from volatile flavor compounds, however, it is not know what specific flavor volatile compounds are related to individual beef flavor attributes from the beef lexicon. Our objective was to determine what volatile flavor compounds are related to major flavor attributes from the beef lexicon (beef identity, browned/roasted, serummy/bloody, fat-like, metallic, liver-like, umami, and overall sweet flavor aromatics; and sweet, sour, salty and bitter basic tastes).

Materials and Methods: Differences in beef flavor attributes were induced through the use of beef cuts (USDA Top Choice and Select beef top loin steaks, top sirloin steaks, flat iron steak, and bottom round roasts) that have been shown to differ in flavor. Steaks, 2.54 cm thick, and roasts, 7 cm thick, were cooked to either 58, 70, or 82°C using a gas grill or George Foreman grill for steaks and a crockpot or roasted in an oven for roasts. Additionally, 16 top loin steaks from high pH (>6.0) were cut and cooked as defined. An expert, trained flavor descriptive attribute panel evaluated the steaks and roasts using the beef lexicon with the Spectrum® Universal 16-point scale (0 = none and 15 = extremely intense). Volatiles were captured from the same steaks or roasts

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evaluated by the panelists using the AromaTrax System. Individual volatile, aromatic compounds were identified by two panelists, each at their own sniff port. Raw meat pH, fatty acid composition, myoglobin content, and non-heme iron content were determined. Aromatic, volatile chemicals defined by the Aroma Trax system (n=413) were used.

Results: Prediction equations using stepwise regression were developed that accounted for 82, 70, 92, 81, 73, 72, 61, 67, 69, 70, 69, 77, and 89 percent of the variability in beef identity, browned/roasted, serummy/bloody, fat-like, metallic, liver-like, umami, overall sweet, and sweet, sour, salty and bitter basic tastes, respectively. Not one single class of compounds from Strecker degradation, Maillard reactions and lipid oxidation were used to predict any of the flavor descriptive attributes. Each flavor attribute, while derived using different volatile compounds, were the result of reactions in the lean and fat portions of meat during cooking. Principle component analyses were conducted using the 13 trained descriptive major flavor attributes.

Conclusion: The purpose of this analyses was to take the compounds used in the stepwise regression and see if they were related to or were accounting for similar variation in the sensory flavor descriptor. Generally, compounds related to Strecker degradation, Maillard reactions, and lipid oxidation tended to cluster with each other. These analyses may help in reducing the number of compounds used to predict each sensory flavor descriptive attribute in future research. These results indicate that to predict any of the specific sensory flavor attributes, multiple volatile flavor compounds were needed.

Keywords: beef flavor, beef lexicon, volatiles

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VOLATILE COMPOUNDS RELATED TO GROUND BEEF SPOILAGE

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Objectives: Little is known regarding the development and origin of compounds related to beef deterioration—further, less is known regarding the variation in pathways among aerobic and anaerobic package types. Of all analyses, volatile compounds may yield the most information regarding the development of spoilage indicators. Therefore, this project aimed to refine a method intended to quantify and characterize headspace volatiles within high-oxygen and anaerobic modified atmosphere packages (MAP).

Materials and Methods: Raw round beef (81:19; lean:fat) was portioned into patties at seven d post-packaging. On the day of production, individual patties (150g) were placed in polypropylene trays and sealed with a high barrier film to form one of two MAP types (n = 9 per type): 80% O₂ / 20% CO₂ (Hi-Ox MAP) or 0.4% CO / 69.6% N₂ / 30% CO₂ (CO-MAP). Packages were stored at an abusive temperature (22°C) under continuous fluorescent lighting (1530 lux) to accelerate the development of spoilage-related compounds. Package headspace was sampled at 0, 24, and 48 h using a solid phase microextraction (SPME) technique. Briefly, a single SPME fiber was exposed to the package headspace for 40 min to collect volatile compounds. Compounds were

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characterized and quantified of volatile compounds using a gas chromatograph/mass spectrophotometer (GC/MS). Volatile compounds were identified using a commercially available MS library and identities were validated using standard reference compounds in addition to comparisons of ion fragmentation patterns from of samples and compounds of interest. Q values, calculated based on the similarities of the ion fragmentation patterns, were confirmatory of compound identity when greater than 90. Relative compound abundance was used to measure compound concentration within the headspace. Data were analyzed in a mixed model with storage length and package type as fixed effects and replication ($n=3$) as a random effect. An α of 0.05 was used for mean separation.

Results: As expected, temperature abuse resulted in rapid quality deterioration and the substantial development of volatile compounds. A total of 20 volatile compounds were identified in the headspace of Hi-Ox and CO-MAP packages. Of particular interest was the similarity in compound identity between package types. While similar in identity, the rate and extent of compound development during storage varied among package types. Interestingly, the relative abundance of particular volatile compounds in CO-MAP—particularly dodecane, a hydrocarbon commonly associated with oxidative pathways—was greater ($P < 0.05$) in Hi-Ox MAP. The larger presence of dodecane in an anaerobic package suggests the potential for alternative development pathways. Regardless, the stability of hydrocarbons in CO-MAP over the 48 h storage period supports the suppression of oxidation. Unexpectedly, the length of storage did not influence ($P > 0.05$) the development of aldehyde compounds or 3-hydroxy-2-butanone in either package type.

Conclusion: These data enhance the development of methods to measure spoilage-related volatile compounds. However, inconsistent volatile presence in aerobic and anaerobic packages—particularly of compounds previously associated with auto-oxidative pathways—suggests that additional oxidation pathways (photo-oxidation, microbial oxidation, etc.) likely influence the development of these compounds in

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meat. Further investigation of volatile development pathways is warranted.

Keywords: beef, packaging, spoilage, volatile

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PRODUCTION, CARCASS, AND MEAT QUALITY CHARACTERISTICS OF COMMERCIAL CROSSBRED GILTS AND BARROWS FED TWO DIFFERENT DIETS

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Objectives: The purpose of this study is to analyze the characteristics of gender and feed type on carcass merit by evaluation of cutability and palatability attributes of fresh pork.

Materials and Methods: Duroc × Landrace × Yorkshire (commercial crossbred) barrows and gilts (n = 67) were utilized in this study. Age, feed rations, feed additives, sex, genetics, and live weight (LW) were provided by the Oklahoma State University Swine Research and Education Center. Utilizing distillers grains, hogs were fed one of two corn based diets, with one containing 14% wheat midds (diet 1) and the other combining 12% soybean meal and 0.009 kg per ton of Paylean[®] (ractopamine hydrochloride; diet 2). Hogs were harvested at the Oklahoma State University Food Agriculture Processing Center. Before rendered unconscious, real-time ultrasound was used to collect measurements of loin eye area (LEA) and 10th rib fat depth (n = 88). Following completed harvest, 1 hr, 3 hr, and 24 hr pH and temperature readings were recorded in the semimembranosus and *Longissimus* muscle on both the left and right side of each carcass. Data for hot carcass weight (HCW), muscle score (MS), dressing percentage (DP), first rib (FR), last rib (LR), and last lumbar vertebra (LLV) fat depth were collected for each carcass. One 2.54 cm loin chop was collected 6 d post-harvest from each carcass. Actual 10th rib fat depth and LEA were

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measured across cut surface of each chop, along with a subjective assessment of pork quality scores (color, texture, and firmness). Pounds of fat free lean (FFL), percent fat free lean (% FFL), and U. S. Grade were calculated for each carcass. A trained sensory panel was utilized to evaluate the cooked chops for juiciness, tenderness, and pork flavor. Using the MIXED Procedure of SAS (SAS Inst. Inc., Cary, NC) with the individual hog as the experimental unit, the study was analyzed as a 2 × 2 factorial with gender (barrows and gilts), feed type (diet 1 or 2) and their interaction as the fixed effects.

Results: Barrows were faster growing with a greater ADG ($P < 0.05$) and were numerically 1.51 kg heavier ($P > 0.05$). No differences were observed between diet 1 and 2 for live weight ($P = 0.37$) and ADG ($P = 0.29$). Numerically, gilts had larger LEA, lower DP, and greater FFL ($P > 0.05$). Barrows had numerically heavier HCW and greater MS ($P > 0.05$), but were fatter opposite the FR, LR, LLV, and 10th rib, and calculated lower %FFL and higher U. S. Grade ($P < 0.05$). There were no differences in HCW between gender and diet ($P = 0.28$; $P = 0.22$). Hogs fed diet 1 had numerically heavier HCW, less fat over LLV, larger LEA, and calculated greater FFL, %FFL, and lower U. S. Grade ($P > 0.05$). Gender or diet had no impact on quality attributes or 1 hr, 3 hr, and 24 hr pH values. Panelists detected a greater initial/sustained juiciness and sustained tenderness in loin chops from gilts fed diet 1 and barrows fed diet 2 ($P < 0.05$). Gilts fed either diet 1 or diet 2 along with barrows fed diet 2, had a more desirable pork flavor compared to barrows fed diet 1 ($P < 0.05$). Real-time ultrasound results indicated that actual and ultrasonic measurements of 10th rib fat depth and LEA were moderately correlated ($r = 0.43$).

Conclusion: Data suggest carcass merit and production were maximized by both diet and gender, and quality attributes of flavor and tenderness that are highly expected among consumers were not affected.

Keywords: carcass characteristics , commercial crossbred swine, meat quality , pork

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EFFECTS OF FEEDING DE-OILED WET DISTILLERS GRAINS PLUS SOLUBLES ON BEEF FATTY ACID PROFILES

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Objectives: This research was conducted to determine the effects of feeding de-oiled wet distiller's grains plus solubles (WDGS) on the nutritional composition and fatty acid profile of beef.

Materials and Methods: Steers were fed one of seven dietary treatments: an all corn control, 35%, 50%, or 65% (DM basis) inclusion of WDGS, either full-fat or de-oiled. Steers were fed 8 per pen with six replications (42 pens total) for a total of 336 steers on feed. Fifteen Choice carcasses (2 - 3 head/pen) were selected within each treatment (n = 105) and strip loins were obtained. After 7 d aging, proximate analysis and fatty acid profiles were determined using powdered LM samples with no subcutaneous fat.

Results: No differences were found in moisture ($P = 0.44$), fat ($P = 0.36$), protein ($P = 0.11$) or ash ($P = 0.89$) content in beef. Significant ($P < 0.05$) differences were found in the C16:1, C18:1T, C18:2 and polyunsaturated fatty acids (PUFA) between the seven dietary treatments. The predominant fatty acid was C16:1 in the corn control and 35% de-oiled WDGS ($P < 0.0001$) but no differences were found between 50% and 65% de-oiled WDGS and all full-fat WDGS diets. C18:1T was least for the corn control, intermediate for all de-oiled WDGS, and greater for all full-fat WDGS diets (120.12 mg/100g, 185.13 mg/100g, and 250.93 mg/100g, respectively). C18:2 were least for corn control and 35% de-oiled WDGS (177.70 mg/100g and 227.16

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mg/100g, respectively), intermediate for 50% de-oiled WDGS (231.08 mg/100g), and greatest for 65% de-oiled WDGS and all full-fat WDGS diets (287.89 mg/100g, 294.87 mg/100g, 279.78 mg/100g and 301.36 mg/100g, respectively). PUFA content was different ($P = 0.0002$) among diets where the corn control cattle had the least amount of PUFA's (223.98 mg/100g), 35% and 50% de-oiled WDGS cattle were intermediate (273.77 mg/100g and 273.84, respectively), and 65% de-oiled WDGS and the three full-fat WDGS cattle had the greatest amount of PUFA's (335.03 mg/100g, 341.54 mg/100g, 324.15 mg/100g, and 347.79 mg/100g, respectively). No differences were detected in monounsaturated fatty acids (MUFA), unsaturated fatty acids (UFA), saturated fatty acids (SFA), SFA:UFA ratio, or total fatty acids ($P > 0.05$).

Conclusion: These findings confirm that feeding WDGS at finishing will increase the PUFA content of beef. However, feeding de-oiled WDGS at lower inclusion levels resulted in decreased PUFA content in relation to full-fat WDGS diets. The removal of the soluble fat portion of WDGS was effective at reducing PUFA content in meat and thus has the potential to reduce lipid oxidation in beef.

Keywords: beef, De-oiled WDGS, fatty acid profile, nutritional composition

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PROXIMATE COMPOSITION OF RAW AND COOKED AUSTRALIAN RETAIL LAMB CUTS

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Objectives: Several Australian lamb cuts are currently marketed in the U.S. USDA Food Safety Inspection Service requires nutrient labeling on major cuts available for purchase. Therefore, it is essential to develop nutritional data for the separable components of raw and cooked lamb cuts. The objective of this study was to evaluate the effect raw and cooked separable components of various lamb cuts originating from Australian meat processors on the proximate analysis of separable lean.

Materials and Methods: Lamb subprimals (n = 12) were shipped from Australian processors to Texas Tech University for fabrication into the following retail cuts: Frenched lamb rack, cap off, rib chops (RC); Frenched lamb rack, cap off, denuded rib chops (RCD); Frenched lamb rack, cap off, roast (RR); Frenched lamb rack, cap off, denuded roast (RRD); Tenderloin (TEN); Hind shank (HS); semi boneless leg with chump/top sirloin on, aitch bone removed, shank on (SB); and butterflied leg (BL). Retail cuts were randomly and evenly assigned to either raw or cooked analysis. Cuts assigned to cooking (grilling-RC and RCD; roasting- RR, RRD, TEN, SBL, and BL; braising- HS) were cooked according to protocols standardized by the USDA Nutrient Data Laboratory. Raw retail cuts, in addition to cooked retail cuts after 24 h of chilling, were dissected to yield separable components. The separable lean from each cut was cubed, frozen in liquid nitrogen, homogenized,

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and stored (-80°C) for later analysis of proximate composition (ash, fat, moisture, and protein). The percent ash for each sample was determined by combustion using the AOAC ash-oven method (923.03). Percent moisture was evaluated using the AOAC-approved oven-drying method (950.46), while percent protein was assessed using the AOAC method 992.15. Analysis of total fat occurred using a modified chloroform:methanol method. All analyses were performed in duplicate and appropriate standard materials were used for validation. Differences in proximate variables among retail cuts were assessed using pair-wise comparisons.

Results: As expected, proximate composition varied for raw and cooked retail cuts derived from Australian lamb subprimals. Specifically, ash content of raw separable lean samples varied among retail cuts. However, the total fat content of separable lean did not differ among raw retail cuts ($P = 0.1311$). Among all raw samples, the moisture content of separable lean from raw RC samples was lowest ($P < 0.05$). Alternatively, the protein content of raw, separable lean was greatest ($P < 0.05$) for RC, while SB and TEN exhibited intermediate protein percentages. The ash, fat, moisture and protein contents of grilled lamb cuts did not differ ($P = 0.0686$, $P = 0.9547$, $P = 0.7633$ and $P = 0.2845$, respectively). Ash content of roasted lamb cuts varied; with TEN separable lean exhibiting the greatest ($P < 0.05$) amount, and RR and RRD the least ($P < 0.05$). Similarly, fat content varied among roasted lamb cuts, separable lean from roasted RR had the greatest ($P < 0.05$) amount of total fat. The moisture content of roasted RR and SB separable lean was lowest ($P < 0.05$) among roasted cuts.

Conclusion: These data indicate that the proximate analysis values of separable lean from raw, grilled and roasted lamb retail cuts varied. These variations will likely influence additional nutritional components and influence nutritional labeling of these retail cuts.

Keywords: labeling, lean, nutrition, proximate

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EVALUATION OF OBJECTIVE JUICINESS MEASUREMENT TECHNIQUES FOR PREDICTION OF SUBJECTIVE TASTE PANEL JUICINESS RATINGS

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Objectives: The objectives of this study were to evaluate the efficacy of objective juiciness measurements for prediction of subjective taste panel juiciness ratings for beef strip loin steaks and to develop prediction equations for beef juiciness utilizing objective measures.

Materials and Methods: Treatments were selected to create variation in juiciness and included five USDA quality grades (Prime, upper 2/3 Choice, lower 1/3 Choice, Select, and Standard) as well as two enhanced Select treatments (12% injection and 7% injection) and were prepared to three degrees of doneness (DOD) [rare (60°C), medium (71°C), and well-done (77°C)]. A consumer study (n=252 consumers; 84/DOD) and 36 (12/DOD) trained panels were conducted to evaluate palatability traits on a 10 cm, verbally anchored line scale. Panelist ratings were averaged for each sample. Instrumental techniques evaluated on raw samples included marbling, L*, a*, b* values, percent fat, moisture, and protein, drip loss, expressible moisture, water holding capacity, Carver press compression values, water activity and water binding ability. Cooked techniques evaluated included cook loss, drip loss, expressible moisture, Carver press compression, slice shear force (SSF), pressed juice percentage (PJP) and fat percentage in expressed PJP fluid (FE).

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Immediately following SSF sample removal, a 1-cm thick slice was taken across the steak width directly medial to the SSF sample and cut into three 1-cm pieces parallel to the muscle fibers. Each sample was compressed between two pieces of VWR 415 filter paper for 30 seconds at 8-kg pressure using an Instron, Model 5542. The percentage of juice lost during compression was quantified as PJP. This compression-based method allowed for both an objective tenderness and juiciness score to be determined from a single steak.

Results: Correlation analyses were used to identify and quantify relationships among instrumental measurements and consumer juiciness (CJ), consumer overall like (CO), trained panel initial juiciness (TI), and trained panel sustained juiciness (TS). Of objective measures evaluated, the strongest correlation ($P < 0.05$) with sensory ratings occurred between PJP and CJ ($r = 0.45$), TI ($r = 0.69$) and TS ($r = 0.67$). Also, FE was positively correlated ($P < 0.05$) with CJ ($r = 0.39$), TI ($r = 0.34$) and TS ($r = 0.37$). Positive correlations ($P < 0.05$) occurred between cooked expressible moisture and CJ ($r = 0.41$), TI ($r = 0.64$) and TS ($r = 0.62$). Percent fat and marbling were positively correlated ($P < 0.05$) with CJ ($r = 0.37, 0.33$), CO ($r = 0.24, 0.21$), TI ($r = 0.23, 0.21$) and TS ($r = 0.26, 0.24$), respectively. Regression analysis indicated TI was predicted ($P < 0.05$) by the equation: $TI = -11.46 + 2.91 \times PJP$ ($r^2 = 0.48$). The equation $TS = -18.10 + 2.94 \times PJP$ explained 45% of the variation in TS ($P < 0.05$). Moreover, CJ was predicted by the equation $CJ = 31.21 + 1.50 \times PJP$ ($r^2 = 0.20$).

Conclusion: Results of this study indicate PJP as a predictor of beef juiciness, explained 48%, 45%, and 20% of the variation in TI, TS, and CJ scores, respectively. The ability to objectively measure both tenderness and juiciness allows for better prediction of overall beef palatability and consumer beef eating satisfaction.

Keywords: beef, compression, juiciness, prediction, slice shear force

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ASSESSMENT OF OBJECTIVE MEASURES OF BEEF STEAK JUICINESS

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Objectives: The objective of this study was to evaluate raw and cooked beef objective measurement techniques for juiciness that may be used simultaneously with current industry objective measurements of beef tenderness.

Materials and Methods: Treatments were selected to create variation in juiciness including: USDA Prime (PR), upper 2/3 Choice (TC), lower 1/3 Choice (LC), Select (SE), and Standard (ST) as well as two enhanced Select treatments (12% (HE) and 7% (LE) injection of a water, salt, and alkaline phosphate solution). After aging (21 d), strip loins were cut into 2.5-cm thick steaks and frozen (-20°C). Steaks were thawed (2 to 4°C) for 24 h before raw objective measurements or cooking. Steaks were cooked on a belt grill to three degrees of doneness (DOD); rare (60°C), medium (71°C) and well-done (77°C) and had a three min rest period prior to cutting. Instrumental techniques evaluated on raw samples included marbling, pH, percent fat, drip loss (DL), expressible moisture (EM), water holding capacity and water binding ability (WBA). Cooked techniques included cook loss, DL, EM, slice shear force (SSF), pressed juice percentage (PJP) and fat percentage in expressed PJP fluid (FE). Immediately following SSF sample removal, a 1-cm thick slice was taken across the steak width directly medial to the

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SSF sample and cut into three 1-cm pieces parallel to the muscle fibers. Each sample was compressed between two pieces of VWR 415 filter paper for 30 sec at 8-kg pressure using an Instron, Model 5542. The percentage of juice lost during compression was quantified as PJP. The weight of the dry matter remaining in the filter paper after drying overnight at 100°C was quantified as FE.

Results: A treatment×DOD interaction was found for SSF ($P < 0.05$). When cooked to rare, PR, TC, SE and ST samples were similar ($P > 0.05$) for SSF. When steaks were cooked to well-done, SSF values tended to decrease ($P < 0.05$) with increased fat levels of non-enhanced samples. Few differences among treatments were found for PJP, with HE having the greatest ($P < 0.05$) value and PR greater ($P < 0.05$) than ST. However, PJP tended to increase in non-enhanced samples with increased quality grade. Also, FE increased ($P < 0.05$) with increased fat percentage. Cook loss was greatest ($P < 0.05$) for SE and ST samples, and decreased with increased marbling levels. Few treatment differences were observed for cooked EM or DL. As DOD increased from rare to well-done, PJP, FE, and cooked EM decreased ($P < 0.05$) and cook loss increased ($P < 0.05$). A greater ($P < 0.05$) percentage of DL at 48 h was observed for rare samples. For raw samples, HE and LE had the greatest ($P < 0.05$) pH. Free water (%) and bound water (%) were inversely related, with HE having greater ($P < 0.05$) bound water (%) than TC, SE and ST. Additionally, HE and LE samples were greater ($P < 0.05$) than TC, LC and ST for WBA. Lastly, ST steaks recorded greatest ($P < 0.05$) 24 h and 48 h raw DL.

Conclusion: These results indicate that enhancement of beef steaks has the greatest potential for impacting factors contributing to juiciness. Additionally, DOD is of greater importance to measurements of juiciness over USDA quality grade. Therefore, enhancement and cookery methods should be considered as primary means to improve beef juiciness.

Keywords: beef, compression, juiciness, slice shear force, tenderness

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DISCRIMINATION OF BEEF DARK CUTTERS AND ENHANCED QUALITY PORK USING VISIBLE AND NEAR INFRARED SPECTROSCOPY

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Objectives: This study examined the potential of visible and near infrared spectroscopy (Vis-NIRS) to segregate dark cutters from normal beef and authenticate enhanced quality pork.

Materials and Methods: Vis-NIR spectra were collected using a portable LabSpec[®] 4 spectrometer (350-2500 nm, ASD) equipped with a fibre-optic high intensity contact probe on 120 steaks (at ~7/8th thoracic vertebrae) from beef carcasses (60 normal and 60 dark cutters) and 888 chops at the end of the loin from 148 pork carcasses subjected to different treatments: aged in a 1 °C cooler for 2 or 14 d (loins from both left and right half carcasses), moisture enhanced (ME) with standard salt (55.530%) and disodium phosphate (51.585%) brine or non-ME (left half carcass), and blast chilled (BC, right half carcass) at -20 °C with a 2.5 m/sec wind speed for 1 h and moved into a cooler at 2 °C for 23 h or conventionally chilled at 2 °C for 24 h (Non-BC, left half carcass). Partial least squares discriminant analysis (PLS2-DA, [1]) was applied on the raw spectra to classify samples between normal and beef dark cutters and between pork subjected to several treatments (2 vs. 14 d aged, Non-ME vs. ME, Non-BC vs. BC).

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Results: PLS2-DA based on Vis-NIR spectra correctly classified 95% of the beef samples from both normal and dark cutter carcasses, 90 and 95% of the 2 and 14 d pork samples, and 99 and 96% of the Non-ME and ME pork samples aged for 2 d, respectively. When pork loins were aged for 14 d, 95 and 94% of the Non-ME and ME samples were correctly classified, respectively. Conversely, when analyses were performed to discriminate BC pork samples from those that were conventionally chilled, Vis-NIRS technology only correctly classified 57 and 54% of the samples aged for 2 d, and 53 and 54% of the samples aged for 14 d for Non-BC and BC samples, respectively.

Conclusion: Vis-NIRS technology has the potential to objectively assist in segregating dark cutters from normal beef and to discriminate 2 vs. 14 d aged and moisture enhanced vs. non-moisture enhanced pork samples. Conversely, Vis-NIRS technology was not able to distinguish blast chilled pork samples from those that were conventionally chilled. This technology needs to be further tested for on-line applications in the abattoir, where portable equipment applied directly on the carcass may objectively assist in segregating dark-cutting beef carcasses for marketing purposes, and in the processing plants to authenticate enhanced quality pork.

Keywords: Blast Chilling, dark cutting, discrimination, moisture enhanced, Vis-NIRS

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USING DUAL ENERGY X-RAY ABSORPTIOMETRY FOR A RAPID, NON-INVASIVE CARCASS FAT AND LEAN PREDICTIONS IN BEEF CARCASS PRIMALS

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Objectives: The objective of this study was to evaluate the potential use of the dual energy X-ray absorptiometry (DEXA) technology for estimating total lean, fat and bone content of beef carcasses and main primal cuts.

Materials and Methods: A total of 158 crossbreed finished steers were used to build calibration equations. All steers were serially slaughtered from 300 to 800 kg of live weight and at ultrasound backfat depths from 2 to 20 mm. Following splitting of carcasses, hot carcass side weights were recorded. After chilling at 2°C for 24 h, left and right carcass sides were weighed to determine cooler shrink loss. Both carcass sides were knife-ribbed between the 12th and 13th rib. After a 20 min exposure to atmospheric oxygen, full blue tag Canadian grade data were assessed by two certified graders. Following industry standard cuts procedures, left sides of each carcass were broken down into Chuck (IMPS 113), Rib (IMPS 103), Long loin (IMPS 172A) and Round (IMPS 158A) primal cuts. Each primal cut was scanned with a Lunar iDXA unit (GE Lunar). After DEXA scanning, left primal cuts were full dissected into subcutaneous fat, intermuscular fat, body cavity fat, lean and bone and weighed by qualified personal. Total lean resulting from every single

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primal cut was bagged and rescanned with the iDXA unit. All statistical analyses were performed using SAS 9.3. The PROC REG was used to evaluate the relationship of the variables.

Results: Carcass weight (208.8-452.8 kg), grade fat (2.0-20.0 mm), estimated lean yield (50.0-62.0 %) and rib-eye area (52.0-114.0 cm²) values of the carcass population used in the present study were within the actual range of the Canadian beef carcass market. For each one of the primal cuts studied, the highest coefficient of determination (R^2) values were observed between DEXA fat content estimation and full dissection fat content while the lowest were found between the DEXA bone content estimation and bone content obtained in the full dissection (Table 1). The R^2 values obtained between the DEXA fat content and full dissection fat content were higher than 0.79 (Round), excluding the shank primal ($R^2 = 0.19$). The highest R^2 values for fat were observed for Rib ($R^2 = 0.92$), Flank ($R^2 = 0.87$) and Loin ($R^2 = 0.87$). Likewise, most of the DEXA lean content estimations were highly correlated with the lean content obtained through the full dissection. Concurring with the fat estimations, the highest R^2 values for lean were observed for Rib ($R^2 = 0.82$), Flank ($R^2 = 0.87$) and Loin ($R^2 = 0.82$). In addition, high overall carcass correlations between DEXA estimated content and full dissection content for fat ($R^2 = 0.96$) and lean ($R^2 = 0.86$) were found in the present study.

Table 1. Relationship (R^2) between DEXA values and traditional carcass cut-out of different primal cuts (n=158).

Beef primal	Fat	Lean	Bone
Chuck	0.858	0.754	0.485
Rib	0.923	0.818	0.636
Brisket	0.815	0.682	0.454
Flank	0.874	0.867	0.308
Shank	0.192	0.076	0.073
Loin	0.865	0.817	0.577
Round	0.788	0.602	0.288
Plate	0.860	0.799	0.270
Overall	0.958	0.862	0.520

Conclusion: The results of the present study suggest that DEXA technology has the potential to estimate beef quality traits such lean yield performance. However, further studies to obtain calibration curves and validate these are needed to increase prediction accuracy for use in beef populations.

Keywords: bone, DEXA, fat, lean, yield

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CUT AND COOKING METHOD EFFECTS ON BEEF FLAVOR ATTRIBUTES

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Objectives: Beef flavor has been defined as an important component of beef demand. Beef flavor, however, is not a “single” attribute, but is composed of multiple attributes. The beef flavor lexicon provided descriptive flavor attributes for intact beef muscle. Beef cuts and cooking method impact beef flavor; however, the effect of cut and cooking method on flavor attributes using the beef flavor lexicon have not been clearly examined. The objective was to examine the beef flavor attributes of four beef cuts from two Quality grades and high pH top loin steaks cooked to three different internal cook temperature endpoints using two cooking methods.

Materials and Methods: Sixteen USDA Top Choice and Select beef top loin steaks, top sirloin steaks, flat iron steak, and bottom round roasts were cut (steaks 2.54 cm thick and roasts 7 cm thick) and were cooked to either 58, 70, or 82°C. Steaks were cooked either on a gas grill or George Foreman grill (GF) and roasts were cooked either in a crockpot or roasted in an oven. Top loin steaks from high pH (>6.0;n=16) were cut and cooked as defined. Steaks and roasts were evaluated by an expert trained flavor descriptive attribute panel using the beef lexicon with the Spectrum® Universal 16-point scale (0 = none and 15 = extremely intense).

Results: Top loin steaks from high pH strip loins had ($P < 0.05$) higher fat-like flavor, lower sour basic taste, and slightly more chemical flavor than Select and Choice top loin steaks. Select top loin steaks had slightly

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higher ($P < 0.05$) medicinal and refrigerator stale flavors than high pH and Choice top loin steaks. Top loin steaks cooked on the gas grill were higher ($P < 0.05$) in beef identity, brown/roasted, fat-like, overall sweet, burnt, chemical, smoky charcoal, and smoky wood flavors, and salty and bitter basic tastes; and lower ($P < 0.05$) in musty-earthly/humus, sour dairy/sour cream, refrigerator stale, and warmed over flavors. As internal cook temperature increased, brown/roasted and burnt flavors increased, and bloody/serummy, metallic flavors decreased ($P < 0.05$). Top sirloin steaks cooked on the gas grill had higher ($P < 0.05$) brown/roasted, fat-like, burnt, and chemical flavors, and lower ($P < 0.05$) soured and musty-earthly/humus flavors than steaks cooked using the GF. As internal cook temperature endpoint increased, flavor was not affected ($P > 0.05$). Choice and Select flat iron steaks did not differ in descriptive flavor attributes. Flat iron steaks cooked on the gas grill had higher ($P < 0.05$) levels of brown/roasted, burnt, chemical, medicinal, and smoky charcoal flavors, and sour and bitter basic tastes, but lower ($P < 0.05$) levels of bloody/serummy, metallic, liver-like, and cardboard flavor. Select bottom round roasts were lower ($P < 0.05$) in liver-like and refrigerator stale flavors, and slightly higher ($P < 0.05$) in heated oil and green grassy flavor than Choice bottom round roasts. Bottom roasts cooked in a crockpot had lower ($P < 0.05$) bloody/serummy flavor than roasts cooked in an oven. As internal cook temperature endpoint increased, beef identity, brown/roasted, umami and liver-like flavors increased, and bloody/serummy and metallic flavors decreased ($P < 0.05$).

Conclusion: Beef flavor was affected by cut and cooking methods and by using the beef flavor lexicon differences in flavor could be detected. The Beef lexicon could help to control or maximizing positive flavors and develop new technologies in order to increase beef demand.

Keywords: beef flavor, beef lexicon

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IDENTIFYING CONSUMER PREFERENCES FOR DIFFERENT BEEF TYPES BASED ON FLAVOR

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Objectives: A recent study conducted to identify and evaluate beef flavor found that beef consumers were able to decipher and indicate preference for the flavor of beef samples resulting from various pre and post-harvest production practices. Despite this, there is not conclusive evidence indicating the proportion of consumers that prefer different flavor profiles and/or different classifications of beef. Therefore, the objectives of this study were to determine the preference for the flavor of beef resulting from various production practices among beef consumers, develop a true ranking of preference for these various beef sources using best-worst scaling methods, and identify the shares of preference for beef resulting from various production practices.

Materials and Methods: Beef strip loins, representing eight different beef product types were selected for inclusion in this study. The 8 product types were: 1) U.S. sourced grass-fed beef, wet aged 14 d (USGF); 2) Uruguayan grass-fed beef, wet aged 56 d (UGF); 3) USDA commodity Choice, wet aged 14 d (CH); 4) USDA Select, wet aged 14 d (SE); 5) USDA Prime, wet-aged 14 d (PR); 6) premium Choice (modest-moderate marbling), wet-aged 14 d (PCH); 7) dry-aged premium Choice (modest – moderate marbling; DA); 8) American Kobe-style beef (F1 Wagyu-Angus cross; slightly abundant or higher

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marbling), wet aged 14 d (AK). For each strip loin, the *Longissimus* muscle (LM) was isolated by removing all external fat, seam fat, and heavy connective tissue. For each treatment, samples were created by mixing and twice-grinding pieces of LM and forming them into one ounce ground beef patties. Patties were stored frozen and thawed prior to cooking them using a cast iron skillet heated to 230°C. Patties were cooked to an internal temperature of 74°C and held at 60°C until serving. Cooked samples were served to 120 consumers in three states (CO, CA, and OH; N = 360). Panelists were instructed to ignore variations in texture and juiciness between samples and to focus only on the flavor attributes for each sample. Each panelist was served 8 separate flights with each flight consisting of 4 of the 8 products followed by a 9th flight containing all 8 products. For each flight, consumers were asked to indicate only their favorite and least favorite sample. Best-worst scaling methods were used to determine the order of preference and shares of preference for each product type was computed using multinomial logit model.

Results: The order of preference for product types was: 1) AK; 2) PCH; 3) PR; 4) DA; 5) CH; 6) SE; 7) USGF; 8) UGF. The shares of preference were 19.0 %, 15.2 %, 14.4%, 13.5 %, 12.5 %, 12.0 %, 7.5 %, and 5.5 % for AK, PCH, PR, DA, CH, SE, USGF, and UGF, respectively.

Image:

Relative importance of specified beef type

Quality attribute	Shares of preference (%)			
	Colorado	Ohio	California	U.S.
Uruguayan grass-fed	6.4	5.2	4.7	5.5
Domestic grass-fed	8.1	7.5	6.7	7.5
Se -/+	12.5	10.8	12.6	12.0
Ch-	12.7	11.9	13.0	12.5
Ch o/+	15.5	15.9	14.2	15.2
Pr -/o/+	13.2	15.2	14.9	14.4
Ch o/+ w/ 21d dry age	15.1	12.1	13.2	13.5
American Kobe Style	16.1	20.8	20.3	19.0

Data was pooled from all states and analyzed.

Conclusion: Generally, products containing higher levels of marbling were preferred over product types with lesser amounts of marbling. The flavor of AK was the most preferred by consumers with a 20 % greater

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likelihood for preference over the next preferred product. Wet-aged PCH beef was preferred over DA with more than an 11 % increase in the likelihood of preference. Collectively, products resulting from predominantly grain-finished sources were much preferred over grass-finished products; however, 7.5 % of consumers preferred USGF and 5.5 % preferred UGF over all other beef products.

Keywords: Beef, Flavor, Preference

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FABRICATION YIELDS OF SERIALY HARVESTED HOLSTEIN STEERS

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Objectives: The objective of this study was to investigate the effect of Zilpaterol Hydrochloride (**ZH**) feeding on fabrication yields in Holstein steers fed over a 280 d period.

Materials and Methods: A 2 x 11 factorial treatment structure was applied in a randomized complete block design. Steers (n=110) were randomly assigned to one of two dietary treatments: a ration supplemented with ZH or a control ration (**CON**); within treatment, steers were randomly assigned to harvest groups of 254, 282, 310, 338, 366, 394, 422, 450, 478, 506 or 534 days on feed (**DOF**). Following a 48 h chill, carcass right sides were fabricated into primals, weighed and summed to achieve a chilled side weight (**CSW**). Primals were subsequently fabricated into subprimals (≤ 6 mm outside trim) from each carcass as follows: blade meat (109B), ribeye roll (112A), shoulder clod (114E), shoulder tender (114F), deep pectoral meat (115D), chuck roll (116A), chuck tender (116B), brisket (120), outside skirt steak (121C), inside skirt steak (121D), back ribs (124), short ribs (130) knuckle (167A), top round (169), outside round (170B), eye of round (171C), bottom round heel (171F), boneless strip loin (180), boneless top sirloin butt (184), bottom sirloin- flap (185A), bottom sirloin-ball tip (185B), bottom sirloin butt-tri-tip (185C), full tenderloin defatted (189A), flank steak (193), hanging tender, rose meat, fat, bone, and 80/20 trim via

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visual assessment. Salable yield (**SY**), fat (**FP**) and bone (**BP**) percentages were calculated by summing the weights of lean, fat and bone from each primal and expressing as a fraction of CSW. Data were analyzed via the MIXED procedure of SAS (SAS 9.3, SAS Institute, Cary, NC) with treatment and DOF included in the model statement as fixed effects and harvest facility as a random effect.

Results: Cattle fed ZH had 3.0% heavier CSW ($P < 0.05$), while simultaneously increasing SY by 2.09 % ($P < 0.01$) and decreasing BP and FP 0.96% and 1.33%, respectively ($P < 0.01$). Additionally, BP and SY decreased linearly ($P < 0.01$) with increasing DOF, while FP increased linearly ($P < 0.01$). Supplementation of ZH led to pronounced effects in the round with increases ($P < 0.01$) of 0.18 percentage units for the knuckle, 0.38 units for the inside round, 0.24 units for the bottom round, 0.05 units for the eye of round, and 0.08 units for heel; however, round yield decreased in a linear fashion ($P < 0.01$) across DOF.

Additionally, ZH supplementation increased yield of the strip loin by 0.11 percentage units ($P < 0.01$), 0.09 units for the tenderloin ($P < 0.01$), and 0.19 units for the sirloin top butt ($P < 0.01$). Interestingly, while the tenderloin decreased linearly ($P < 0.01$) across DOF, neither the strip loin nor the sirloin top butt decreased in a linear or quadratic fashion ($P > 0.10$). There were no treatment effects with ZH supplementation upon the ribeye roll, flank, or chuck-eye roll ($P > 0.10$), however, yield of the ribeye roll decreased quadratically ($P < 0.01$) with increasing DOF.

Conclusion: These data suggest that ZH supplementation significantly alters carcass weight and saleable product of valuable subprimals in Holstein cattle while concomitantly decreasing total carcass fat percentage and carcass bone percentage regardless of marketing endpoint.

Keywords: cutability, Holstein

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ANTIMICROBIAL INTERVENTIONS FOR BLADE TENDERIZED WHOLE MUSCLE NON-INTACT BEEF BONELESS STRIP LOINS: EVALUATION OF SHELF-LIFE AND SENSORY CHARACTERISTICS

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Objectives: During blade tenderization, blades can act as a vehicle for translocating surface pathogens into the sterile interior of the meat. The objective of this study was to evaluate the effects of two novel and two industry standard antimicrobial interventions on the quality and sensory characteristics of steaks from blade tenderized beef strip loins.

Materials and Methods: Twenty boneless beef strip loins were assigned to one of five treatments. Electrolyzed oxidizing water (pH 6.2-6.5, free chlorine concentration = 50 ppm) (EOW) and 0.2% levulinic acid plus 0.02% sodium dodecyl sulfate (LVA+SDS) were considered novel antimicrobial interventions while peroxyacetic acid at 200 ppm (PAA) and 4.5% lactic acid (LA) were considered industry standard antimicrobial interventions and blade tenderization with no antimicrobial intervention (CON) was used as a control. Treatments were applied to subprimals lean side up using a six-nozzle sanitizing cabinet equipped with a conveyor belt system. The automatic premixed spray treated all sides of the subprimal at a flow rate of 0.42 liters/min/nozzle, with a pressure of ~ 275.79 kPa as product advanced on conveyor belt. Following treatment, subprimals made a single pass through the mechanical tenderizer. Two steaks for warner-bratzler shear force (WBSF) and sensory analysis along with subprimals, were vacuum packaged, boxed and held (0±2°C) for an additional 4 days to simulate

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transportation and storage. Following 4 day storage, strip loins were cut into 2.54 cm thick steaks, which were randomly assigned 0, 1, 3, 5, or 7 days of shelf-life display, placed in Styrofoam trays, PVC overwrapped and then placed in coffin style retail cases ($4\pm 2^{\circ}\text{C}$, 1600-2100 lux) with 24 h luminescence. Steaks selected for sensory analysis and WBSF 4 days prior were frozen until further analysis. Steaks were collected on respective shelf life days for microbiological analysis (aerobic plate count) and lipid oxidation analyses (TBARS) along with trained subjective color and objective color CIE $L^* a^* b^*$, hue, chroma, 630/580 nm that was recorded on day 7 steaks. Data were analyzed using Proc Mixed of SAS. Subprimal identification within replication by treatment was included as the random variable. Main effects and all treatment by day interaction were tested when applicable.

Results: Peroxyacetic acid (200 ppm) and LA hindered ($P < 0.05$) psychrotrophic organisms growth more than EOW, LVA+SDS, and CON throughout 7 day display. There was no difference in lipid oxidation ($P > 0.05$) and objective color measurements ($P > 0.05$) among treatments. Discoloration increased during time in display for all treatments, however by day 3 PAA had the largest percentage of surface discoloration; However by day 5 all treatments were similar ($P > 0.05$). In all treatments, worst point color (WPC) increased during time in display. However, by day 7 LA ($P < 0.05$) had lower WPC scores than EOW and PAA but was similar to CON ($P > 0.05$). Panelist detected no differences in sensory characteristics between treatments; however, LA ($P < 0.05$) had greater WBSF values compared to PAA, CON, and LVA+SDS. Shear force for all treatments fell within USDA tenderness claim.

Conclusion: Results suggest that the two novel antimicrobial interventions would be acceptable to use on beef subprimals subjected to blade tenderization without detrimental effects to quality and shelf-life. **Keywords:** Antimicrobial, Beef, blade tenderization, sensory evaluation

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THE INFLUENCE OF GROWTH STAGE ON CARCASS COMPOSITION AND FACTORS ASSOCIATED WITH MARBLING DEVELOPMENT IN BEEF CATTLE

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Objectives: Both subcutaneous and intramuscular adipose increase in beef cattle during the feeding phase. However, these adipose depots are antagonistic in regard to their contribution to beef carcass value. Previous research in cattle has explored the presence or activity of various cellular factors and how these factors correlate to or impact marbling. Nonetheless, many of these factors have only been measured in finished cattle. Thus, a lack of knowledge remains as to how these factors change throughout the feeding phase and how they could potentially be manipulated to produce carcasses which are both high quality and cutability. Therefore, given that marbling is an early developing tissue, our hypothesis was that the cellular factors which influence marbling development are growth stage dependent. The objective of this study was to determine whether cellular factors associated with marbling development change with growth stage throughout the feeding period and whether they are correlated to marbling relative to carcass composition.

Materials and Methods: Twenty four steers of known origin with the CT leptin genotype were allotted to three harvest groups. Six steers per group were harvested at the following predetermined points: 35 days (d) on feed (early-feeding period; EF), average live weight of 464 kg (mid-feeding period; MF), and 1.17 cm 12th rib subcutaneous fat thickness

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(late-feeding period; LF). Longissimus muscle (LM) samples were collected within 30 m postmortem and snap frozen for real time PCR and western blot analysis of lipoprotein lipase, AMP activated protein kinase α (AMPK α), stearoyl-CoA desaturase (SCD), peroxisome proliferator-activated receptor γ (PPAR γ), CCAAT/enhancer binding protein β , and myostatin. Carcass data were recorded and LM samples were collected and aged 2, 7, 14, and 21 d postmortem for Warner-Bratzler shear force determination. Carcass composition was estimated by dissection of the 9-10-11 rib section and subsequent proximate analysis of the soft tissue.

Results: Intramuscular fat content of the LM increased linearly ($P < 0.0001$; $R^2 = 0.8373$) throughout the feeding period. As this increase began in the first stage of the feeding period, these results give additional support to marbling as an earlier developing tissue than previously believed. Expression of AMPK α was found to be down-regulated while SCD expression was up-regulated in the LF group relative to the earlier two harvest groups. Additionally, SCD and PPAR γ were down-regulated in the EF group relative to the latter two harvest groups. These changes in gene expression only resulted in a linear increase in PPAR γ protein abundance ($P = 0.0278$) and a trend for myostatin to increase in a linear fashion ($P = 0.07$). A correlation was found between intramuscular fat and PPAR γ abundance ($P = 0.04$, $R^2 = 0.2382$). Additionally, LF steaks were more tender than MF or EF steaks; indicating improved tenderness with increased days on feed.

Conclusion: This increase in PPAR γ abundance, coupled with the up-regulation of PPAR γ in the latter two harvest groups, gives further evidence of the importance of hyperplasia in increasing marbling. These results indicate targeting and increasing myostatin and PPAR γ expression may serve as a mechanism to increase marbling deposition in beef cattle.

Keywords: beef, Carcass Composition, fat, Growth, marbling

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DEVELOPMENT OF AN INTACT MUSCLE PORK FLAVOR LEXICON

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Objectives: Flavor impacts consumer perception and satisfaction in red meats, including pork. Identifying differences or levels of pork flavor attributes using trained, descriptive sensory panelists can assist the pork industry in understanding factors that affect consumer pork flavor attributes. However, a lexicon of pork flavor attributes needed to be developed and defined so that clearly delineated attributes can be measured across studies. The objective was to develop a pork flavor lexicon using intact muscle pork samples that varied in pork flavor attributes and were representative of pork present in the pork retail meat case.

Materials and Methods: Varying cooking temperatures, cooking technique, and cuts were used to induce differences in flavors and aromas. Various cuts of pork (center loin boneless and bone-in pork chops, whole tenderloins and medallions, enhanced boneless pork chops, fresh ham legs, shoulder roasts and pork chops, center loin roasts, non-enhanced and enhanced picnic roasts, and pork bellies) were purchased from a wide range of retail grocery stores. Pork chops were cooked to differing internal endpoint temperatures (57.2°C, 68.3°C, and 79.4°C) and whole tenderloins, fresh ham legs, roasts, and pork bellies were cooked to 62.7°C. A Presto flat griddle set at 400°F was used to cook pork chops and tenderloin medallions to emulate a high temperature cook method such as a commercial flat top grill. All other cuts were cooked using the braising method (product is seared in vegetable oil in a

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dutch oven over high heat then cooked in water on medium heat until product reaches its internal endpoint temperature) and the roasting method (product is cooked in an oven preheated to 325°F and cooked until the product reaches its internal endpoint temperature). The pork lexicon was validated using pork shoulder chops, tenderloin medallions, center loin boneless pork chops, and inside ham chops cooked to four different internal endpoint temperatures (62.7°C, 68.3°C, 73.8°C, and 79.4°C) and were cooked on a Presto flat griddle set at 400°F.

Results: Five highly trained panelists identified and defined a total of 25 aroma and flavor attributes in approximately 80 samples. Pork identity, brown/roasted, bloody/serumy, metallic, fat-like, astringent, and four of the five basic tastes were most prevalent in most samples. Other attributes were present in some samples, but these did not occur as frequently. For each attribute, the definition and training references were defined.

Conclusion: This lexicon can be used by trained, flavor descriptive attribute sensory panelists to examine the effect of various factors on pork flavor of intact muscle.

Keywords: flavor, lexicon, Pork, sensory evaluation

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SARCOMERE LENGTH DOES AFFECT QUALITY ATTRIBUTES OF DRY AND WET AGED STRIP LOIN

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Objectives: It's well known that dry-aged beef has a distinctive flavor that contrasts with the "wet aged" flavor, which is vacuum. However, this practice is almost unknown by beef cattle producers, processors, restaurants and consumers in Brazil. Besides flavor, tenderness of dry aged beef needs to be assured to fill the consumer satisfaction, and the sarcomere length plays an important role in sensorial and instrumental tenderness. The objective of this research was to investigate the effects of two aging methods (wet and dry) and 3 aging times (4, 11 and 18 days) on the physical and chemical properties of aged beef strip loins, primarily Warner Bratzler shear force (WBSF), and try to detect a relationship of sarcomere length at day 4 (SL) with WBSF in the three times of aging (4, 11 and 18 days).

Materials and Methods: At a packing plant, sections from bone-in strip loin (n = 16), 30 cm long (11th thoracic vertebrae to 2nd lumbar vertebrae), were collected randomly from beef carcass on the 3rd day *post mortem*. The sections were vacuum packed and shipped to the meat lab. In the next day, two steaks (2.5 cm) from the center of the section were collected to run analysis of day 4 (4 days *post mortem*). The two remaining halves were assigned randomly to the wet or dry aging treatment. Each one was halved and the resulting samples were assigned either to 11 days or 18 days. The wet aging sections were deboned prior

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to packaging. Both aging methods were performed in a chamber at 2°C and 60% relative humidity. At day 4, steaks were analyzed for pH, SL using laser diffraction, WBSF, moisture and fat content, and instrumental color (L^* , a^* , b^*). After 11 and 18 days of wet or dry aging, samples were analyzed for aging loss (moisture loss), trim loss, pH, WBSF, moisture and fat content, and instrumental color. The statistical analyses were performed by a 2 x 3 factorial ANOVA (2 aging methods and 3 aging times), and the means were compared by the Tukey test ($P < 0.05$).

Results: There was no interaction ($P > 0.05$) between method and time of aging for pH, WBSF, moisture, fat, and color, however there was interaction for age loss ($P < 0.05$). The pH, moisture, fat and color were not affected by method or time of aging ($P > 0.05$), and the average values were 5.6 for pH, 72.9% for moisture, 4.2% for fat, and 34.5, 20.5 and 16.9 for L^* , a^* , b^* , respectively. The average of SL for the sixteen samples was 1.66 μm , which ranged from 1.35 to 1.83 μm . Aging loss was similar to samples aged for 11 and 18 days in vacuum pack (0.7%; $P > 0.05$). However, when samples were dry aged, the increasing time of aging increased the losses (11 days = 6.6% and 18 days = 10.6%; $P < 0.05$). Trim loss was evaluated only for dry aged samples, and it was not affected by aging time ($P > 0.05$; 6.5%). There was no difference for WBSF between aging methods (7.0kg; $P > 0.05$). However, as the aging time increased, the steaks have tenderized (4 days = 8.1kg, 11 days = 6.7kg and 18 days = 5.5kg; $P < 0.05$). At day 4 and 18 of aging, the simple correlation coefficients between SL and WBSF, although noticeable were not significant (-0.35 and -0.40, respectively; $P > 0.05$). However, at day 11, the correlation was high, negative, and significant (-0.74; $P < 0.05$).

Conclusion: These data suggest that the sarcomere length measured at day 4 of aging could be a good indicator of tenderness either for wet or dry aged beef, when both are aged by 11 days, but not for 18 days.

Keywords: beef tenderness, dry aging, sarcomere length

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ESTIMATION OF CARCASS COMPOSITION USING RIB DISSECTION OF CALF-FED HOLSTEIN STEERS SUPPLEMENTED WITH ZILPATEROL HYDROCHLORIDE

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Objectives: A serial harvest was conducted every 28 d from 254 to 534 days on feed (DOF) to quantify changes in growth and composition of calf-fed Holstein steers (n = 110, initial BW = 449.2 ± 19.9 kg).

Materials and Methods: One-half were supplemented with the β -2 adrenergic agonist zilpaterol hydrochloride (ZH; 8.33 mg/kg 100% DM basis) during the final 20 d followed by a 3 d withdrawal prior to harvest with the remainder fed a control (CON) ration. Five steers were randomly selected out of the contemporary group and harvested after 226 DOF which served as a reference point for modeling purposes. Carcasses were fabricated into industry standard cuts and later thoroughly ground, mixed, and subsampled for proximate analysis. Moreover, following the traditional method of rib dissection which includes the 9th, 10th, and 11th rib contained within the IMPS 103 primal, the relationship of chemical composition of rib samples and carcass soft tissue was evaluated. Using the REG procedure in SAS (SAS 9.3., SAS Institute, Cary, NC), models were calculated that may be used to better describe the relationship of rib dissection (RD) composition including separable lean (RD_{SL}), separable fat (RD_{SF}), separable bone (RD_{SB}), ether extract (RD_{EE}), protein (RD_P), moisture (RD_M), and ash (RD_A) with carcass composition.

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Results: Ranges for RDSF, RDSL, and RDSB were 7.2 to 27.6, 42.2 to 65.3, and 14.9 to 35.7, %, respectively. The ranges for chemical composition of RDM, RDP, RDEE, and RDA were 35.3 to 66.2, 9.9 to 26.5, 14.6 to 52.7, and 0.2 to 2.7, %, respectively. Ranges for carcass fat (CF, %), lean (CL, %), and bone (CB, %) were 7.9 to 31.5, 56.9 to 72.4, and 12.5 to 24.1, %, respectively. Chemical composition of the carcass ranged from 14.5 to 37.3, 7.4 to 23.3, 46.1 to 72.3, and 0.6 to 1.3, % for carcass ether extract (CEE), protein (CP), moisture (CM), and ash (CA) respectively. Prediction of CF was estimated using an equation with an R^2 of 0.42 and root mean square error (RMSE) of 0.04 { $CF = 0.057 + (0.828 * RDSF) + (0.01 * ZH$ (dummy variable where 0 d = 0; 20 d = 1))}. Prediction of CL was estimated using an equation with an R^2 of 0.26 and RMSE of 0.02 { $CL = 0.42 + (0.375 * RDSL) - (0.007 * ZH)$ }. Prediction of CB was estimated using an equation with an R^2 of 0.23 and RMSE of 0.02 { $CB = 0.125 + (0.264 * RDSB) - (0.004 * ZH)$ }. For prediction of CM, an equation was developed with an adjusted R^2 of 0.51 and an RMSE of 0.04 { $CM, \% = 0.276 + (0.593 * RDM) + (0.002 * ZH)$ }. Prediction of CEE included an equation with an R^2 of 0.51 and RMSE of 0.04 { $CEE, \% = 0.096 + (0.483 * RDEE) - (0.002 * ZH)$ }. For prediction of CA an equation was developed with an adjusted R^2 of 0.15 and RMSE of 0.001 { $CA, \% = 0.007 + (0.208 * RDA) + (0.0001 * ZH)$ }. For prediction of CP, the overall f test was not significant ($P = 0.91$) and therefore non-estimable.

Conclusion: Overall, the relationships quantified and equations developed in this investigation do not support use of 9/10/11 rib dissection for estimation of carcass composition of calf-fed Holstein steers.

Keywords: Beef, Carcass Composition, Zilpaterol Hydrochloride

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DETERMINATION OF THE OPTIMAL CIRCUMFERENCE OF CUBE ROLLS FROM NEW ZEALAND GRASS FED CATTLE

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Objectives: Many factors have been shown to influence the economic return that is received for the products of a carcass. It is of vital interest for producers to get a maximum return for the cuts that are produced. Previous literature has shown the main determinants of economic return of the carcass are meat yield and distribution. Currently, cube rolls in New Zealand are sorted based on weight, and discounts can be applied when cube rolls reach a certain threshold (>4.5 kg). Discounts are applied based on the assumption that heavier cube rolls will produce heavier steaks when fabricated to a constant thickness. However, we believe that not only the circumference of cube rolls, but also the length contributes to increased weight. The objective of this experiment was to determine the ideal circumference of cube rolls necessary to obtain the maximum number of 250 g steaks when cut to a constant thickness of 25 mm.

Materials and Methods: Circumference was measured at the center as well as the anterior and posterior ends of cube rolls (Handbook of Australian Meat #2244) to determine the greatest circumference along the length of the sub-primal. Prior to packaging, cube rolls (n=39) were selected based on the measurement of greatest circumference to represent the following thirteen measurements: ≤ 35.5 , 36, 36.5, 37, 37.5, 38, 38.5,

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39, 39.5, 40, 40.5, 41, and 41.5 cm. Cube rolls were cut manually into 25 mm steaks starting at the anterior end of the cube roll using a standardized cutting guide. Steaks were weighed, and weight was recorded according to position of the steak. Data were analyzed using the mixed procedure of SAS (version 9.3, SAS Inst. Inc., Cary, NC) with circumference as the fixed effect.

Results: The predominate weights of cube rolls having a circumference \leq 35.5, 36, 36.5, 37, 37.5, 38, 38.5, 39, 39.5, 40, 40.5, 41, and 41.5 cm were 200-250 (79%), 255-300 (58%), 200-250 (47%), 255-300 (64%), 255-300 (62%), 255-300 (56%), 255-300 (38%), \geq 300 (46%), \geq 300 (69%), 255-300 (49%), 255-300 (54%), \geq 300 (59%), and \geq 300 g (81%), respectively. The correlation procedure was used to generate Pearson correlation coefficients to determine the relationships between carcass side weight, sub-primal weight, length, and circumference. The correlation value between carcass weight and cube roll weight ($r=0.72$) indicated that heavier carcasses had heavier cube rolls. A similarity of the relationship between cube roll weight and length ($r = 0.54$) and the relationship between cube roll weight and circumference ($r = 0.51$), suggested that neither trait contributed more to increased sub-primal weight. Steak weight typically increased, as cube roll circumference increased ($P < 0.05$). With the exception of 36.0 cm circumference steaks that had an average weight of 266.5 g, when the circumference of cube rolls were ≤ 36.5 cm average steak weight was ≤ 250 g. When circumference of cube rolls measured 37.0 to 39.0 cm average steak weights ranged from 250 - 300 g. Furthermore, average steak weight was typically over 300 g, when cube roll circumference was greater than 39.0 cm.

Conclusion: This information could be used to revise the sorting system of cube rolls to include dimensional attributes as opposed to weight alone. Discounts could be minimized while also generating the maximum number of 250 g steaks when cut to a constant thickness of 25 mm.

Keywords: correlation, measurement, meat quality, yield

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EFFICACY OF DETERGENT AND QUATERNARY AMMONIUM SANITIZER ON SHIGA-TOXIN PRODUCING *ESCHERICHIA COLI* (STEC) ATTACHED TO STAINLESS STEEL

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Objectives: The objective was to determine the efficacy of a detergent and quaternary ammonium based sanitizer (QAS) to remove STEC attached to stainless steel (SS) coupons. Understanding how STEC from serogroups *Escherichia coli* O26, O45, O103, O111, O121, O145 and *E. coli* O157:H7 grow and interact while in the food processing environment is important to beef safety. Our hypothesis was that the efficacy of using both detergent and QAS against STEC on SS will vary depending on strain tested and will result in biomass removal.

Materials and Methods: Seven strains (one from each serogroup) previously determined to have a strong affinity for attachment were used in this study. Strains were used to inoculate 2.2 cm² SS coupons in M9 minimal salt media and incubated at 25°C for 24 h. Coupons (n=5/strain) were rinsed to remove loosely attached cells and assigned to treatment (no treatment, control (water/water), detergent (detergent/water), sanitizer (water/sanitizer), or detergent/sanitizer combination. Treatments were applied by immersion with a contact time of 5 min for each step and a sanitizer concentration of 200 ppm. Coupons were rinsed, dried, and crystal violet was applied. Crystal violet was removed from the coupon and solution absorbance at 590 nm was measured.

Results: Significant differences ($P < 0.0001$) were found among treatments. All treatments significantly reduced bacteria present as compared to the untreated coupons. The detergent/sanitizer

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combination resulted in the largest reduction of attached bacteria and was significantly ($P = 0.018$) more effective than a control rinse of only water. Differences in strain ($P < 0.0001$) were also observed, although this was expected as previous research has noted differences in ability to attach and form biofilms between strains.

Conclusion: These results illustrate a complete sanitation program including both detergent and quaternary ammonium based sanitizer can help to remove STECs attached to surfaces of SS. However, there is evidence that while the attachment was reduced, it was not eliminated. This study used an approved sanitizer concentration for food contact surfaces and coupons were treated by immersion only. Further research is needed to understand how removal of these bacteria occur under varying environmental conditions, such as other equipment surfaces, varying temperatures, and when different concentrations of sanitizers are applied. It may be necessary to utilize additional interventions to fully remove all attached STECs on SS surfaces to prevent cross-contamination from one day to the next.

Keywords: Attachment, Sanitizer, Stainless Steel, STEC

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EFFICACY OF BUFFERED VINEGAR AND POTASSIUM LACTATE FOR CONTROLLING *LISTERIA MONOCYTOGENES* ASSOCIATED WITH COMMERCIALY-PREPARED, DELI-STYLE HAM AND ROAST BEEF DURING EXTENDED STORAGE AT 4°C

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Objectives: We evaluated the efficacy of buffered vinegar, a natural antimicrobial, to inhibit *Listeria monocytogenes* on commercially-prepared, deli-style ham and roast beef during extended refrigerated storage.

Materials and Methods: Cured ham and roast beef chubs (ca. 6 to 8 lbs. each) were formulated by a commercial processor to include buffered vinegar (1.0 to 2.5%), or a blend of potassium lactate and sodium diacetate (2.0% for ham or 3.0% for roast beef), or no antimicrobials. Ham and roast beef were sliced (ca. 1.25 cm thick) and subsequently surface inoculated on both the top and bottom faces to a target level of ca. 3.5 log CFU/slice with a five-strain cocktail of *L. monocytogenes*. The inoculated slices were placed into nylon-polyethylene bags, vacuum-sealed, and stored at 4C for up to 90 d. The pathogen was enumerated throughout refrigerated storage using the USDA package rinse/recovery method.

Results: When ham was formulated without any added antimicrobials, *L. monocytogenes* numbers increased by ca. 4.0 log CFU/slice over 90 d at 4C, whereas when 2.0% of a blend of potassium lactate and sodium diacetate was added to the formulation, pathogen numbers increased by ca. 3.4 log CFU/slice. In contrast, when 1.5% of buffered vinegar was added to the ham formulation, pathogen numbers remained unchanged after 90 d of storage at 4C, whereas inclusion of 2.0 or 2.5% of buffered

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vinegar as an ingredient reduced pathogens numbers by 1.1 and 2.0 log CFU/slice, respectively. Likewise, when roast beef was formulated without inclusion of any antimicrobials, *L. monocytogenes* numbers increased by ca. 5.3 log CFU/slice, whereas pathogen numbers increased by ca. 2.2 to 2.4 log CFU/slice when 1.0 or 1.5% of buffered vinegar or 3.0% of a blend of potassium lactate and sodium diacetate were added to the formulation. However, inclusion of 2.0 or 2.5% of buffered vinegar in roast beef decreased pathogen numbers by 0.7 and 1.2 log CFU/slice over 90 d of storage at 4C.

Conclusion: Results demonstrated that inclusion of 2.0 and 2.5% of buffered vinegar was noticeably more effective for inhibiting outgrowth of *L. monocytogenes* on the surface of ham and roast beef when compared to samples formulated with 3.0% of potassium lactate and stored over 90 d at 4°C. Thus, our results validated buffered vinegar as an alternative to “lactates” as an ingredient for controlling *L. monocytogenes* on surface of deli-style ham and roast beef during extended refrigerated storage.

Keywords: Antimicrobials, Buffered vinegar, Food safety, *Listeria monocytogenes*, Ready-to-eat meat

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EFFECT OF PACKAGING AND STORAGE TIME ON REDUCTION OF *LISTERIA MONOCYTOGENES* IN RTE MEAT SNACKS

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Objectives: The effects of two packaging types [heat sealed with O₂ scavenger (HSOS) and nitrogen flushed with O₂ scavenger (NFOS)] and four ambient storage times (0, 24, 48, and 72 h, and 14 d) on reduction of *L. monocytogenes* on five commercial RTE meats and poultry snacks were evaluated.

Materials and Methods: Three batches each of the five RTE meat and poultry meat snacks, namely, whole muscle beef jerky, beef tenders, beef sausage sticks, pork jerky, and turkey sausage sticks, were obtained from a local retail establishment. Samples were dipped into a five-strain *L. monocytogenes* cocktail, air dried at 24.0°C for 1-2 hours, packaged, and then enumerated for *L. monocytogenes* at 24, 48, and 72 h, and 14 d after packaging.

Results: Based on measured product characteristics, whole muscle and restructured jerky products had an a_w of ≤0.80, pH of ≤6.35, MPR of 0.71-0.75:1, and 5-26% fat content. Sausage sticks had an a_w of ≤0.91, pH of ≤5.10, MPR of 1.07-1.45:1, and 22-39% fat content. No growth of *L. monocytogenes* was observed on negative control samples. Initial level following inoculation of *L. monocytogenes* on beef jerky, beef tenders, pork jerky, beef sausage sticks, and turkey sausage sticks were 5.1, 4.7, 4.8, 3.8, and 3.7 log CFU/cm², respectively. No packaging by time interaction ($P > 0.05$) was observed for mean log CFU/cm² reduction of *L. monocytogenes* on all RTE products. Mean log CFU/cm² reduction on beef jerky and turkey sausage sticks was affected by time ($P < 0.05$)

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regardless of packaging type. Beef jerky achieved >1.0 log CFU/cm² *L. monocytogenes* reduction after 48 h storage, 0.81 log CFU/cm² at 72 h storage, but achieved a >2.0 mean log CFU/cm² reduction ($P < 0.05$) after 14 d HSOS or NFOS packaging. Regardless of packaging type, turkey sausage sticks achieved >1.0 mean log CFU/cm² *L. monocytogenes* reduction after 48 and 72 h ambient storage, and >2.0 log CFU/cm² ($P < 0.05$) after 14 d. In addition, beef tenders, pork jerky, and beef sausage sticks achieved pooled means of 1.78, 1.70, and 1.17 log CFU/cm² reduction of *L. monocytogenes*, respectively, regardless of packaging type and storage time.

Conclusion: Results suggest that turkey sausage sticks need at least 48 h of ambient storage to achieve >1.0 log CFU/cm² reduction of *L. monocytogenes*. Beef jerky would need to be stored at least 14 d to ensure a margin of safety for *L. monocytogenes* control. For products like beef tenders, pork jerky, and beef sausage sticks, a mean *L. monocytogenes* reduction of >1.0 log CFU/cm² would be achieved, regardless of packaging type and storage time.

Keywords: *Listeria monocytogenes*, packaging, storage, shelf-stable, poultry, beef, pork, jerky, sausage, ready-to-eat

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THE INFLUENCE OF MEAT PROPERTIES ON THE ATTACHMENT AND INTERNALIZATION OF SHIGA-TOXIN PRODUCING *ESCHERICHIA COLI* (STEC) IN BLADE TENDERIZED BEEF PRODUCTS

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Objectives: The threat of pathogen translocation in non-intact beef is a concern for beef processors; however, relatively little is known about the influence carcass and meat properties have on pathogen attachment and internalization. Therefore, the purpose of this study was to investigate the impact of pH and composition on the attachment and internalization of non-O157 and O157:H7 Shiga-toxin producing *Escherichia coli* (STEC) in blade tenderized strip loins using beef from dark cutting and non-dark cutting USDA Choice and Select carcasses. We hypothesized that pH and meat composition would impact pathogen attachment and translocation.

Materials and Methods: Carcasses were selected to represent four USDA grade (Choice and Select) and pH (dark cutter: 5.88 - 6.24; non-dark cutter: 5.31 - 5.26) treatment combinations. Paired strip loins obtained from each carcass were portioned into eight segments for inoculation (10^6 log CFU/cm²) with one of seven individual STEC serogroups (O157:H7, O26, O45, O103, O111, O121, and O145). After inoculation, strip loin segments were vacuum-packaged and stored for 14 d prior to blade tenderization and portioning into 2.54-cm thick steaks. Samples for enumeration of pathogen populations were obtained from the sub-primal surface (post-inoculation and post-storage) and steak surface (post-tenderization and portioning). In addition, steak

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cores were obtained under aseptic conditions after portioning for quantification of internalized pathogens.

Results: In support of the hypotheses, the data indicate USDA Quality grade and pH category had a limited influence on pathogen attachment to subprimals before or after 14 d of storage. However, samples taken after blade tenderization and steak portioning indicated a pH and Quality Grade influence on amount of pathogen internalization.

Specifically, steaks derived from USDA Select, dark-cutting strip loins had a greater number of STEC ($P < 0.05$) present on the steak surface - particularly for strip loins inoculated with O45, O103, O111, and O121. Although the amount of STEC present on the steak surface was influenced by meat pH, percent fat, and moisture, STEC populations from internal steak cores did not show a similar attachment and translocation pattern as the steak surface.

Conclusion: These results strengthen the body of evidence documenting the internalization of pathogens into blade-tenderized meat products. Furthermore, these data suggest pH and quality grade can influence the attachment of STEC to the surface of meat products.

Keywords: Beef, blade tenderization, *Escherichia coli*, pathogen, STEC

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EFFECT OF FERMENTATION AND COOKING TIMES AND TEMPERATURES FOR CONTROLLING SHIGA TOXIN-PRODUCING *ESCHERICHIA COLI* IN A DRY FERMENTED TYPE SAUSAGE

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Objectives: The objective of the present study was to evaluate typical fermentation and cooking parameters (i.e., time and temperature) to deliver a 5-log or a 2-log reduction of Shiga toxin-producing *Escherichia coli* (STEC) in a pepperoni-like, dry-fermented sausage and meet the USDA/FSIS performance standard for such products..

Materials and Methods: Coarse ground meat (25:75% beef:pork and 30:70% fat:lean) was purchased from a local vendor. The meat was mixed with a dry spice mix (3.69%), cure salt (3.60%), and a commercial starter culture (0.0188%; *Pediococcus acidilactici*) and inoculated with an 8-strain cocktail (ca. 7.0 log CFU/g) comprised of single strains of serotype O157:H7, O104:H4, O26:H11, O45:H2, O103:H2, O111:H-, O121:H19, and O145:NM of STEC. Next, the batter was fine ground (3/16" grinding plate), stuffed into a 55-mm fibrous casing, and subsequently fermented at 96°F (35.6°C) and ca. 85% relative humidity to a final target pH of 4.6 or 5.2. After fermentation, the pepperoni-like sausages were cooked to target internal temperatures of 100°F (37.8°C),

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110°F (43.4°C), 120°F (48.9°C), and 130°F (54.4°C) and held for 0.5 to 12.5 h. In each of two to four trials, three chubs were analyzed at each sampling interval for each treatment tested.

Results: Regardless of the cooking temperature, after fermentation to a target pH of pH 4.6 or pH 5.2, the endpoint pH ranged from ca. pH 4.5 to 4.7 and ca. pH 4.8 to pH 5.1, respectively, whereas regardless of the target endpoint pH, following cooking, pH decreased to ca. 4.0 to 4.4. When sausages were fermented to pH 4.6 or pH 5.2 and then cooked to 100° to 130°F and holding for 0.5 to 12.5 h, water activity of sausages ranged from 0.934 to 0.951. Regardless of the target endpoint pH, fermentation alone delivered a 0.33- to 1.58-log CFU/g reduction in pathogen numbers. However, sausages fermented to pH 4.6 required less time to achieve appreciable reductions of the STEC cocktail than otherwise similar sausages that were fermented to pH 5.2. Fermentation to ca. pH 4.6 followed by post-fermentation cooking to 100°, 110°, 120°, or 130°F and holding for 0.5 to 12.5 h generated reductions of ca. 1.0 to 2.4, 0.9 to 5.2, 1.6 to 7.0, and 0.9 to 6.7 log CFU/g, respectively. Likewise, fermentation to ca. pH 5.2 followed by post-fermentation cooking to 100°, 110°, 120°, or 130°F and holding for 1 to 12.5 h generated reductions of 0.3 to 1.4, 1.2 to 6.8, 0.5 to 6.5, and 1.0 to 6.7 log CFU/g, respectively.

Conclusion: Collectively, these data validated that fermentation to pH 4.6 or pH 5.2 delivered an approximate 5-log reduction in pathogen levels following post-fermentation cooking for 1 to 10 hours at 110° to 130°F. These data will be useful for manufacturers of dry-fermented sausages to validate/achieve the required reduction of STEC while producing a high-quality and wholesome product.

Keywords: Shiga toxin-producing *Escherichia coli*, fermented sausage, post-fermentation cooking, food safety.

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EVALUATION OF ANTIMICROBIAL EFFICACY OF CITRIC AND LACTIC ACID BASED TREATMENTS ON *ESCHERICHIA COLI* AND *SALMONELLA* SPP. REMOVAL IN FRESH BEEF STEAKS

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Objectives: Greater consumer interest and demand for safe beef products warrants the beef industry to constantly strive for novel and efficient decontamination applications to enhance beef microbial safety and quality. Despite advanced carcass decontamination systems, microbial status of fresh beef products remain exposed to additional contamination and therefore application of a decontamination step later in the production line may improve microbial security of the final product. Even though organic acids such as lactic and citric acids at 1 to 3% concentrations have widely been used in meat decontamination, the combined effect of citric and lactic acids in antimicrobial blends have not been extensively studied. Therefore, the objective of this study was to evaluate the antimicrobial efficacy of citric acid (CIT), lactic acid (LAC), a buffered blend of natural L (+) lactic acid-citric acid blend (LAC-CIT) all at 2.5% concentration, hydrochloric-citric acid blend (HCl-CIT) at pH 0.52 and sterile water (W) in removing attached bacteria from inoculated beef samples and compared to an inoculated control (INCON).

Materials and Methods: Steaks obtained from beef bottom rounds were inoculated with 10⁵ CFU/ml cocktail contained *E. coli* (EC) O157:H7, O26, O103, O111, O121, O45, and O145 and *Salmonella* Typhimurium (ST) DT 104, and *Salmonella* Newport MDR-AmpC. Following overnight storage at 4°C for further bacterial attachment, assigned

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antimicrobial treatments (n=36; 2 replicates/treatment) were sprayed on to both sides of inoculated beef steaks using an electrostatic sprayer (~0.1 ml/g). Treated samples, along with the untreated inoculated control (INCON), were placed on plastic foam trays and over wrapped with polyvinyl chloride film. The packages were stored under simulated retail conditions (4°C) until sampled on day 1, 2, and 3 of display for EC, ST, coliform (CO) and aerobic plate counts (APC).

Results: Although CIT and LAC treatments achieved over 1 and 2 log less CO and EC counts ($P < 0.05$) compared to INCON respectively on day 1 of display, the citric acid blends (LAC-CIT and HCl-CIT) outperformed those treatments resulting in over a 3 log reduction ($P < 0.05$). All treatments achieved significantly lower ($P < 0.05$) APC compared to INCON on days 1 through 3 of display. The citric acid blends along with LAC antimicrobial treatment showed significantly higher ($P < 0.05$) reduction in *Salmonella* populations when compared to all the other treatments on day 2 and 3 of display.

Conclusion: Therefore, citric acid blends may offer an economically feasible option to the beef industry for reducing pathogen loads in contaminated beef products. In addition electrostatic applications of these treatments allow efficient antimicrobial usage with less wastage. Further evaluations on the effects of these treatments in reducing individual strains of *E. coli* and *Salmonella* in meat products along with sensory color, texture and processing abilities of these treatments under un-inoculated conditions are needed.

Keywords: beef decontamination, microbial population, organic acids, *Salmonella*, STEC

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ESTABLISHMENT OF *SALMONELLA* AND *E. COLI* O157 PREVALENCE IN SHOW GOATS

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Objectives: Goat meat demand is increasing in the United States and plays an important role in the food supply system worldwide; however, there is limited data available about the microbial baseline in goats. Information is known about the baseline of these organisms in cattle, but less research has been published about their prevalence in small-ruminants. The objective of this study was to determine the prevalence of *Salmonella* and *Escherichia coli* O157 in goats.

Materials and Methods: A total of 24 show goats from a stock show in Texas were harvested at the Gordon W. Davis Meat Science Laboratory in Lubbock, TX over two days in late winter. At the time of slaughter, four types of samples were collected; hide swabs, fecal samples, lymph nodes (mandibular, mesenteric and subiliac) and carcass swabs at three timepoints (pre-evisceration, post-evisceration and post-intervention). Hide swabs were taken post exsanguination at one sampling location (rump). Fecal samples were collected aseptically from the gastrointestinal tract post-evisceration. Lymph nodes were trimmed from their respective locations during harvest. Carcass swabs were taken using one sponge swab at three locations during each sampling time (neck/brisket, flank and rump). Carcass swabs were enriched and analyzed using a rapid multiplex polymerase chain reaction (PCR) system, and cultured for confirmation of presumptive positives. Hide swabs and fecal samples were analyzed for *Salmonella* using two selective enrichment broths

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(Rappaport-Vassiliadis (RV) and Tetrathionate (TT)) and two different selective media (Xylose Lysine Tergitol 4 (XLT4) and Brilliant Green Sulfur (BGS) agars). Lymph nodes were, trimmed, boiled, pulverized and analyzed with standard immunomagnetic separation (IMS) procedures for *Salmonella*, then plated to two selective agars (Xylose Lysine Desoxycholate (XLD) and BGS) . In addition, hide swabs and fecal samples were enriched with Gram-negative broth with added antibiotics (8 µg/ml of vancomycin, 50 ng/ml of cefixime and 10 µg/ml of cefsulodin) to suppress background micro flora, analyzed for *Escherichia* O157 using standard immunomagnetic separation (IMS) procedures.

Results: *Salmonella* was detected in 4.17% (1/24) of hide swabs, 1.39% (1/72) of lymph nodes, and 4.17% (3/72) of carcass swabs. *Salmonella* was not detected in any fecal samples analyzed. *E. coli* was detected in 50% (12/24) of all fecal samples, and *E. coli* O157 was not detected in any of the hide swabs.

Conclusion: Overall, *Salmonella* prevalence was low but present in the hide swabs, lymph nodes and carcass swabs. While *Salmonella* was not present in any of the fecal samples, *E. coli* O157 was present in half of the fecal samples. These results indicate that *Salmonella* and *E. coli* O157 are present in goats and demonstrate a need for further studies to be done to determine if organism prevalence could be fluctuate by season, region or production practices.

Keywords: cabra, *Escherichia coli* O157, goat, *Salmonella*, small-ruminants

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AN INITIAL EVALUATION OF A NOVEL ANTIMICROBIAL SOLUTION ON FRESH MEATS

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Objectives: Food grade antimicrobial solutions may be incorporated into fresh meat products, as a marinade ingredient or direct application, to reduce foodborne pathogen contamination and extend the product shelf life of fresh meats. The objective of this study was to determine the effectiveness of a novel antimicrobial solution at inhibiting pathogenic bacteria growth on fresh beef top round steaks during storage at four sampling time points, 0, 6, 24, and 48 h.

Materials and Methods: An antimicrobial solution incorporating 2% chitosan, lauric arginate ester (2.14 $\mu\text{L}/\text{mL}$), and nisin (486 IU/mL) was directly applied to the surface of fresh top round steaks inoculated with either 4 or 6 log of *Escherichia coli* cocktail, Shiga Toxin-Producing *Escherichia coli* (STEC) cocktail, *Salmonella* spp. cocktail, or *Listeria monocytogenes* cocktail. The antimicrobial solution was applied at high (stock solution), medium (1:5 dilution in distilled water), and low (1:10 dilution in distilled water) concentrations and distilled water was applied as a control. Treated samples were refrigerated at 4°C until sampling at 0, 6, 24, or 48 h following application of the antimicrobial solution. Tukey pair-wise comparisons were performed in SAS version 9.2, with significance being determined as $P \leq 0.05$.

Results: No antimicrobial solution by time by pathogen interaction was found ($P = 0.07$). A pathogen by time interaction was observed ($P < 0.0001$) but lacks a practical application consistent with our objectives. An antimicrobial solution by time interaction was observed ($P < 0.0015$) as was an antimicrobial solution by pathogen interaction ($P < 0.0001$). Pathogen growth was inhibited by high, medium, and low

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concentrations of the antimicrobial solution at 0, 6, 24, and 48 h compared to water control treatment ($P < 0.0001$). Medium and high antimicrobial solution concentrations were more effective ($P < 0.05$) than the low concentration at the 24 and 48 h time points. Pathogen by time interaction demonstrated the antimicrobial solution effectively inhibited microbial growth across pathogens inoculated at the same level ($P > 0.05$) with differences observed for the water controls ($P < 0.001$).

Conclusion: The antimicrobial solution effectively inhibits the growth of pathogens on fresh beef. The required effective concentration of the antimicrobial solution decreases as the length of marination time increased. Additional research will be conducted to determine if meat quality and sensory properties are affected by the addition of the antimicrobial solution, and if effects are influenced by incorporating the antimicrobial with other marinade ingredients.

Keywords: Antimicrobial , *Escherichia coli* , *Listeria monocytogenes* , meat safety , *Salmonella* spp.

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EFFECTIVENESS OF INNOVATIVE SANITIZING PRODUCTS ON CONTROLLING *Listeria innocua* ON RETAIL DELI SLICERS

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Objectives: The objectives of this study were to assess the efficacy of quaternary ammonium chloride (QAC)-based wet and dry foam (WF and DF) sanitizer application methods (600 ppm) on reduction of *Listeria innocua* (a non-pathogenic surrogate of *Listeria monocytogenes*) on hard to clean and frequently touched areas of a retail deli slicer, as compared to traditional chlorine (Cl) treatment (200 ppm), to compare sanitizer surface contact times (10 min and 15 min) for pathogen surrogate control, and to develop recommendations from the findings of this study to enable retail deli meat operations to enhance safety by reducing overall pathogen load on retail deli slicers.

Materials and Methods: Over three replications, ready-to-eat (RTE) turkey frankfurters were blended with water to create a slurry which was then inoculated with *L. innocua*. The inoculated slurry was then used to inoculate seven high-risk sites on a commercial slicer by spreading on the surface with a Sponge-Stick. After 30 min attachment, slicers were wiped (to remove excess organic matter) but not washed or cleaned, followed by a randomly assigned sanitizer treatment. Slicer surfaces were then rinsed with distilled water and surviving *L. innocua* cells were differentially enumerated by plating on modified Oxford's (MOX) agar not containing antimicrobial supplement to allow repair and colony formation of sub-lethally injured *L. innocua* cells. Replicate-specific *L. innocua* reductions were calculated as \log_{10} CFU/cm² of control minus \log_{10} CFU/cm² of the enumerated survivors for each sanitizer-treated site. Least squares means of reductions were calculated with a $\alpha = 0.05$, using

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the general linear model of SAS. Significant differences were determined using the PDIFF function ($P < 0.05$).

Results: All three sanitizer treatments differed ($P < 0.05$) from each other with Cl producing the least reduction ($1.46 \log_{10}$ CFU/cm²) and WF the greatest reduction ($2.83 \log_{10}$ CFU/cm²). There was not an effect of sanitizer contact time on reductions of *L. innocua* observed; a significant ($P < 0.05$) site by treatment interaction was observed.

Conclusion: The results of the study indicate that QAC sanitizers (600 ppm) applied by both WF and DF were more effective at reducing *L. innocua*, from residual turkey slurry film than a traditional Cl sanitizer (200 ppm) on unwashed slicer surfaces.

Keywords: *Listeria monocytogenes*, Quaternary Ammonium Chloride, Retail Deli Slicer

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ORALLY INOCULATED *SALMONELLA* TYPHIMURIUM IS DETECTED IN THE LYMPH NODES AND SYNOVIAL FLUID OF SWINE

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Objectives: *Salmonella* is a foodborne pathogen that has been associated with illnesses from the consumption of meat products. Traditional carcass sampling techniques fail to account for contamination via atypical carcass reservoirs such as lymph nodes and synovial fluid that may harbor *Salmonella*.

Materials and Methods: This study was conducted twice utilizing pigs at weaning (n = 36 from Trial 1; n = 38 from Trial 2) that were orally inoculated with *Salmonella* Typhimurium (2×10^{10} CFU/pig) to investigate *Salmonella* migration from the gastrointestinal tract to peripheral lymph nodes and synovial fluid. Fecal samples were collected via terminal rectum swabs at 24, 48, and 72 h post-inoculation. Moreover, ileocecal, subiliac, popliteal, and mandibular lymph nodes as well as synovial fluid from the coxofemoral, shoulder, and stifle joints were collected at similar timepoints and cultured for the presence of the inoculated pathogen.

Results: *Salmonella* prevalence in feces tended to be greater in Trial 1 as compared to Trial 2 ($P = 0.06$; 52.78 vs. 31.58%). *Salmonella* prevalence

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in Ileocecal lymph nodes was 41.67% for pigs in Trial 1 and 37.00% for pigs in Trial 2. Both mandibular and subiliac lymph nodes were positive in 2.78% of pigs in Trial 1; however, inoculated *Salmonella* Typhimurium was not detected in these lymph nodes in Trial 2. Examination of synovial fluid revealed 2.63% of pigs were positive in all sampled locations in Trial 2 but was not different from synovial fluid from Trial 1 pigs ($P = 0.30$).

Conclusion: These results suggest it is possible for orally inoculated *Salmonella* Typhimurium to migrate to musculoskeletal lymph nodes and synovial fluid. Bacterial contamination of these tissues could lead to contamination of food products if not managed properly at the processing plant. However, further research is needed to elucidate how *Salmonella* Typhimurium infects these tissues to aid in the identification of pre-harvest interventions.

Keywords: lymph node, *Salmonella*, synovial

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SHIGA-TOXIN PRODUCING *ESCHERICHIA COLI* (STEC) SEROGROUPS EXHIBIT VARIED THERMAL SUSCEPTIBILITY IN MARINATED BEEF PRODUCTS

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Objectives: The translocation and post-cooking survival of Shiga-toxin producing *Escherichia coli* (STEC) serogroups in marinated beef is not well understood and is a concern for beef industry. As concern regarding six serogroups designated as the 'Big Six' STEC increases, determining the variation in exhibited characteristics among serogroups is of extreme importance. This study evaluated the post-cooking susceptibility of seven individual STEC serogroups (O157:H7, O26, O45, O103, O111, O121, and O145) which were used to surface inoculate beef sirloin flaps.

Materials and Methods: Beef bottom sirloin flaps (n = 4 per STEC) were inoculated (10^6 log CFU/cm²) with a multi-strain cocktail of each individual serogroup prior to vacuum tumbled marination (30 or 60 min) with a standard marination solution containing a food-grade dye. The dye was incorporated to track the migration of a marinade. Inoculated sections were stored at refrigeration for 14 d before cooking to four targeted internal temperatures (55, 60, 65, and 71°C) using a dry-heat method. After cooking and a three min rest period, sterile internal cores were removed and subjected to detection of surviving pathogens using a rapid-PCR based detection system. The experiment was completely randomized block design with a split-split-plot arrangement in which internal cooking temperature and marination length were independent variables, while post-cooking pathogen presence was the dependent variable of interest.

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Results: Broadly, the study results indicated significant variation in post-cooking survival among serogroups. Specifically, serogroups O26, O103, and O111 were detected in sirloin flap sections cooked to 55 and 60°C while O157:H7 was detected in samples cooked to 60 and 65°C. Among the seven serogroups, O145 was the only serogroup with confirmed pathogen survivability across all internal cooking temperatures while O121 and O45 were not detected in samples cooked to any temperature. The average cooking time for all serogroups cooked to an internal temperatures of 55, 60, 65, and 71° C were 5.32, 7.05, 7.78, and 8.87 minutes prior to resting for 3 minutes.

Conclusion: These data imply that although O157:H7 is often thought to be a suitable indicator of the characteristics and susceptibilities of other pathogenic STEC, the serogroups behave differently when exposed to similar stresses. Consideration of these variations should be implemented when determining appropriate intervention and cooking recommendations.

Keywords: Beef, Cooking, Marination, non-intact, STEC

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EVALUATION OF LACTIC ACID AND SODIUM METASILICATE AGAINST PATHOGENS OF CONCERN ON FRESH BEEF, PORK, AND DELI MEATS

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Objectives: An important aspect of the meat industry is food safety. Lactic acid is a “Generally Recognized As Safe” (GRAS) food additive commonly used in the meat industry. Sodium metasilicate is approved for antimicrobial use in ready-to-eat meat and poultry products. There is very little research about sodium metasilicate use on meat and meat products, especially in regards to pork and deli meats. The United States Department of Agriculture Food Safety and Inspection Service (USDA FSIS) has a zero tolerance policy for *L. monocytogenes* in ready-to-eat meat and poultry products. Spraying or dipping cured meats post-processing in organic acids has been proven to reduce *L. monocytogenes*. The purpose of this study was to determine if lactic acid and sodium metasilicate could effectively lower pathogenic bacteria on fresh beef and pork and deli meats.

Materials and Methods: Lactic acid 4% (LA, v/v), sodium metasilicate 4% (SM, w/v), and a distilled water control were applied to fresh beef and pork lean muscle and deli meats. Antimicrobials were mixed in solution with distilled water. Fresh meat of beef bottom round and pork ham steaks were cut into 100 cm² pieces. Roast beef, ham, and turkey deli meats were manufactured at the Lambert Powell Meat Laboratory without the use of antimicrobial solutions. Meat samples were cut to 100 cm² pieces. Each piece was individually inoculated and treated with the antimicrobial treatment assigned. Fresh meat pieces were inoculated with *Escherichia coli* O157:H7 (5 strains), non-O157 shiga-toxin producing

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Escherichia coli (STEC, 1 strain each of the “Big 6”), or *Salmonella* spp. (5 strains). Deli meats were inoculated with *Listeria monocytogenes* (5 strains). After 30 min of contact time samples were treated with the antimicrobial solution or control and then allowed 30 min of contact time. Half of the deli meat samples were vacuum packaged and treated in a hot water bath for 2 min at 90.6 °C. Samples were serially diluted and plated on MacConkey Agar with Sorbitol (*E. coli*), XLT4 (*Salmonella* spp.), or Modified Oxford Medium (MOX, *L. monocytogenes*). Data were analyzed using the PROC MIXED procedure of SAS and Tukey pairwise comparisons.

Results: In fresh meat samples, the control treatment resulted in greater microbial counts regardless of inoculum or species than either the LA or SM treatments ($P < 0.01$). Within species, the SM treatment was more effective at reducing *E. coli* O157:H7 contamination than the LA treatment ($P < 0.01$). Beef treated with LA had less *Salmonella* spp. than pork treated with SM ($P = 0.03$). The deli meat treatments including post-packaging lethality decreased the bacterial load of samples in comparison to those that did not receive the post packaging lethality treatment ($P < 0.01$). Regardless of post-packaging lethality treatments, there were no differences in microbial counts among treatment groups ($P > 0.73$).

Conclusion: Both lactic acid and sodium metasilicate can be applied to fresh beef and pork as an effective hurdle technology in the fight for food safety. Treating deli meats with lactic acid or sodium metasilicate did not reduce *L. monocytogenes* loads. However, adding a post-packaging lethality treatment was able to minimize microbial contamination.

Keywords: fresh meats, deli meats, lactic acid, sodium metasilicate, food safety

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AMP DEAMINASE INHIBITION EXTENDS POSTMORTEM GLYCOLYSIS

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Objectives: Postmortem energy metabolism drives hydrogen accumulation in muscle and results in a fairly constant ultimate pH, even across different species. Extended glycolysis results in adverse pork quality but is possible with greater adenonucleotide availability postmortem. Therefore, we hypothesized that retarding adenonucleotide removal through inhibition of AMP deaminase with pentostatin would extend glycolysis and lower the ultimate pH of muscle.

Materials and Methods: *Longissimus dorsi* samples from eight pigs were excised at 0 min postmortem and homogenized in an anaerobic glycolysis simulating buffer with or without 150 μ M pentostatin (AMP deaminase inhibitor). Aliquots were removed at 0, 30, 120, 240 and 1440 min to determine pH, glycogen, glucose 6-phosphate, lactate, ATP, ADP, AMP, and IMP concentrations.

Results: Pentostatin accelerated pH decline ($P = 0.02$), lowered ultimate pH ($P < 0.0001$), and increased lactate and glucose 6-phosphate with time ($P < 0.0001$) due to either elevated AMP ($P = 0.04$) or ADP ($P < 0.0001$). Based on these results and that AMP-activated protein kinase $\gamma 3^{\text{R200Q}}$ (RN⁻) mutated pigs are known to produce low ultimate pH pork, we hypothesized AMP deaminase activity and protein abundance would be lower in RN⁻ muscle compared to wild-type. *Longissimus dorsi* samples were taken from eight pigs of each genotype at 0, 30, 60, 120 and 1440 min postmortem to compare AMP deaminase activity and protein levels. RN⁻ muscle contained lower AMP deaminase abundance ($P = 0.03$) and lower AMP deaminase activity ($P \leq 0.02$) at 0, 30, 60 and 120 min.

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Conclusion: These data show that altering adenonucleotide availability postmortem can alter the extent of glycolysis and pH decline and suggests that AMP deaminase activity may contribute to the low ultimate pH of RN⁻ pork.

Keywords: AMP Deaminase, Glycolysis, Pork Quality, Ultimate pH

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STUDIES WITH THE HEME BINDING PROTEIN APOSHP SUGGEST HEMOGLOBIN IS THE PRIMARY PROMOTER OF LIPID OXIDATION IN PORK MUSCLE MINCE

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Objectives: Lipid oxidation is a process occurring in muscle foods during storage that leads to off-flavors and off-odors. The mechanism of lipid oxidation is not fully understood in muscle foods due to the interconnected nature of many chemical reactants and reactions. Identification of the primary promoter of lipid oxidation is important in understanding the mechanism and developing targeted antioxidant strategies. Hemoglobin (Hb) and myoglobin (Mb) promote lipid oxidation in muscle foods. Despite efforts to remove blood by post mortem bleeding, significant quantities of Hb remain. ApoShp is a heme binding protein that removes heme from Hb, not Mb, and inhibits lipid oxidation in fish and poultry muscle. This suggests Hb, not Mb, as the primary promoter of lipid oxidation in fish and poultry muscle. The objective of this research was to determine significance of residual Hb in promoting lipid oxidation in pork muscle using apoShp as a reagent that selectively inactivates Hb.

Materials and Methods: ApoShp was expressed in *E. coli* cells transformed by a pET(21) plasmid containing the Shp gene and purified. Ability of apoShp to remove heme from pork metHb was spectrophotometrically determined (n=2) in solution by observing absorbance shifts from 405nm (metHb peak) to 418nm (holoShp peak) during incubation at 0.2°C and pH 5.9. To investigate significance of residual Hb in promoting lipid oxidation in pork muscle, the *Semitendinosus* was selected as a model muscle. The muscle was trimmed

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to select the red portion, ground with a 5mm plate, and minced in a food processor. Heme content of the mince was determined by acid-acetone extraction. Lipid oxidation in stored mince (0.2°C, pH 5.9, n=2) with and without added apoShp was investigated by thiobarbituric acid reactive substances (TBARS) measurement. Statistical analysis employed the MIXED procedure of the SAS system.

Results: Promotion of lipid oxidation in the mince was affected by the presence of 1.5% NaCl at 0.2°C and pH 5.9. The 1.5% NaCl treatment achieved a significant increase in TBARS formation over the 0% treatment ($P = 0.0005$). By 241 hours of storage, TBARS in the 1.5% NaCl treatment reached 48.45 ± 2.45 $\mu\text{mol TBARS/kg mince}$, while TBARS in the 0% NaCl treatment reached 0.049 ± 0.069 $\mu\text{mol TBARS/kg mince}$, representing a 989-fold increase in TBARS formation ($P < 0.0001$). To determine the significance of residual Hb in promoting lipid oxidation in the mince, effect of a 2.5-fold excess of apoShp over total heme pigment content on TBARS formation in the mince was investigated in the presence of 1.5% NaCl. ApoShp significantly inhibited TBARS formation ($P = 0.0019$). By 131 hours of storage, TBARS in the apoShp treatment reached 0.490 ± 0.690 $\mu\text{mol TBARS/kg mince}$, while TBARS in the apoShp-free treatment reached 9.129 ± 0.439 $\mu\text{mol TBARS/kg mince}$, representing a 95% inhibition of TBARS formation ($P < 0.0001$). To determine ability of apoShp to remove heme from pork metHb, a 4-fold excess of apoShp over metHb was incubated with pork metHb, in the presence of 1.5% NaCl. Evidenced by a shift in absorbance from 405nm to 418nm, apoShp removed increasing quantities of heme from pork metHb over 91 hours.

Conclusion: These data suggest Hb, not Mb, as the primary promoter of lipid oxidation in pork *Semitenidinosus* muscle, and reinforce the importance of residual blood in postmortem muscle as a target for antioxidant strategies.

Keywords: blood, hemoglobin, muscle, oxidation, rancidity

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COMPARISON OF IODINE VALUE EQUATIONS AMONG PORK CARCASS FAT DEPOTS OF IMMUNOLOGICALLY CASTRATED PIGS

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Objectives: Iodine value (IV) is a commonly used measure of pork fat quality. Some pork processors have set a maximum IV level at 74 for differentiating acceptable and unacceptable pork fat quality. The AOCS (1998) and Meadus et al. (2010) equations are commonly used to calculate IV. The Meadus et al. (2010) equation includes more unsaturated fatty acids than the AOCS (1998) equation. Therefore, our objective was to determine the differences in IV estimates derived from these equations in jowl fat, backfat, and belly fat of immunologically castrated (*gonadotropin releasing factor analog - diphtheria toxoid conjugate*; Zoetis, Inc., Florham Park, NJ) pigs fed varying amounts of corn dried distillers grains with solubles (DDGS).

Materials and Methods: At 8 wk of age (WOA), pigs were assigned randomly to 1 of 4 dietary treatments, which were fed in 4 phases (Phase1 = 3 wk, Phases 2 and 3 = 4 wk each, Phase 4 = 5 wk) and included: positive control (PCon, pigs fed 0% DDGS in all phases), step down (SD; pigs fed 40%, 30%, 20%, and 10% DDGS in 4 phases, respectively), withdrawal (WD, pigs fed 40% DDGS in phases 1-3 and 0% DDGS in phase 4), and negative control (NCon, pigs fed 40% DDGS in all phases). Pigs were selected randomly (n = 2 per pen) at 13 WOA and harvested at 24 WOA for collection of subcutaneous jowl fat, backfat, and belly fat. Fatty acid composition was determined and IV

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calculated using AOCS (1998; IV-AOCS) and Meadus et al. (2010; IV-M) equations, along with the difference between these IV equations (IV-diff). Data were analyzed using pen ($n = 24$ per dietary treatment) as the experimental unit.

Results: There was no diet x fat depot x equation interaction ($P > 0.05$). As a result, each fat depot was analyzed individually. Jowl fat had higher ($P < 0.05$) IV compared to belly fat and backfat, and belly fat had greater ($P < 0.05$) IV compared to back fat (IV-M: 72.6, 69.5, 65.2 \pm 1.2, respectively; IV-AOCS: 69.4, 66.6, 62.4 \pm 1.2, respectively). All fat depots had greater ($P < 0.05$) IV-M than IV-AOCS, but the magnitude of difference changed depending on dietary feeding strategy and depot location. In belly fat and backfat, IV-diff was greater ($P < 0.05$) in pigs fed NCon compared to pigs fed PCon, SD, and WD (belly fat: 3.14 vs. 2.69, 2.77, and 2.81 \pm 0.13, respectively; backfat: 3.08 vs. 2.57, 2.81, and 2.63 \pm 0.11, respectively). Differences of IV among dietary treatments were most pronounced in jowl fat. Pigs fed NCon had greater ($P < 0.05$) IV-diff in jowl fat than all other dietary treatments. However, jowl fat of pigs fed WD and SD had greater ($P < 0.05$) IV-diff compared to pigs fed PCon (3.59, 3.16, 3.07, 2.67 \pm 0.09, respectively). As a result, the acceptability of fat quality depended on the fat depot and IV equation. All pigs fed NCon had IV-M > 74 regardless of fat depot. When IV-AOCS was calculated for backfat, pigs fed NCon had IV < 74 . Use of WD resulted in jowl fat IV-M = 74, but IV-AOCS was < 74 .

Conclusion: Use of IV-M resulted in greater differences among dietary feeding strategies than IV-AOCS because it included more unsaturated fatty acids in the equation. The use of different IV equations as an objective measure of pork fat quality and acceptability threshold does not lead to consistent pork fat quality assessment.

Keywords: backfat, belly fat, iodine value, jowl fat, pork

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ZINC METHIONINE ALTERS MUSCLE CROSS-SECTIONAL AREA AND FIBER TYPE OF HOLSTEIN STEERS FED ZILPATEROL HYDROCHLORIDE.

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Objectives: Zinc (Zn) has been shown to have allosteric binding sites on β_2 -adrenergic receptors (β -AR), enhancing agonist affinity, and inhibiting antagonist binding. Therefore, our objective was to determine the effect of supplementing a Zn methionine complex (ZINPRO[®]) during the last 115 d of feed, when zilpaterol hydrochloride (ZH) is fed for the final 20 d, with a 3-d withdrawal prior to slaughter on muscle fiber type, cross-sectional area, β -AR, and satellite cell density of calf-fed Holstein steers.

Materials and Methods: Steers (n = 211; initial BW = 468.5 \pm 0.5 kg) were blocked by weight and randomly assigned to pens and treatment: 1) Control; ZnSO₄ added to provide 90 ppm Zn, and 2) ZINPRO; control plus 720 mg Zn/hd/d provided by ZINPRO at the time of terminal implant. Steers were harvested at a commercial abattoir, and 20 steers per treatment were randomly selected for *semimembranosus* muscle immunohistochemistry analysis 0.5 h postmortem. *Semimembranosus* muscle samples were cryosectioned (10 μ m) and immunofluorescence stained. Myosin heavy chain (MHC) type-I, IIA, IIX were identified and area was measured. Total cell count, nuclei, β_1 - adrenergic receptor (β_1 AR), β_2 - adrenergic receptor (β_2 AR), β_3 - adrenergic receptor (β_3 AR) and satellite cell densities (mm²) were determined via Nikon imaging software analysis.

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Results: Myosin heavy chain-IIA and IIX cross-sectional areas were increased in ZINPRO fed cattle ($P < 0.05$). Cattle fed ZINPRO had a greater percentage of MHC-I fibers ($P < 0.05$) and tended to have a higher percentage of MHC-IIA fibers ($P < 0.10$). Control cattle had a higher percentage of MHC-IIX fibers ($P < 0.05$). Control cattle had a greater density of nuclei and less total muscle cells ($P < 0.05$). There was a greater density of cells expressing Pax7 ($P < 0.05$), and tendency for an increased density of β_3 AR and internalized β_2 AR in ZINPRO cattle ($P < 0.10$). Control cattle had a greater density of β_2 AR ($P < 0.05$).

Conclusion: Feeding ZINPRO altered muscle fiber type, and these changes may positively impact muscle hypertrophy and meat quality.

Keywords: zilpaterol hydrochloride, myosin heavy chain, zinc methionine, β -adrenergic receptor

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CHANGES IN PORK LOIN SARCOPLASMIC PROTEIN PROFILE IN RESPONSE TO CHILLING METHOD

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Objectives: Pork carcass chilling regimens are known to impact overall pork loin quality, notably tenderness. The purpose of the experiment was to determine how rate of pork carcass chilling alters the sarcoplasmic protein profile of the *Longissimus dorsi*.

Materials and Methods: The current experiment used 8 pork carcasses (86 to 91 kg; 54 to 57% fat free lean). At 40 min postmortem, one side from each carcass was placed in a rapid chilling (RC) or conventional chilling (CC) treatment. Treatments were defined with target 3 h postmortem loin temperature of 6.5°C (RC) and 20°C (CC). Sarcoplasmic protein samples from day 2 postmortem were used for two-dimensional difference in gel electrophoresis (2D-DIGE) to establish changes in the protein profile. Samples from RC and CC chilled sides from a single carcass along with a pooled internal sample were run on each gel (n = 8 gels run in duplicate). After 2D-DIGE, protein spots found to be different, along with other proteins of interest were identified using matrix assisted laser desorption/ionization time of flight mass spectrometry.

Results: Loin pH prior to chilling was not different due to treatment group (6.72 vs. 6.74). Differences in loin pork quality were indicated by lower 24 hr pH (5.79 vs. 5.70) and star probe values (7.10 vs 6.29) in the RC treatment. A total of 21 spots were identified as nine different

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proteins. These proteins included phosphoglucomutase-1 (6 spots), serotransferrin (1 spot), carbonic anhydrase-3 (2 spots), creatine kinase M-type (1 spot), beta enolase (2 spots), glyceraldehyde-3 phosphate dehydrogenase (3 spots), fructose bisphosphate aldolase A (2 spots), muscle glycogen phosphorylase (3 spots), and dihydrolipoamide dehydrogenase precursor (1 spot). In the RC group spots identified as being decreased in abundance included carbonic anhydrase-3 (2 spots) and beta enolase (2 spots), 8 to 12 percent ($P = 0.05-0.14$) and 17 to 27 percent ($P = 0.03$ to 0.04) respectively. Muscle glycogen phosphorylase (3 spots) was found to be increased in abundance in the RC group by 37 to 43 percent ($P = 0.02$ to 0.08). Identification of the same protein across multiple spots on a 2D-SDS-PAGE gel often indicates changes in the isoelectric point of the protein often caused by posttranslational modifications. Staining for phospho-proteins, a type of posttranslational modification, confirmed that phosphoglucomutase-1, muscle glycogen phosphorylase, and beta enolase are modified via phosphorylations. Posttranslational modifications such as phosphorylation of proteins results in multiple spots of a single protein. Indicating chilling treatment impacts the protein profile and perhaps the activity during the conversion of muscle to meat.

Conclusion: The data support the conclusion that protein profile can change in postmortem muscle due to chilling. It is most likely that these differences reflect treatment effect on protein degradation, denaturation, solubility, and alteration of phosphorylation. These data indicate the sarcoplasmic protein profile at day 2 postmortem changes in response to chilling treatments and this information can be used to understand how quality features are altered by accelerated processing procedures. This work was funded by National Pork Board Project 12-086

Keywords: 2D-DIGE, Pork Quality, Protein Profile

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EFFECTS OF MUSCLE TYPE AND DISPLAY TIME ON BEEF MITOCHONDRIA

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Objectives: Consumer purchasing decisions of beef are largely based on color, which is determined by the predominant form of myoglobin on the steak surface. Oxymyoglobin is associated with the consumer-preferred cherry-red color, and can be oxidized to metmyoglobin, resulting in brown discoloration. Mechanisms that limit oxidation can improve beef shelf life and color stability. In particular, mitochondria remain biochemically active in post-mortem muscle and can influence meat color by competing with myoglobin for available oxygen and providing reducing equivalents for metmyoglobin reduction. Differences in steak surface oxygen consumption and nitric oxide metmyoglobin reducing activity between muscle types have been documented. However, limited research has examined the role of mitochondria in muscle-dependent color stability. The objective of this study was to investigate the effects of muscle type on the oxygen consumption rate (OCR) and metmyoglobin reducing activity (MRA) of isolated mitochondria.

Materials and Methods: Using a split plot design, *Longissimus dorsi* (LD, n=6) and *Psoas major* (PM, n=6) muscles were fabricated into 1.91 cm steaks, packaged in polyvinylchloride overwrap, and randomly assigned to color measurement and mitochondrial isolation on day 0, 1, 3, 5 or 7 of display at 4°C. Steak color stability (CIE a* values) during display was measured using a HunterLab Miniscan XE Plus with Illuminant A and a 10° observer. Mitochondria were isolated from steaks and used to assess the effects of muscle type and display time on

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mitochondrial OCR and MRA. Mitochondria (2 mg/mL) were reacted with succinate (20 mM) or NADH (0.275 mM) and OCR was measured using a Clark electrode with a reaction chamber maintained at 25°C and pH 5.6. Bovine metmyoglobin (0.15 mM) and mitochondria (3 mg/mL) were reacted in the presence of succinate (20 mM) at pH 5.6 and 25°C and MRA was quantified by measuring the increase in ferrous myoglobin. Meat pH was determined using a 10 g muscle sample, 90 mL of deionized water, and an Accumet 50 pH meter. Data were analyzed using the MIXED procedure of SAS.

Results: There was no difference ($p > 0.05$) in pH and a^* values between muscle types on day 0 of display. However, the PM was less color-stable ($P < 0.05$) during display compared with the LD. There was a significant muscle type x time interaction for both mitochondrial OCR and MRA ($P < 0.05$). For both muscle types, OCR decreased during display, albeit the PM decreased more rapidly than the LD. Mitochondria from the PM had greater ($P < 0.05$) OCR at the beginning of display. However, mitochondria from LD steaks had greater ($P < 0.05$) OCR on days 5 and 7 of display due to more stable OCR for the LD. Similarly, MRA decreased during display regardless of muscle type. However, this decrease was less ($P < 0.05$) for mitochondria from LD steaks. As a result, mitochondria from the LD were more resistant to display-mediated effects on OCR and MRA.

Conclusion: The results from the current study indicate that mitochondrial activity during display differs between color-stable and color-labile beef muscles. More pronounced decreases in OCR and MRA during display in PM muscles likely contribute to its shortened shelf life. In contrast, the increased color stability of the LD is likely due in part to mitochondrial activity that is more resistant to display.

Keywords: Color , mitochondria, Myoglobin, Oxygen consumption

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HEAT SHOCK PROTEIN RESPONSE TO ACUTE HEAT STRESS IN THE PORCINE SEMITENDINOSUS MUSCLE

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Objectives: Heat stress (HS) is a threat to the efficient production of pork. Therefore, defining the physiological response to HS is of utmost importance to the swine industry. Heat shock proteins (Hsp) play a main role in the animal's response to HS. In postmortem muscle, Hsps may influence meat quality by delaying apoptosis. Hsp expression has been observed to be negatively correlated with certain meat quality attributes such as tenderness, juiciness, and color scores. The experimental objective was to determine the temporal effect of acute HS on Hsp27 and 70 abundance in the sarcoplasmic fraction of muscle.

Materials and Methods: Crossbred gilts (n=8/time point) were exposed to 0 hour thermal neutral (TN, 20°C, 40% relative humidity) or HS (37°C, 40% relative humidity) conditions for 2, 4, 6, or 12 hours with ad-libitum feed intake. At the conclusion of HS, gilts were euthanized and the semitendinosus was separated into red (RST) and white (WST) portions, and immediately snap frozen. Western Blot analyses were performed on sarcoplasmic protein extracts to measure the abundance of Hsp70, mitochondrial Hsp70 (mtHsp70), and Hsp27. Data were analyzed using a complete randomized block design with random effect of day. In addition to comparisons between individual treatments, a contrast statement was used to analyze the overall effect of HS on Hsp protein abundance.

Results: The main effect of HS treatment was not significant for mtHsp70 in the WST ($P = 0.23$). However, WST mtHsp70 abundance increased from 0 to 4 hours HS ($P < 0.05$). In the RST, mtHsp70

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abundance was significantly increased after 4 hours of HS, and declined thereafter ($P < 0.05$). One explanation for the observed increase in mtHsp70 in the sarcoplasmic fraction of the RST may be that the mitochondria release mtHsp70 into the sarcoplasm in response to HS. A subsequent decline in mtHsp70 abundance may be a result of chaperone activity causing mtHsp70 to be removed from the sarcoplasm. Hsp70 in the WST was significantly increased after 12 hours HS compared to all other time points ($P < 0.001$). In contrast, Hsp70 tended to be decreased in the RST as an overall response to HS ($P = 0.09$). These Hsp70 data demonstrate that the WST may respond more quickly to HS via Hsp70 synthesis. The main effect of HS treatment was not significant for Hsp27 in either the RST or WST. However, Hsp27 abundance in the RST tended to decrease from 0 to 4 hours of HS ($P = 0.12$) and subsequently increased between the 4 hour and 12 hour HS treatments ($P = 0.02$). Again, decreases in Hsp abundance in the sarcoplasmic fraction could be a result of chaperone activity causing the Hsps to migrate towards proteins affected by HS and subsequently be removed from the sarcoplasm. The decline, then increase in abundance of Hsp27 in the RST provides evidence of initial Hsp27 activity in response to HS, followed by a somewhat more delayed synthesis of Hsp27 as HS progresses.

Conclusion: It is possible that HS may result in a translocation of the Hsps from their normal, non-stressed muscle fraction. These novel results provide compelling evidence that muscle fiber types differ in their speed and pattern of heat shock protein response to heat stress. This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-67003-30007 from the USDA National Institute of Food and Agriculture.

Keywords: heat shock proteins, heat stress, pork

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DIETARY EFFECTS ON CIRCULATING RISK FACTORS FOR OBESITY-RELATED METABOLIC DISORDERS USING THE SWINE BIOMEDICAL MODEL

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Objectives: This study was conducted in order to determine if differences in body composition and blood chemistry are associated with a high calorie, high fat ground beef diet.

Materials and Methods: Twenty-one Yorkshire x Duroc x Hampshire gilts born over a five-day period from the same sire were provided *ad libitum* access to a low lysine diet (total Lys = 0.45%) to promote hyperphagia and adiposity. Upon reaching 3 cm subcutaneous backfat (10BF; 10/11th rib interface), dietary treatments were allocated across BW and BF to a ground beef (GB; n = 5) or control (CON; n = 5) treatment. The GB diet was 99.9% cooked ground beef (65:35 lean:fat) plus 0.1% calcium carbonate while CON comprised 70.55% ground corn, 15% vegetable oil, 8.5% DDGS and 4.25% soybean meal. Both rations met NRC requirements for gilts of this size and weight. Intake and orts were recorded daily. Body weights and blood draws were collected on d0, 28, 56, and 84. Gilts were humanely euthanized on d85 for tissue collections and body composition analysis. One gilt was removed from the GB due to foot infection. Blood analysis was conducted using an iSTAT point of care device (Abaxis, Inc.) which measured sodium, potassium, ion calcium, glucose, hematocrit, hemoglobin, pH, PCO₂, PO₂, TCO₂, HCO₃, base excess, and SO₂. Blood lipid panel was assayed for total cholesterol (CHOL), LDL, HDL, and Triglycerides.

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Results: The GB gilts had significantly greater daily caloric intake ($P = 0.05$) and a lower percent body weight change from day 0 ($P = 0.01$) than CON gilts. GB gilts tended to have a lower percent subcutaneous fat change ($P = 0.09$). The GB gilts had greater circulating LDL ($P = 0.02$), CHOL ($P = 0.02$), and lower HCO₃ ($P = 0.04$) and TCO₂ ($P = 0.04$) than CON. Top, middle, and bottom heart ventricular thickness recorded on the right and left sides did not differ ($P > 0.10$) across treatments. CON gilts had significantly greater IGF-1 ($P = 0.02$) and tended to have greater porcine growth hormone (pGH; $P = 0.09$).

Conclusion: In conclusion, both treatments gained in BW and adiposity; however, GB gilts had greater intake and consumed more total calories, but gained less body weight and deposited less subcutaneous fat over the 84 day trial period. However, GB gilts recorded a greater circulating cholesterol concentration regardless of lower fat deposition. Feeding ground beef decreased IGF-1 concentrations when compared to a carbohydrate rich diet (GB = 98.56 ng/mL versus CON = 117.76 ng/mL) contrary to the belief that red meat is linked with increased IGF-1 concentrations.

Keywords: Biomedical, Gilts, IGF-1

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INFLUENCE OF DIET ON SERUM GLUCOSE AND INSULIN CONCENTRATIONS, INSULIN RECEPTOR CONCENTRATION IN ADIPOSE AND MUSCLE TISSUES, AND OXYGEN CONSUMPTION IN LIVER AND MUSCLE IN GILTS.

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Objectives: The objectives of this study were to determine the effects of feeding a ground beef versus a corn/soybean meal-based diet on: 1) serum glucose and insulin concentrations, 2) insulin receptor (**IR**) density in adipose and muscle cells and 3) in vitro liver and muscle energy use (oxygen consumption).

Materials and Methods: Twenty-one gilts (Yorkshire × Duroc × Hampshire) born over a five-day period were provided *ad libitum* access to a low lysine diet (Lys = 0.45%) to promote hyperphagia and adiposity. Gilts were assigned to either a ground beef (**GB**; n = 5) or control (**CON**; n = 5) treatment upon reaching 3 cm subcutaneous backfat (**10BF**; 10/11th rib interface) and were fed for 84 d. The GB diet was 99.9% cooked ground beef (65:35 lean:fat) plus 0.1% calcium carbonate while CON comprised 70.55% ground corn, 15% vegetable oil, 8.5% DDGS and 4.25% soybean meal. Both rations met NRC requirements for gilts of this size and weight. Feed intake and orts were recorded daily. Body weights (**BW**) and blood samples were collected on d 0, 28, 56, and 84 for blood chemistry analysis. One gilt was removed from the GB treatment after d56 due to foot infection. Gilts were humanely euthanized on d 85 for tissue collections and body composition analysis. Samples of *Longissimus* thoracis muscle (**LT**; 10/11th rib interface), gracilis muscle (**GR**), 10BF, and liver tissues were snap frozen for IR

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qPCR analysis, and fixed in formalin for immunohistochemical evaluation of IR density. For in vitro oxygen consumption analysis, samples of sternomandibularis muscle and liver were collected.

Results: The GB gilts had a greater percent change from d 0 on test for BW ($P = 0.01$) and tended to increase 10BF ($P = 0.09$), however there were no differences in perirenal fat weight or as a percentage of BW. There were no treatment differences for adrenal, kidney, liver, or spleen weight or as percentage of BW, however there was a treatment by slaughter day interaction for pancreas weight and pancreas as a percentage of BW ($P < 0.01$). There was a tendency for blood glucose to be higher in GB versus CON ($P = 0.06$). Level of fasted serum insulin was not different between treatments ($P = 0.61$). Image analyses of photomicrographs of tissues stained for IR did not differ between treatments for IR density in 10BF or pooled muscle, however GB GR IR density was significantly greater ($P = 0.04$) than CON GR, CON LT, and GB LT. No differences were observed for mRNA expression of IR in the LT, GR, 10BF, and liver ($P = 0.43, 0.2, 0.13, \text{ and } 0.19$, respectively). Oxygen consumption ($\mu\text{mol}/\text{min}/\text{g}$) in liver was greater ($P = 0.04$) in GB gilts compared to CON. However, O_2 consumption ($\mu\text{mol}/\text{min}/\text{g}$) in muscle did not differ between treatments.

Conclusion: The higher density of insulin receptors in GR from ground beef-fed gilts could suggest the initiation of tissue-specific insulin resistance of that tissue. The increase in O_2 consumption in liver and elevated fasted serum glucose in GB gilts could be indicative of enhanced gluconeogenesis and the increased workload associated with excess protein metabolism. Further research is necessary to determine if consumption of a high calorie, high glycemic diet could lead to tissue-specific insulin resistance and to determine the specific metabolic role of the liver.

Keywords: Gilts, Insulin receptor, Biomedical

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EFFECTS OF PHOSPHOLIPASE A2 ON LIPID OXIDATION IN PORK, POULTRY, AND FISH

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Objectives: Lipid oxidation is an undesirable reaction in muscle foods since it is often associated with loss of sensory quality. Previous studies showed the negative correlation between the amount of free fatty acids and lipid oxidation in cod muscles. Phospholipase A2 (PLA2) is a hydrolytic enzyme responsible for liberating free fatty acids from phospholipids. However, relatively little research has been done to investigate the effect of added PLA2 on lipid oxidation in poultry and pork. Therefore, the objectives in this study were 1) to investigate the effect of added PLA2 on lipid oxidation in minced muscles from cod, chicken leg, and porcine semitendinosus and 2) to assess the effect of NaCl on PLA2 activity in minced porcine semitendinosus.

Materials and Methods: Cod fillet, chicken leg (thighs and drumsticks) and porcine semitendinosus muscles were cut and ground through a 5-mm plate. Ground chicken and pork were further minced using a Waring blender. For ground cod muscles, trout hemoglobin, PLA2 from pig pancreas and streptomycin sulfate were added at 40 μmol heme/kg, 10 mg/kg and 200 mg/kg muscle, respectively. The addition of PLA2 is equivalent to 3,330 units of activity per kg muscle. In control samples, Milli-Q water was added instead of PLA2 at the same volume. The moisture content was adjusted to 85%. Samples were stored on ice throughout the study. For minced chicken and pork muscles, the same procedure was applied except that trout hemoglobin was not added and that NaCl (0 or 1.5% (w/w)) was added to the minced pork. Changes in free fatty acids (FFAs), thiobarbituric acid reactive substances (TBARS),

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peroxide values (PV) and hexanal were measured. The experiment designs were completely randomized with repeated measures. Data were analyzed using PROC MIXED of SAS (n = 3 per treatment). Means were separated by using differences of least squares at the significance level of 0.05.

Results: The PLA2 treatment resulted in a significant increase in FFAs in all muscles tested ($P < 0.05$). In cod, TBARS was almost completely inhibited by PLA2 (10.69 ± 0.21 $\mu\text{mol TBARS/kg}$ at Day 5), compared to 73.07 ± 2.45 $\mu\text{mol TBARS/kg}$ in control samples ($P < 0.05$). In contrast, the opposite effect of PLA2 in minced chicken led to significant increases in TBARS (104.75 ± 10.41 vs 48.36 ± 0.46 $\mu\text{mol TBARS/kg}$; $P < 0.05$) and PV (706.83 ± 10.79 vs 377.04 ± 37.44 $\mu\text{mol PV/kg}$; $P < 0.05$), compared to controls after 7 days of ice storage. The addition of 1.5% (w/w) NaCl to minced pork induced increases in TBARS and PV, compared with unsalted minced pork ($P < 0.05$). At Day 12, the added PLA2 exerted partial suppression of TBARS, PV and hexanal of the salted pork by approximately 24%, 67% and 43%, respectively ($P < 0.05$). This partial inhibition could be due to decreased PLA2 hydrolysis of phospholipids by NaCl ($P < 0.05$).

Conclusion: In conclusion, the effect of PLA2 on lipid oxidation is species-dependent being antioxidant in cod and pork muscles but pro-oxidative in chicken muscle. The addition of NaCl at 1.5% (w/w) can partially suppress phospholipid hydrolysis and antioxidant activity of PLA2.

Keywords: chicken, free fatty acids, Lipid oxidation, phospholipase A2, pork

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SPECIES SPECIFIC EFFECTS ON NON-ENZYMATIC METMYOGLOBIN REDUCTION

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Objectives: Meat color is an important quality attribute that influences purchasing decisions. Development of brown colored metmyoglobin on the surface of beef products results from oxy-/deoxmyoglobin oxidation. Thus, metmyoglobin reducing activity (MRA), which regenerates ferrous oxy- or deoxmyoglobin by enzymatic and/or non-enzymatic process, is critical for extending color life. Non-enzymatic MRA indicates that no enzymes are involved in the reduction processes. Although, studies have characterized the species specific effects on myoglobin oxidation, no reports are available determining the species specific effects on non-enzymatic metmyoglobin reduction. Therefore, our objectives were to determine the effects of species specific effects on non-enzymatic metmyoglobin reduction and to characterize the effects of pre-incubation of 4-hydroxy-2-noneal (HNE) with myoglobin on metmyoglobin reduction.

Materials and Methods: Myoglobin was isolated from porcine and bovine heart using ammonium sulfate precipitation and gel-filtration techniques. Equine skeletal myoglobin was commercially purchased. All species myoglobin were converted to metmyoglobin and the pH of the myoglobin solutions were adjusted to either 5.6 or 7.4 by passing through PD-10 chromatographic columns pre-calibrated with pH 5.6 or 7.4 phosphate buffer. The myoglobin concentrations of all species were adjusted to 0.05 mM and was confirmed using absorbance at 525 nm ($A_{525\text{ nm}} = 7.6\text{ mM}^{-1}\text{ cm}^{-1}$). For the second objective, different myoglobin were pre-incubated with HNE (1:7 ratio between myoglobin:HNE). Control samples received a volume of ethanol similar

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to that used to deliver HNE. The binding of HNE to myoglobin samples were confirmed using electron-spray mass spectrometry. The assay mixture contained metmyoglobin, EDTA, methylene blue, and NADH. The reaction was initiated by the addition of NADH. Non-enzymatic reducing activity was calculated as nanomoles of metmyoglobin reduced per minute during the initial linear phase of the assay, using a difference in molar absorptivity of $12000 \text{ mol}^{-1} \text{ cm}^{-1}$ at 582 nm for 100 seconds. The data were analyzed (n= 5 replications) using the Mixed Procedure of SAS and were considered significant at $P < 0.05$.

Results: There was a significant effect of species on non-enzymatic metmyoglobin reduction (beef > equine > pork; $P < 0.05$). pH 5.6 resulted in a greater reduction compared with pH 7.4. Pre-incubation of HNE with different species myoglobin significantly decreased metmyoglobin reduction compared with control at pH 5.6 ($P < 0.05$). The covalent binding was most effect in pork>beef> equine ($P < 0.05$) in decreasing metmyoglobin reduction.

Conclusion: The results indicate that primary structure of myoglobin can influence non-enzymatic metmyoglobin reduction. Thus, understanding the biochemical reactions that affect myoglobin primary structure is critical to increase the body of knowledge related to meat discoloration.

Keywords: non-enzymatic metmyoglobin reduction

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PROTEOMIC ANALYSIS OF YAK *LONGISSIMUS* DORSI MUSCLE BY TWO-DIMENSIONAL ELECTROPHORESIS

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Objectives: Yak (*Bos grunniens*) is the only bovine species adapted to the cold and hypoxic environment of the Qinghai-Tibetan Plateau. Yak meat is widely favored by consumers for its special game-like taste and flavor besides its eco-character. To understand the molecular mechanisms behind yak meat quality, proteomic analysis of *Longissimus dorsi* (LD) muscles in yaks and cattle was performed by two-dimensional electrophoresis (2-DE).

Materials and Methods: LD were obtained from adult male Maiwa yaks (n=3) from Hongyuan county and cattle (n=3) from Chengdu Plain of Sichuan Province.

Protein extraction. The tissue was ground into powder and incubated in lysis buffer. Protein concentration was determined by the method of Bradford.

2-DE. Isoelectrofocusing was conducted using a Multiphor II gel apparatus. Focused IPG strips were equilibrated before proteins were separated with Ettan DALTsix apparatus SDS-PAGE(12.5 % resolving gel).

Image scanner and data analysis. 2-DE gels were scanned on UMAX scanner. The statistical significance was determined using Student's *t*-test. A spot abundance (vol %) ratio of greater than 2 and $P < 0.05$ were set as the threshold to identify differentially expressed proteins.

Protein identification. MALDI-TOF-TOF/MS procedure was performed by Beijing Genomics Institute.

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Results: Proteins expression. There were about 530 and 500 spots detected in yak and cattle muscles, respectively. Thirteen differentially expressed proteins were found, among which 11 proteins were up-regulated while 2 were down-regulated in yaks compared with cattle.

Identification of differentially expressed protein. Eleven protein spots were successfully identified, and matched to 8 proteins (Table 1), which could be classified into categories of myofilament (MLC-2v, MyBP-H, MLC2F, actin alpha), energy metabolism (PGM 1, FABP, malate dehydrogenase), and antioxidant enzyme (peroxiredoxin-1) based on their function. The myofilament proteins may be related to meat tenderness while the antioxidant enzyme influence oxidative stability in yaks.

Table 1 Differentially expressed proteins identified by MALDI-TOF-MS /MS.

Spot No.	Protein name ^a	Accession No. ^a	Score ^b	Coverage (%) ^c	Mr (kDa)/pI theoretical	Change (Fold)
1	Phosphoglucomutase-1	gi 122132319	406	41.28	61.6/6.36	3.5
2	Peroxiredoxin-1	gi 66773956	145	27.14	22.2/8.59	4.1
3	Myosin regulatory light chain 2, ventricular	gi 122142995	110	37.95	19.0/4.83	2.8
4	Peroxiredoxin-1	gi 66773956	65.2	25.13	22.2/8.59	2.3
6	Malate dehydrogenase	gi 92087000	81.2	23.35	36/6.16	-2.1
7	Phosphoglucomutase-1	gi 122132319	99.3	24.38	61.6/6.36	2.5
8	Phosphoglucomutase-1,	gi 122132319	123	19.4	61.6/6.36	3.1
9	Myosin-binding protein H, MyBP-H	gi 115495599	81.3	26.68	53.1/5.71	3.2
11	Fatty acid binding protein,	gi 75077416	69.5	33.08	14.8/6.73	-4.3

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12	Fast myosin regulatory light chain 2	gi 122143222	167	31.18	19.0/4.88	5.4
13	Actin, alpha	gi 62287933	314	24.93	42.1/5.23	2.4

a From NCBI.

b Result of $[-10 \times \log(p)]$ lower than the significant threshold ($P < 0.05$)

c The coverage of the matched peptides in relation to the full-length sequence.

Conclusion: Our analyses based on proteomic data may reveal there were differences between the two species and provide a new insight into the molecular mechanisms behind meat quality in yak meat.

Keywords: *Longissimus dorsi*, proteome, two-dimensional electrophoresis, yak

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QUANTIFICATION OF BEEF *LONGISSIMUS* AND PSOAS MUSCLE MITOCHONDRIA USING REAL-TIME POLYMERASE CHAIN REACTION

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Objectives: Mitochondria are important organelles that remain active postmortem and can influence myoglobin redox state. Mitochondrial content in muscle is often determined by quantifying mitochondrial specific enzyme activity. Here, we describe a highly-accurate and repeatable method for comparing the concentration of mitochondria in postmortem muscle samples. The objectives were: (1) to quantify the mitochondrial content in beef *Longissimus* and psoas muscles using real time quantitative polymerase chain reaction (q-PCR) and (2) to use the relative concentration to determine accurate mitochondrial oxygen consumption in muscle.

Materials and Methods: Six USDA Select beef strip loins (*Longissimus lumborum*) and tenderloins (*Psoas major*) were obtained within 48 h of harvest from a local purveyor. Samples from each muscle were used to quantify total DNA and mitochondrial oxygen consumption. Total DNA was isolated using a QIAamp DNA Mini Kit and using manufacturer's instructions. Relative quantification of mitochondrial copy number was performed using quantitative real-time PCR (qPCR). A 274 bp amplicon of mitochondrial cytochrome b gene was used to evaluate the mitochondrial copy number and a 119 bp amplicon based on the 18S rRNA gene was used as the normalizer. Relative mitochondrial copy number was calculated using the comparative CT method. For the second objective, mitochondria were isolated using differential centrifugation and the oxygen consumption was determined using a

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Clark electrode with the addition of succinate as substrate (20 mM; pH 5.6, 25 °C). The fixed effects include muscle type (*Longissimus* or psoas) and the random terms included animals (block) and unspecified residual error. The data were analyzed (n= 6 replications) using the Mixed Procedure of SAS and was considered significant at $P < 0.05$.

Results: *Psoas major* had a 1.5 fold greater mitochondrial DNA content compared with *Longissimus* ($P < 0.05$; a value of 1 in qPCR indicates *Longissimus* = psoas mitochondrial content). This data indicate that psoas muscle has 50% greater mitochondria per unit weight compared with *Longissimus*. Beef *Longissimus* and psoas mitochondrial oxygen consumption were 32.4 and 43.3 nanomoles of oxygen per mg of mitochondria per minute, respectively ($P < 0.05$). In tissue, considering 1.5 fold greater mitochondrial content, oxygen consumption will be 32.4 and 64.9 nanomoles of oxygen ($P < 0.05$). Therefore, accurate determination of mitochondrial DNA content will help to determine the more realistic oxygen consumption in muscle. This relationship can be used in in-vitro research assessing interrelationship among mitochondria, myoglobin, and lipid oxidation.

Conclusion: The results suggest that q-PCR can be used as a valuable tool to quantify mitochondrial concentration in postmortem muscle. The quantification of mitochondrial concentration in muscles is important to understand the biochemistry of meat color.

Keywords: Beef color, mitochondria, Oxygen consumption

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COMPARISON OF EXTRACTION PROCEDURES TO CHARACTERIZE BEEF *LONGISSIMUS* METABOLOMIC PROFILE

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Objectives: Characterizing tricarboxylic acid (TCA) and glycolytic substrate changes in postmortem muscle is critical to understand the fundamental basis for meat discoloration. The application of metabolomics techniques allow simultaneous detection and quantification of hundreds of metabolites such as TCA and glycolytic substrates, amino acids, sugar, and lipids in meat. Extraction of metabolites is an important step in identification of compounds. Although metabolomics is a valuable tool to study biochemical changes of small molecules that influence functionality of proteins and enzymes in medical science, limited meat science research has compared efficacy of metabolite extraction procedures. Therefore, the objective was to compare two metabolite extraction procedures to characterize beef *Longissimus* metabolomic profile.

Materials and Methods: Two grams of beef *Longissimus* muscle samples were collected immediately after slaughter (approximately 2 h). For extraction procedure, one gram each of muscle tissue was placed in separate falcon tubes. To the first sample, 1 mL of methanol was added and stored at -80 °C. The second sample was frozen at -80 °C (without methanol addition) in a separate falcon tube. Here after, the first sample will be referred as methanol extraction procedure (MEP) and the second sample will be referred as tissue extraction procedure (TEP). Both samples were stored in a -80 °C freezer until further processing. For

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MEP, 100 μ L of methanol was directly taken from the falcon tube. However for the TEP, frozen tissue was minced, homogenized in methanol, and 100 μ L of supernatant was taken after centrifugation. Ribitol was added as an internal standard in MEP and TEP. Both samples were dried under nitrogen, derivatized, and metabolites were separated by gas chromatography and analyzed by mass spectrometry (GC/MS). Chromatograms and spectral data on four different animals (n= 4 replications) were collected using Chemstation software. Spectra were analyzed by first using AMDIS deconvoluting software and compounds were identified by comparing spectral profiles to the NIST spectral database.

Results: Analyses of chromatograms indicate that both extraction procedures were efficient in extraction of metabolites. The peak intensity and retention time for both MEP and TEP were compared using a GC/MS ChemStation Software. In general, both extraction procedures has similar peaks (retention time). However, MEP had more peaks in chromatogram indicating more metabolites compared with TEP ($P < 0.05$). Deconvoluted mass spectra of compounds were compared with spectra in the NIST library. TCA and glycolytic substrates, sugar, and amino acids were detected in chromatograms of both extraction procedures. The results suggest that MEP is less laborious at the same time more efficient in extraction of polar metabolites.

Conclusion: Metabolomics is a powerful tool to characterize metabolites in muscle. Hence, optimizing accurate and less lengthy extraction procedure is critical to maximize the utility of this technique in meat quality research.

Keywords: Beef color, Mass spectrometry, Metabolomics

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OXIDATIVE AND THERMAL STABILITIES OF BRAHMAN (*BOS INDICUS*) MYOGLOBIN

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Objectives: Brahman (*Bos indicus*) cattle contribute to beef production in southern United States. Previous research indicated that beef color stability is influenced by animal genetics. Earlier investigations in beef color focused on biochemistry of myoglobin from European cattle (*Bos taurus*). On the other hand, efforts were not undertaken to characterize the biochemistry of myoglobin from *Bos indicus* animals. Therefore, our objective was to characterize the oxidative and thermal stabilities of myoglobin from Brahman cattle, in comparison with myoglobin from European cattle, at meat storage condition.

Materials and Methods: Myoglobin was purified from cardiac muscles of five (n = 5) Brahman (100% *Bos indicus*) and European (100% *Bos taurus*) beef animals. Oxymyoglobins (0.15 mM) were prepared in 50 mM sodium citrate buffer (pH 5.6). Autoxidation and lipid oxidation-induced oxidation were evaluated at typical meat storage condition (pH 5.6 and 4°C) for 7 days. Absorbance spectra (from 700 to 400 nm) were recorded every day, and metmyoglobin formation was calculated. Thermal stability was assessed by incubating oxymyoglobin (at pH 5.6) at 71°C for 20 min in a water bath, and percentage myoglobin denaturation (PMD) was determined at 5 min intervals.

Results: Metmyoglobin content increased ($P < 0.05$) over time in both cattle species. In addition, lipid oxidation accelerated ($P < 0.05$) myoglobin oxidation irrespective of species. Nonetheless, oxymyoglobins from Brahman and European cattle exhibited similar ($P > 0.05$) trend in

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autoxidation and lipid oxidation-induced oxidation. PMD increased ($P < 0.05$) over time in both species, but was not influenced ($P > 0.05$) by species.

Conclusion: The results suggested that genetic variations in beef color stability may be due to endogenous factors other than myoglobin biochemistry.

Keywords: Redox stability, *Bos indicus*, Myoglobin, Thermal stability

New Technical Summaries (not open to academic members, including students)

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ORGANIC ACID EFFECTIVENESS: A NEW ALTERNATIVE FOR LISTERIA CONTROL

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Objectives: To educate on the organic acid mode of action and how newly approved organic acid based antimicrobials can be more effective and consistent than traditionally used preservatives available in the marketplace.

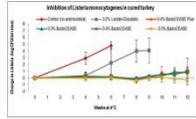
Materials and Methods: Propionic acid is an ingredient that is affirmed Generally Recognized as Safe (GRAS) by the FDA for use as an antimicrobial in a variety of food applications. It has been safely used as a key ingredient in antimicrobials since the 1950s in food items such as baked goods, non-alcoholic beverages, but until recently was on the list of prohibited ingredients for use in meat & poultry products. Meat manufacturers have had one primary option for *Listeria* control since the early 2000s; technology based on lactates and diacetates. With the addition of propionic acid and its' salts (sodium propionate) to 9 CFR 424.21(c) meat processors now have an additional option for *Listeria* control.¹

Results: Lactates and diacetates have made an impact on reducing meat recalls and increasing consumer safety over the past years. However, there are several challenges presented by these products including the lack of consistent pathogen control throughout the desired product shelf-life, high rates of inclusion in meat products which indicate low effectiveness; in addition to a cost of 2 to 3 cents per pound of meat. As meat and poultry manufacturers are looking to implement additional food safety measures to meet FSIS requirements, they now have an additional option that can extend product shelf-life more consistently

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when compared to traditional lactate-based ingredients based on liquid sodium propionate technology.²

Image:



Conclusion: FSIS-USDA was first petitioned by an ingredient supplier requesting the amendment of 9 CFR 424.21(c) to list liquid sodium propionate as an acceptable antimicrobial agent for use in RTE meat and poultry products in 2010. The Final Rule was approved on March 7, 2013 and propionic acid and sodium propionate were added to the FSIS Directive 7120.1 revision effective May 6, 2013.¹ Propionic acid, the active ingredient in liquid sodium propionate, is a time-tested ingredient that is used in various FDA-regulated food products, including the tortilla industry where it is considered a standard and highly effective antimicrobial. Published data has confirmed that the relative effectiveness of propionic acid at various pH levels between 5.5-8.0 was more effective than lactic acid for different strains of *Listeria*; this is mainly due to the organic acid mode of action and effect on the cell.³

References

1. FSIS directive
2. Glass, K., McDonnell, L., Sindelar, J., VonTayson R., Wanless, B., Badvela, M. (2013). Inhibition of *Listeria monocytogenes* by propionic acid-based ingredients in cured deli-style turkey. *Journal of Food Protection*, Vol. 76, 2074-2078.
3. Koussai, Y., Shelef, L.A., Department of Nutrition and Food Science, Wayne State University (1996). Metabolic activities of *Listeria monocytogenes* in the presence of sodium propionate, acetate, lactate and citrate. *Journal of Applied Bacteriology*, Vol 81., 147-153

Keywords: *Listeria*, organic acids

New Technical Summaries (not open to academic members, including students)

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EVALUATION OF SIGNS OF INSENSIBILITY FOR ELECTRICALLY STUNNED TURKEYS

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Objectives: The purpose of this study was to evaluate the traditional signs of insensibility that are used during bleed out for commercially raised market weight turkeys after electrical water bath stunning.

Materials and Methods: Turkeys were raised on a commercial grow-out farm and transported to a single processing facility where they were stunned using an electrical water bath system. The turkeys were randomly distributed into three treatment groups: left cut (LC), right cut (RC) or both cut (BC) based on which neck cut was applied. Immediately after stunning, birds were individually hung on a stationary shackle, a handheld electrocardiograph (ECG) unit was attached, and the designated neck cut was used to sever both the carotid artery and jugular vein. Immediately after the neck cut, birds were monitored for righting reflex (R), palpebral reflex (E), rhythmic breathing (B), and interphalangeal reflex (S) at 30 second intervals for 3 minutes. To confirm the time to death by exsanguination, the ECG machine was used to monitor heart rate over the full duration of bleed out. After exsanguination, birds continued through further processing and were collected after chilling to be further examined for meat quality defects.

Results: In this study, all but one bird showed an absence of response post stun for rhythmic breathing, righting reflex, and interphalangeal reflex. A small number of turkeys had a palpebral reflex early in the bleed out which was not present after the first 60 seconds. One bird had an inconsistent response which was unclear based on the individual signs of insensibility that were measured. In this case, several signs of insensibility

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were used to determine the status of the bird. There were no differences in the signs of insensibility or breast meat defects attributed to the different treatment groups.

Conclusion: The results of this study indicate that traditional measures of insensibility are effective means to evaluate consciousness in turkeys when used in combination. There are several instances in the literature that state that a partial incidence of palpebral reflex in electrically stunned poultry can be observed even after proper stun is applied. Thus, palpebral reflex alone may not be a completely accurate measure of early insensibility when electrical stunning is used.

Keywords: turkey, insensibility

New Technical Summaries (not open to academic members, including students)

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USE OF CITRUS FLOUR AS A REPLACEMENT FOR SODIUM PHOSPHATE, SOY PROTEIN OR MEAT IN COMMINUTED MEAT PRODUCTS

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Objectives: The objective of the study was to evaluate quality characteristics of smoked sausage utilizing TexDry LC™ Citrus (citrus flour made from citrus pulp) as a replacement for sodium phosphate, soy protein or meat.

Materials and Methods: Five treatments of smoked sausage were formulated: Trt. 1: Control 1 containing no soy protein, Trt. 2: Control 2 containing 1.5% soy protein, Trt. 3: 1% TexDry LC Citrus replacing soy protein, Trt. 4: 1% TexDry LC Citrus replacing sodium phosphate and Trt. 5: 1% TexDry LC Citrus hydrated 1:4 replacing 5% pork 72s and 50s. Cook yields were measured by difference in weight before and after cooking the sausages in a smokehouse to an internal temperature of 161F. Firmness was measured on sausages reconstituted to a temperature of 140F by heating it in a water bath at 194F for 10 min. The sausages were cut to a length of 20 mm and compressed to 30% of the height using a TAXT2 Texture Analyzer equipped with a 75 mm diameter flat probe. Purge over 4 weeks of refrigerated storage was measured biweekly by measuring the amount of free liquid in the vacuum packaged sausages. Statistical analysis was performed using ANOVA ($P < 0.05$) with Statview for Windows on 3 replications.

Results: Cook yields were not significantly ($P > 0.05$) different when soy protein was replaced (Trt. 2 vs. Trt. 3), when sodium phosphate was replaced (Trt. 1 vs. Trt. 4), or when meat was replaced (Trt. 1 vs. Trt. 5) with TexDry LC Citrus. The peak force (firmness) was significantly ($P <$

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0.05) higher when soy protein was replaced (Trt. 2 vs. Trt. 3) and when meat was replaced with TexDry LC Citrus (Trt. 1 vs. Trt. 5). Purge was significantly ($P < 0.05$) lower for all TexDry LC Citrus treatments compared to respective controls after 2 and 4 weeks of refrigerated storage.

Conclusion: Until recently, left over material from fruit and vegetable production was underutilized as a value added food ingredient source. An all-natural, minimally-processed innovative manufacturing procedure makes use of the plant fiber from sustainable biomass to make a novel whole food fiber known commercially as TexDry LC. The technology “activates” the plant fiber and performs in a unique manner similar to many known hydrocolloids. The plant fibers in TexDry LC are attracted to calcium ions to form 3-dimensional gels through ion-polymer reactions. When TexDry LC is incorporated into meat products it provides specific functions such as gelation, water-binding and thickening. The performance of TexDry LC can be optimized when used in conjunction with an available calcium source (calcium sulfate, calcium carbonate or calcium chloride) and other physical processing techniques. The process results in an allergen free ingredient which can replace some or all of traditional binders in meat products. TexDry LC can also be used to replace meat providing cost savings. TexDry LC Citrus per FSIS guidelines is labeled as “citrus flour” in comminuted meat and poultry products.

The results of this study indicates that TexDry LC Citrus is a cost-effective, functional ingredient that can replace sodium phosphate and soy protein while improving yield and reducing purge in comminuted meat products. TexDry LC Citrus provides meat scientist with a truly novel ingredient that gives a wide variety of texture options. TexDry LC Citrus has a consumer friendly label declaration and is an economical and sustainable option to formulations where texture development is required.

Keywords: Citrus flour, sodium phosphate replacement, soy protein replacement, meat replacement

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New Technical Summaries (not open to academic members, including students)

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USE OF NATURAL STABILIZED RICE BRAN AS A REPLACEMENT OF ALLERGENIC INGREDIENTS IN COMMINUTED MEAT PRODUCTS

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Objectives: The objective of this study was to evaluate quality characteristics of meatballs by utilizing stabilized rice bran (SRB) to replace breadcrumbs for a gluten free product; soy protein concentrate powder or meat for cost savings.

Materials and Methods: Four treatments of meatballs were formulated as follows: Trt. 1 (Control) containing 85% lean beef, 3.5% breadcrumbs and 2% soy protein concentrate powder, Trt. 2 containing 3.5% SRB replacing 3.5% breadcrumbs, Trt. 3 containing 2% SRB replacing 2% soy protein concentrate powder and Trt. 4 containing 72% lean beef replacing the 85% lean beef + 2% SRB. Cook yield were measured by difference in weight before and after cooking in a convection oven using steam to an internal temperature of 161F. Texture profile analysis was done on the meatballs that were reheated from the frozen state in a convection oven to 160F using a TAXT2 Texture Analyzer equipped with a 3-inch diameter flat probe, compressing the meatballs to 30% of the height. Freeze-thaw purge was measured by subjecting the frozen meatballs through two freeze-thaw cycles. Statistical analysis was performed using ANOVA ($P < 0.05$) with StatView for Windows on three replications.

Results: Cook yields were significantly ($P < 0.05$) higher for Trt. 2, Trt. 3 and Trt. 4 compared to the control. The hardness, gumminess and

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chewiness values were significantly ($P < 0.05$) higher for Trt. 2, Trt. 3 compared to the control. Freeze-thaw purge was significantly ($P < 0.05\%$) lower for all test treatments compared to the control.

Conclusion: Until recently, rice bran, a by-product of rice milling, was considered unfit for prolonged storage and human consumption and has been used primarily in animal feeds. Eight to ten percent of the rice kernel contains the majority of the nutritional value of rice and is concentrated in the bran and germ fractions. Due to the stabilizing technology to inactivate the enzyme lipase, rice bran is used as an all-natural, versatile and highly nutritious food ingredient. SRB is an allergen-free, functional ingredient which can replace some or all of the traditional binders in meat products. Due to its fat binding ability, SRB can be used to replace leaner meat with meat with higher fat content to provide cost savings. In June 2008, SRB was approved by the USDA as a binder in comminuted meat and poultry products such as sausages, chicken patties, meatballs, meat loaf and meat patties where binders are approved. USDA standard of identity for meatballs states no more than twelve percent total binder and no less than sixty-five percent meat in the formulation. Typical binders used in meatball formulations are soy protein, breadcrumbs and texturized soy protein.

Results of this study show that SRB is a functional ingredient that can replace soy protein concentrate powder, breadcrumbs or leaner meat with meat with a higher fat content while improving yield and reducing freeze-thaw purge in meatballs. SRB may be the ingredient of choice to produce a cost effective gluten free meatballs.

Keywords: stabilized rice bran, comminuted meat products, allergen replacement, meat replacement

New Technical Summaries (not open to academic members, including students)

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DEVELOPMENT OF SUSTAINABLY GROWN ROSEMARY FOR PRODUCTION OF EFFECTIVE TARGET MOLECULES

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Objectives: This poster describes a vertically integrated research, development and production initiative focused on the breeding and agronomic scale-up of new cultivars of species such as rosemary (*Rosmarinus officinalis* L.). The target molecules that can be extracted from this plant have many applications including assistance in protecting and maintaining the flavor and visual appeal of food products. Because sustainability has become an increasingly recognized and desired characteristic of food ingredients, Kemin has worked to have their rosemary be third party certified as sustainably grown.

Materials and Methods: Use of effective natural ingredients, as opposed to synthetic ingredients, is a first step for a sustainability profile. However, sustainability also requires strict process requirements; and third party auditing of these processes is generally necessary for customers, whether they are food manufacturers or consumers, to be confident that claims of sustainability have been validated. To the end, SCS Global Services was approached to analyze Kemin's rosemary growing operation for sustainable practices. SCS has been a third party certifier of agricultural product claims for three decades. In developing sustainability benchmarks, SCS utilized active stakeholder input from a non-government coalition organized by the International Rights Forum and comprised of the Pesticide Action Network, CACTUS and Oxfam. SCS is currently updating their Sustainably Grown certification in

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collaboration with the Leonardo Academy ANSI Sustainably Agriculture Standard.

Results: Kemin is currently one of the largest commercial growers of rosemary in the world with over 1100 acres planted in Texas and New Mexico. SCS's "certifiably grown" standard utilizes multiple indicators and benchmarks when analyzing growing operations for sustainability. They can be grouped into eight main categories that can be described as demonstrating a commitment to:

- Implement best practices for environmental, social and quality performance.
- Stimulate continuous improvement and innovation in agriculture.
- Enhance agro-ecosystem structure and functioning.
- Increase energy efficiency of agricultural systems.
- Reduce greenhouse gases from agricultural operations.
- Support bioregional production and consumption of agricultural products.
- Optimize land use for the production of food, fiber and biofuel crops.
- Raise public awareness and stimulate consumer purchases that reinforce adoption of sustainable agriculture practices.

Kemin has been successful in getting its rosemary certified as sustainably grown by following these parameters. The auditing process is ongoing so that SCS can validate that Kemin is continuously improving in these benchmarks. Kemin is currently the only supplier of extract from rosemary that is certified sustainably grown.

Conclusions: Expertise in conventional plant breeding and modern, sustainable agronomy can be applied to develop target molecules for

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strategic partners and grow effective plant species to commercial scale.

Third party certification of Kemin's rosemary as sustainably grown signifies that Kemin is able to provide natural rosemary extract-based ingredients to customers who wish to have the highest level of sustainable agricultural practices validated and recognized by consumers.

Keywords: Rosemary, Shelf life extension, Sustainability, Vertical Integration

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MEAT PROCESS CONTROL AND INSTRUMENTATION: WIRELESS DEVICES TO MEASURE TEMPERATURE, WEIGHT AND AIRFLOW AT VARYING PARAMETERS

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Objectives: Matrix Product Development desired to create one uniform, wireless sensor for the meat processing industry that will measure weight, air flow and temperature all in one device. The objective was not only to have one device to collect data, but to have a data acquisition software program deliver all of the data in one graph and file for ease of use. The data collected satisfies FDA and HACCP compliance initiatives, as well as cook cycle optimization for meat processors.

Materials and Methods: Matrix created specifications for this device based on hands-on experience in large meat processing plants. Materials used are in-depth, expert wireless expertise which addresses which wireless frequency is best for moisture-rich meat environments. Additionally, meat environments generally have a lot of stainless steel, so a suitable wireless frequency needed to be selected. Matrix used a Spectrum Analyzer to analyze wireless frequency in these environments to determine the best wireless frequency. Matrix also field-tested many different batteries, sealants, plastics, and electronic components to find the best materials and manufacturing methods to deliver a quality, reliable system.

Results: After significant research and development, Matrix was able to identify technology, materials, and manufacturing techniques that will allow temperature, weight and air flow data collection in one system with one device.

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Conclusion: A successful wireless weight, air flow and temperature sensor in one device with one data acquisition program was achieved for food processing environments.

Keywords: Air Flow Sensing, Process Control, Temperature Validation, Weight Validation, Wireless Technologies

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INHIBITION OF *SALMONELLA* TYPHIMURIUM AND *ESCHERICHIA COLI* O157:H7 IN ENHANCED PORK LOIN BY BUFFERED VINEGAR

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Objectives: (i) To evaluate the inhibition of *Salmonella* Typhimurium (*ST*) and *E. coli* O157:H7 (*EC*) in pork chops from loins enhanced to 110% of original weight by injecting with a brine solution containing water, salt, sodium phosphate and buffered vinegar, stored at 4 °C for up to 5 weeks, and (ii) to determine the effect of treatments on sensory, quality (color, purge and cook loss) and microbiological characteristics (APC counts).

Materials and Methods: The treatments tested include 3% sodium lactate-diacetate (LD), 0.75% BactoCEASE NV (buffered vinegar), 1% BactoCEASE NV (buffered vinegar). An untreated control without buffered vinegar or LD served as negative control. The study was conducted in three replications. Pork chops were surface inoculated with *ST* and *EC* separately to provide approximately 5 log CFU per 100-g package and stored at 4 °C for up to 5 weeks. Duplicate samples were assayed by rinse method for changes in *ST* and *EC* by plating on XLD and SMAC agar respectively and incubated at 37°C for 24 h. Sampling was discontinued for a formulation if there was >2-log CFU/pkg for two or more consecutive sampling intervals. For plotting the results, the log differences of the pathogen counts were calculated over the period for each treatment.

Duplicate uninoculated samples were assayed for APC and pH at weekly intervals. (CIE) L^* , a^* , b^* values and purge loss by weight difference method were measured on duplicate uninoculated samples at weekly intervals. Informal sensory evaluation was conducted on a 9 point hedonic

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scale on the uninoculated treatments at 0, 3 and 5 weeks during each replication. Cook loss was determined by weighing the pork chops before and after cooking. The microbiological data was reported as average values and standard deviations (log CFU/ml rinse) for duplicate samples and three separate trials (n=3) for each test formulation. Differences between the experimental treatments and the untreated control were analyzed by multifactor ANOVA using the STATGRAPHICS® software. Color, purge loss, cook loss and sensory results were subjected to multifactor ANOVA. All statistically significant differences in the study were reported at $p < 0.05$ level.

Results: Statistical analysis confirmed that all treated samples inhibited ($P < 0.05$) the growth of *ST* and *EC* for 5 weeks when compared with the untreated control. Untreated control showed >1 log increase at the end of 2 weeks and 4 weeks for *ST* and *EC* respectively. APC counts of untreated control showed >7 log CFU/g by the end of 3 weeks and the counts for the buffered vinegar and lactate treatments were in the range of 2-6 log CFU/g by the end of 5 weeks. With few exceptions, no significant differences were seen in L^* , a^* and b^* values among the treatments across testing intervals. Purge loss and sensory results showed no significant differences between the treatments. Overall cook loss results showed no significant differences between the treatments with the exception of 1% buffered vinegar which had higher cook loss at week-0 when compared with the remaining treatments.

Conclusion: Overall, this study demonstrated that clean label ingredient like buffered vinegar can be used for extending the shelf life of enhanced pork loin without negatively impacting the quality characteristics and at much lower application levels compared to sodium lactate-diacetate.

Keywords: Antimicrobial, *E. coli*, Pork, *Salmonella*, Vinegar

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IMPROVEST® CONTROLS BOAR AROMA IN MALE PIGS

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Objectives: In the US, physical castration (PC) of male pigs is performed usually within the first week of life to reduce aggressive behavior and improve pork quality by reducing the incidence of unpleasant aroma in the meat of some male pigs called boar taint. Two compounds contribute to boar aroma in pork. Androstenone is a testicular pheromone with a urine-like odor. Skatole is a product of bacterial metabolism in the gut with a fecal-like odor. These compounds accumulate in fat of intact male pigs at puberty.

Immunological castration (IC) using Improvest® (*gonadotropin releasing factor analog-diphtheria toxoid conjugate*) is an alternative to physical castration that uses the pig's immune system to temporarily block testicular function by production of antibodies to GnRF. IC occurs close to the time of slaughter, when immunized animals temporarily become like castrates, with a similar control of boar aroma and objectionable behavior. However, the difference in timing allows IC pigs to grow as intact males for most of their life, benefitting from the naturally induced improvements in feed conversion and carcass composition. This report summarizes results from 56 global studies of the effects of Improvest on chemical and sensory assessment of boar aroma.

Materials and Methods: Two types of assessments were conducted and aggregate results are reported. Chemical analysis of fat from PC, IC and intact males for androstenone and skatole was determined in 29, 56 and 35 global studies, respectively. Results are given as the percentage of pigs below established thresholds for both compounds. Sensory evaluations by both trained and consumer panels were conducted in 35 studies.

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Table 1. Effects of Improvest on androstenone and skatole from 35-56 global studies.

Results:

Treatment	# Studies	# Pigs	% with Androstenone ^a	# Pigs	% with Skatole ^a
Physical castrates	39	2544	0.1	3083	0.2
Immunological castrates	56	4941	0.5	5875	0.6
Intact males (boars)	35	2212	40.3	2225	15.4

Conclusion: Sensory and chemical studies repeatedly demonstrated that immunological castration is effective in reducing boar aroma to levels of PC barrows. The aggregate results of chemical analysis studies are shown in Table 1. While chemical assays are reliable indicators of boar taint, boar taint is complex and is, by definition, a human sensory perception. Therefore, sensory evaluation by trained and consumer panels provide a “real life” assessment of the efficacy of IC. In the 35 global and US studies that performed sensory evaluations, all studies showed that the eating quality of pork from IC barrows was as good as pork from PC barrows or females. US FDA registration studies showed that trained panelists were able to identify meat from intact males (boars) but were unable to differentiate pork from PC or IC pigs. In the same registration studies, consumers who were representative of the general public found pork from IC barrows was not inferior to pork from PC barrows. Taken together, these results show that IC is effective in reducing boar aroma to levels at or below physical castrates. These data were generated in well-controlled field trials where protocols eliminated any cryptorchid or abnormal pigs from the study. Each individual study was designed for statistical evaluation, although the aggregate results are not suitable for comparison across groups.

Keywords: boar taint, immunological castration, Improvest, Pork Quality, sensory evaluation

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MEAT QUALITY PARAMETERS OF PORK PRODUCED FROM IMMUNOLOGICALLY CASTRATED PIGS REARED UNDER US CONDITIONS

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Objectives: Immunological castration (IC), produced by immunization against gonadotropin releasing factor (using Improvest® (*gonadotropin releasing factor analog– diphtheria toxoid conjugate*) is a relative new practice in the United States. By utilizing IC, physical castration (PC) early in life can be replaced with IC close to slaughter, offering production advantages while maintaining effective reduction of boar taint, which is the primary reason for performing castration of male pigs. However, other aspects of meat quality are also of interest to the pork industry. Parameters such as pH, color, firmness, marbling and water holding capacity (drip loss) can directly affect economic return through impacts on product weight, shelf life and manufacturing suitability, as well as influencing consumer acceptability. It is known that these characteristics can differ between boars and PC barrows. Male pigs reared using Improvest transition from being boars to being IC barrows shortly after receiving the second dose (D2), which is administered 3 to 10 weeks prior to slaughter.

Materials and Methods: Results from seven controlled studies are reported, three of which involved multiple groups of animals giving 11 data sets in total. All trials had comparable groups of PC and IC pigs reared to slaughter, either at set times (resulting in the IC males being slightly heavier) or at a set weight (resulting in the IC males being slightly younger). A subset of carcasses were selected and subjected to meat quality analysis. Measurements were made on boneless loins using a handheld electronic probe (pH), a Minolta CR 400 device (objective

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color) and individual assessment against NPPC (National Pork Producers Council) standards (subjective color, marbling and firmness). Drip loss was measured by suspending a 1.25 cm thick chop in a Whirl-Pak bag for 24 hr at 4°C and measuring the % weight loss. Differences in experimental procedures between studies were small, but minor variations, including in device calibration, may have existed. For this reason, and because of differences in the ages, breeds and diets of the animals used, only within-study comparisons are valid.

Results:

	Difference IC versus PC					
	pH	Minolta L*	NPPC Color	NPPC Firmness	NPPC Marbling	Drip Loss %
Boler et al, D2+4 wks	0.00	1.6	-0.1	-0.1	-0.2	0.5
Boler et al, D2+5 wks	-0.05	-1.0	-0.2	-0.2	-0.3	1.0
Boler et al, D2+6 wks	0.10	-1.5	0.1	-0.3	-0.4	0.0
UIL-11008(equal wt.)	0.00	-1.6	-0.1	0.1	-0.2	-1.2
UIL-11011, D2+4wk	-0.03	0.3	-0.3	-0.3	-0.4	0.5
UIL-11011, D2+7wk	-0.04	1.1	-0.1	-0.1	-0.5	0.0
UIL-11011, D2+8wk	0.03	-1.1	0.1	0.1	-0.3	0.5
UIL-11129, D2+5wk	-0.02	0.1	-0.3	-0.1	-0.5	0.5
KSU 2012-1, D2+5wk	-0.07	1.3	-0.2	0.0	-0.5	0.6
KSU 2012-1, D2+7wk	-0.02	0.6	0.0	-0.2	-0.1	0.1
ISU 2012-1, D2+5wk	0.01	-0.1	0.0	NA	-0.1	0.4
Average difference	0.01	0.00	-0.10	-0.03	-0.32	0.26

Conclusion: Differences in pH, color, firmness and drip loss were small, not significant within individual studies, and inconsistent in direction. More consistent and sometimes statistically significant reductions in marbling were seen in IC males, but numerically these were also small and would normally be of limited practical importance.

Keywords: immunological castration, Improvest

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LIFE-CYCLE ENVIRONMENTAL BENEFITS DERIVED FROM IMMUNOLOGICAL CASTRATION OF PIGS

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Objectives: As the world's population grows, global meat consumption will also increase. There is pressure from all sectors of society to produce food more sustainably. This will mean further intensification and industrialization of livestock production and adoption of technology that improves production efficiencies while also accounting for animal welfare issues. Improvest[®] (*gonadotropin releasing factor analog-diphtheria toxoid conjugate*, Zoetis, Florham Park, NJ) reduces boar taint and it is a safe and effective alternative to physical castration and is approved for use in 63 countries, including European Union and Japan. This product works with the pig's immune system. Boars grow to their full potential with all the inherent advantages of intact males; improved feed conversion, less manure, and carcasses with a greater percentage of lean meat than barrows. These efficiencies and resource savings provide significant life cycle environmental benefits. This life cycle assessment (LCA) quantified the potential environmental benefits of using Improvest in US pork production.

Materials and Methods: During 2009-2011, a global study was conducted using life cycle burden data collected from modern farms with intensive pig production where pigs were physically castrated (PC) and compared to data collected from the same/similar farms in the same countries where pigs were immunologically castrated (IC). The study was conducted using LCA ISO compliant guidelines. Data were collected by direct interviews in modern farms and abattoirs in many countries and an Environmental Product Declaration was published in early 2012. When

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Improvest was introduced in the US in 2011, the global LCA model was adapted to the US specific inputs according to the University of Arkansas LCA model.

Results:

Global warming potential	PC kg CO ₂ e	IC kg CO ₂ e
Live wt, per kg	3.91	3.66
Carcass wt, per kg	5.21	4.79

Conclusion: The GWP (Global Warming Potential) contributions for 2 doses of immunological product manufacturing are negligible and represented only 0.01% of the total GWP for one kg of pig live weight. The main contributions to the GWP are related to the production of feed given to pigs and pig manure management. The US LCA model key input was feed conversion and came from results from 8 trials conducted for product approval; the improvement in feed conversion for IC pigs compared to PC pigs was 8.4% which resulted in feed savings of 26 kg/pig. Based on USDA statistics for crop yields during the years 2009 - 2011 (2012 yield data was excluded due to drought conditions), a land savings (devoted to crop production) of 31 m²/pig is realized. Reduction in manure, in the absence of direct measurement, was assumed to be proportional to the reduction in feed intake. IC pigs had a 6.1% lower GWP than PC pigs when comparing live weight results and 3.8% for carcass weight results (Table 1). Potential reductions in carbon footprint with increasing Improvest adoption are shown in Table 1. For a 124 kg of pig (live), the use of the Improvest over the baseline scenario of physical castration results in a reduction of GWP of about 28.6 kg CO₂ equivalents per pig. If only 33% of the 53.3M male pigs (2011 data) raised annually in the US were IC, that is equivalent to approximately 508,000 mt of avoided GHG emissions per year, equivalent to removing emissions of 99,579 passenger vehicles/year or the carbon sequestered by 164,850 hectares of pine forests.

Keywords: environmental benefit, immunological castration, Improvest, Sustainability

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USING CARBON DIOXIDE EMITTERS FOR EXTENDING THE SHELF LIFE OF CHICKEN BREAST FILLETS

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Objectives: In modified atmosphere packaging (MAP), carbon dioxide (CO₂) is the main inhibitor of microorganisms. However, the percentage of CO₂ in gas mixtures for meat must be limited due to CO₂ absorption, collapse of packages and increased drip loss. Typically, gas mixtures for fresh meat in the USA contain ca. 30 % CO₂. For avoiding collapse of packages, CO₂ emitters have the ability to gradually produce CO₂ in the headspace during the early stage of storage. The purpose of the study was to investigate how different concentrations of CO₂ are affecting microbiological shelf life and drip loss of chicken breast fillets, and moreover, how CO₂ emitters can increase the efficiency of MAP.

Materials and Methods: Fresh de-boned chicken breast fillets (*Pectoralis major*) were packaged in 5 series of 0, 30, 60 and 100 CO₂, supplemented with nitrogen (N₂), in addition to 100 % CO₂ combined with CO₂ emitters. Packaging was performed on a Multivac R145 thermoforming machine with high barrier films and a gas volume : product volume ratio of 2.5:1. Fillets of all series were stored at 4 °C and sampled (n=6) at days 0, 8, 14, 20, 26 and 30 or until shelf life was over. Analyses included measurements of drip loss, odor, psychrotrophic bacteria, lactic acid bacteria, *Brochothrix thermosphacta* and pseudomonads. Data were analyzed with ANOVA.

Results: Drip loss increased with storage time. Due to high CO₂ uptake in the meat and package squeezing, the drip loss for the fillets in 100 % CO₂ was 7.3 %, while meat in the other gas blends had 1.9-3.3 % loss at the end of storage (p<0.05). Use of CO₂ emitters in 100 % CO₂ reduced the loss to 2.5 %. In general, psychrotrophic bacteria, lactic acid bacteria,

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B. thermosphacta and pseudomonads all grew in the order $0 > 30 > 60 > 100$ (with or without emitter) % CO₂. For the fillets to reach log 7 in psychrotrophic bacteria counts, it took approximately 10, 14, 17 and 22 days of storage, respectively. In the series with 0 and 30 % CO₂, *B. thermosphacta* reached levels of approximately log 5 at approximately 10 days, and might contribute to off-odor and spoilage.

Conclusion: Packaging of chicken fillets in 100 % CO₂, with or without CO₂ emitters, increased the microbiological shelf with 5-8 days, compared to commercial CO₂ levels of 60-30 %. For counteracting collapse of packages and reducing drip loss, adding CO₂ emitters to the packages is beneficial. CO₂ emitters can reduce the need for high initial gas:meat ratios, and provide space for more packages during transportation and retail display. We propose that the extended shelf life and reduced requirement for space by adding CO₂ emitters to packages with all CO₂ can lower the environmental impact of chicken meat production.

Keywords: CARBON DIOXIDE EMITTERS, CHICKEN BREAST FILLETS, DRIP LOSS, SHELF LIFE

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USE OF CAPTIVE BOLT FOR ON-FARM EUTHANASIA OF TURKEYS

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Objectives: The use of mechanically applied methods of euthanasia are emerging as an improvement in practices used for on-farm culling for a variety of animal species. Traditionally, captive bolt devices were primarily used on large animals in processing plants settings due to logistical considerations and equipment limitations. Recent advances in captive bolt technologies have resulted in new designs that are sized for smaller animals, more suitable for on-farm use, and can be used for a variety of species. The use of captive bolt specifically for the on-farm culling of large turkeys is becoming more common in the US. Captive Bolt is proving to be a more consistent and reliable means of rendering animals insensible compared to traditional methods for euthanasia. Proper operation, use, and maintenance are all critical to ensure proper function and effectiveness.

Materials and Methods: In order to promote consistency of application, this instructional poster details the proper procedures that must be followed for humane euthanasia of large turkeys with a non-penetrating captive bolt.

Results: It includes aspects of best practices for operation, procedural details for ensuring proper application, suitability for turkeys of different size and age, worker safety, device maintenance and other challenges associated with on-farm implementation.

Conclusion: Diagrams represent worker positioning and anatomical targeting to maximize rate of effectiveness.

Keywords: Turkey, captive bolt

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PURGE REDUCTION DURING STORAGE IN PRE PACKED FULLY COOKED-SLICED DELI OVEN ROASTED TURKEY

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Objectives: High levels of purge during shelf life on sliced and pre packed fully cooked products are unappealing and unacceptable for the consumer. Our objectives were:

- To determine and understand fully cooked sliced and prepackaged deli turkey purge level that causes rejection from the consumer standpoint.
- To understand effect of slight pump reduction on level of purge in fully cooked –sliced deli turkey formula during storage.
- To understand effect of tumbling time and speed on level of purge in fully cooked –sliced deli turkey formula during storage.
- To determine the effect of turkey broth on purge control during shelf life in fully cooked –sliced deli turkey.

Materials and Methods: Experiment 1 consisted of five purge level treatments: 10, 15, 20, 25 and 30 ml. Panelists evaluated the different purge level randomly throughout the study. **Experiment 2a** consisted of 2 treatments: Control with 20% pump and test 17% pump formula keeping other brine ingredients at the same concentration. Product % purge levels were monitored during shelf life at 1.7°C on display panel storage.

Experiment 2b consisted of 2 treatments: Control treatment was blending speed 3 x g (RCF) for 30 min vacuum blending time versus test speed was 1 x g (RCF) for 60 min vacuum blending. During the time experiments 2 were conducted, raw material pH and water hardness were monitored. **Experiment 3** was designed to determine the effect of inclusion of natural dehydrated turkey broth as functional ingredient into formula to bind and stabilize free water to reduce purge during product

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shelf life. Control and test samples purge level were monitored during shelf life at 1.7°C storage. Difference from control test and 1-9 structure hedonic scales were used for products sensory evaluation.

Results: Purge study: One-on-one interviews results indicated that 1 in 4 consumers rejected when the product reached purge levels between 3.0 - 3.8 % (20 - 25 ml).

Process Change results indicated that there were no significant differences between test and control for both experiments (2a and 2b). All treatments reached unacceptable purge levels (> 3.0%) by 21 days after slicing. Raw material pH and water hardness ranged within normal levels throughout the course of the experiment.

Turkey Broth Inclusion results indicated that rate of increase in purge as a function of time is greater for the control. Although the sensory panel (n= 58) indicated marginal difference between test and control at $\alpha = 5\%$, No differences ($p > 0.05$) were found in consumer acceptability among the treatments

Conclusion: It concluded that natural dehydrated turkey broth has the potential to improve protein functionality characteristics of the product. This highly functional protein ingredient reduced purge package significantly without any compromise on organoleptic attributes. No differences ($P > 0.05$) in consumer acceptability existed among the treatments. Process changes (pump level and blending protocol) were not effective in controlling purge amount during the shelf life.

Keywords: Purge, Shelf life, Turkey