

Meat and Poultry Processing, Ingredient Technology and Packaging

26: QUALITY CHARACTERISTICS OF LOW-FAT PORK SAUSAGES WITH PAPRIKA POWDER

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Objectives: This study was performed to evaluate the quality characteristics of low-fat pork sausage (LFPS, <3%) containing paprika powder (PP) to partially replace with sodium nitrite (NaNO₂).

Materials and Methods: LFPSs were prepared commercially with or without NaNO₂ (37.5 ppm) and paprika powder (0.05~0.1): Control (CTL-37.5 ppm, NaNO₂), Reference (REF-150 ppm, NaNO₂), TRT1-37.5 ppm, NaNO₂ +0.05 % PP; TRT2-37.5 ppm+0.1% PP). After the sausages were cooked by boiling (75 °C/30 min) or smoking (72°C), physicochemical and textural properties were measured. Sensory evaluation was performed with 7 semi-trained panels with 8 point- hedonic test. Experimental design of this study is one-way analysis of variance (ANOVA) with three replications.

Results: The addition of PP into sausage mixture increased redness values (a*) similar to those of REF. Boiled sausages with 37.5 ppm NaNO₂ and 0.05% PP (TRT 1), and smoked sausages with 37.5 ppm NaNO₂ with both 0.05 and 0.1% were most similar to those with REF. However, the physicochemical and textural properties of LFPS were not different with the addition of PP. TRT1 in boiling sausage and TRT2 in smoked sausage showed highest in overall sensory evaluation.

Conclusion: Thus, the addition of PP into the sausage mixture increased redness values and sensory evaluation, regardless of cooking method, and might be useful to partially replace with NaNO₂.

Keywords: low-fat pork sausages, paprika powder, quality characteristics, sodium nitrite

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27: HIGH PRESSURE PROCESSING (HPP) DOES NOT AFFECT TEXTURE AND SENSORY ATTRIBUTES OF SMOKED HAMS CURED BY CONVENTIONAL AND ALTERNATIVE METHODS

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Objectives: High Pressure Processing (HPP) is a post-lethality treatment applied on RTE meats to reduce or eliminate *Listeria monocytogenes*. Previous research showed that HPP can affect texture and sensory attributes by modifying the myofibrillar structure and inducing lipid oxidation. Additionally, the increasing demand for natural and organic products created niche markets for uncured and alternatively cured hams. This experiment evaluated the effects of HPP on texture profile, WBSF, and sensory attributes of uncured, and conventionally and alternatively cured hams.

Materials and Methods: Thirty-two boneless pork top rounds (m. semimembranosus and m. adductor) were obtained from a commercial USDA inspected plant. Eight samples were assigned to one of four curing treatments. Treatments included conventional curing with nitrite (TRT1), alternative curing with celery powder (TRT2), uncured with apple cider, wine, and garlic (TRT3), and alternative curing with celery powder and buffered vinegar (TRT4). Samples were injected to 110% of green weight with a brine solution, immersed for 3 days, and smoked for 10 h at 107 °C until the final product reached at least 71.1 °C at the geometric center. From each sample, a total of four 2.54 cm thick slices were obtained. Two were treated with HPP at 87,000 psi for 3 min (HPP) and two were assigned as HPP control (NOHPP). Texture profile analysis (TPA) was performed on three cubes (2.54 cm²) from each slice and WBSF was analyzed from six 1.27 cm cores. A consumer sensory panel (480 panelists, 16 sessions, 30 panelists per session) evaluated color, odor, flavor, texture, and overall desirability by using a numerical scale (1=Dislike extremely and 9=Like extremely). Panelists also scored off-flavor intensity from 1=No off-flavor to 9=Off-flavor extremely intense. Data was analyzed by using PROC GLIMMIX of SAS as a split plot design where curing treatment was the whole plot and HPP the sub plot.

Results: HPP did not affect hardness, adhesiveness, springiness, gumminess, chewiness and WBSF of smoked hams. However, a significant effect of HPP was observed for cohesiveness (0.38 for NOHPP and 0.34 for HPP; $P < 0.0001$). No interaction between TRT and HPP was observed for any texture profile attributes. Curing treatment only affected springiness (6.21^a, 6.28^a, 5.78^b, and 5.90^{ab}, for TRT1, 2, 3, and 4, respectively; $P = 0.03$). For sensory analysis, interaction between TRT and HPP main effects were observed on odor ($P = 0.02$) and off-flavor ($P = 0.006$). No single effect of HPP was observed on other sensory attributes. Curing treatment affected color, flavor, texture, and overall desirability ($P < 0.0001$). Overall TRT1 and TRT4 had better scores when compared to TRT2 and TRT3.

Conclusion: HPP did not affect texture and WBSF of smoked hams cured by conventional and alternative methods. Hams cured conventionally and alternatively with celery powder and buffered vinegar had better color, flavor, and overall desirability. Uncured hams had the lowest overall desirability when compared to cured hams.

Keywords: Celery powder, Ham, High Pressure Processing, Nitrite

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28: LIGHT-INDUCED DISCOLORATION OF SLICED PACKAGED SALAMI IS NON-REVERSIBLE

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Objectives: Sliced fermented salami sausages packaged in modified atmospheres (MA) are prone to discoloration by a combination of residual O₂ in the headspace and light at retail display. To avoid discoloration, packages of uncooked salami should be stored in darkness until all O₂ is removed by internal processes in the product, usually within a few days. The aim of this study was to determine if the color of salami could return from brown to red by extended illuminated display in packages with MA's, in which residual O₂ was present in the early, but not the later stage of display.

Materials and Methods: Dry fermented raw salami was produced with pork, pork fat, beef, starter culture, salt, sugars and 120 ppm sodium nitrite. Packages with 150 g sliced salami were inserted with air and CO₂ through self-sealing septas to contain ca. 5 % O₂, 50 % CO₂ and 45 % N₂ with a gas to product ratio of 1.1 to 1. The lower and upper films for the packages were laminates with EVOH as O₂ barrier. The transparent packages were exposed to continuous LED light type 68 W 830 (Glamox AS, Oslo, Norway) of 3.5 W/m² (1100 lux) for 10 days at 20 °C. Concentrations of O₂ in the packages were measured at the time of packaging and days 1, 2, 3 and 4 of display with a Checkmate 3 instrument (Dansensor, Ringsted, Denmark). CIE L*a*b* values (lightness, redness and yellowness) were analyzed through the packaging films at days 0, 1, 2, 3, 4, 7 and 10 of display with a Minolta Chroma Meter CR-400 (Konica Minolta Inc., Tokyo, Japan). The experiment included 3 batches of salami with 5 packages per batch. Analysis of variance was performed for all data using a general linear model in Minitab 17 Statistical Software (Minitab Inc., State College, PA, USA), and means were separated by Tukey's multiple comparison test.

Results: Concentrations of O₂ were reduced from the initial 5 % to 0 % at day 4 of display. The initial a* values of sausages from the 3 batches were ca. 16, which is fully red. Within 2 days of display, a* values were substantially reduced to 9-10 (P <0.05), with a distinct browning or discoloration. By end of display at day 10, a* values were slightly higher at 10-11 (P <0.05), but sausages were still clearly discolored. L* and b* values were not affected by residual O₂ and light display (P >0.05). Packages from one of the 3 batches had higher O₂ concentrations at days 2 and 3, consistent with slightly lower a* values of the sausages at the middle and late period of display than the other 2 batches (P <0.05).

Conclusion: Illuminated display of salami slices in MA's with initial high residual O₂ resulted in a non-reversible discoloration of the product, despite that it was kept under anaerobic conditions for the middle and late display. A subsequent and minimal increase in a* value at this time of display would not be noticed by consumers.

Keywords: discoloration, light, residual oxygen, salami

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29: EFFECTS OF ACETIC ACID ON 'DARK CUTTING' BEEF QUALITY CHARACTERISTICS

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Objectives: Lean color is a driving factor in beef retail acceptance and likelihood of purchase. Dark, firm, and dry (DFD) lean otherwise known as “dark cutting” meat is characterized by an apparent dark purplish-red color as a result of a pH greater than 5.7 due to a depletion of muscle glycogen prior to harvest resulting in minimal conversion to lactic acid. Lean from a DFD carcass is used for ground beef production. Innovative research focusing on adding value in terms of lean color appeal to the loin of DFD carcasses using previously under-utilized Generally Recognized as Safe ingredients could be of value to the industry by increasing the bottom line and increasing consumer and food service satisfaction. The experimental objective was to evaluate the effects of buffered acetic acid on meat quality attributes of dark cutting beef strip loins.

Materials and Methods: Following a Latin square design, four injection treatments (0.0%, 0.4%, 1.2%, and 1.6% acetic acid) were applied to sectioned (n = 4 per strip loin) no-roll DFD striploins (n = 16) for a total of 64 pieces and compared to USDA Select strip loins (RFN) (n = 2) to evaluate meat quality. Pre-treatment, initial color and pH was evaluated. After injection, strip loin sections were vacuum packaged and stored at $4 \pm 2^{\circ}\text{C}$ for three days. Prior to analysis, all sections were cut into three individual 2.54 cm steaks (n = 192). Final color and pH were obtained. Sensory analysis was performed following the American Meat Science Association sensory evaluation research guidelines. Data were analyzed using the PROC Mixed procedure of SAS.

Results: A difference was seen ($P < 0.05$) for initial pH comparing DFD loins and RFN loins; 6.04 and 5.59 respectively. Final pH values did not differ between the DFD and RFN loins; however, there was a difference between treatments ($P < 0.05$). No differences were seen regarding cook loss. DFD loins yielded a lower drip loss percentage ($P < 0.05$). Warner-Bratzler shear force (WBSF) values did not differ for treatment or between DFD and RFN loins. Initial L* values were greater for RFN loins compared to DFD loins ($P < 0.05$). A difference was observed in initial b* values between DFD and RFN loins ($P < 0.05$). Final L*, final a*, and final b* values were different ($P < 0.05$) between treatment levels in the DFD loins. Final b* values were greater ($P < 0.05$) for RFN loins compared to DFD loins; 15.12 and 12.78, respectively. No difference was observed in cooked internal L* values. However, cooked internal a* values differed ($P < 0.05$) between DFD and RFN loins; 7.88 and 6.56, respectively. Thiobarbituric Acid Reactive Substances (TBARS) values did not differ between DFD and RFN loins. Treatment, location, and loin type had no effect on the following sensory traits: initial juiciness, sustained juiciness, initial tenderness, sustained tenderness, and beef flavor intensity.

Conclusion: Buffered vinegar was only sufficient at altering the final raw color and pH to a level that closely represents a USDA Select strip loin and did not have a substantial effect on cook loss, WBSF, TBARS, and cooked internal color. Results do suggest that it could be valuable to investigate the use of buffered vinegar in conjunction with an antioxidant and/or a functional ingredient used for binding water for synergistic effects possibly resulting in improved raw and cooked color as well as increased water holding capacity in the raw product while reducing cook loss.

Keywords: acetic acid, beef, color, quality

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30: USE OF STABILIZED RICE BRAN AS A REPLACER OF SOY PROTEIN CONCENTRATE OR MEAT IN A BEEF AND BINDER PRODUCT

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Objectives: Until recently, rice bran, a by-product of rice milling was considered unfit for human consumption after prolonged storage. Due to recently developed stabilizing technology to inactivate the enzyme lipase, rice bran is no longer used as waste material. Stabilized Rice Bran (SRB) is an allergen-free functional ingredient which can replace some or all of the traditional binders in meat products. SRB can be used to replace lean meat to provide cost savings. In June 2008, SRB was approved as "rice bran" by the USDA as a binder/extender in comminuted meat and poultry products. Approved products where SRB can be used includes products such as sausages, chicken patties, meatballs, meatloaf and meat patties where binders are permitted. The objective of this study was to evaluate quality characteristics of beef and binder product by utilizing stabilized rice bran (SRB) or defatted rice bran (DRB) to replace soy protein concentrate (SPC) or meat.

Materials and Methods: Five treatments of beef and binder product were formulated: Control with 2.70% SPC, TRT 2: 2.7% SRB replacing 2.7% SPC, TRT 3: 2.7% DRB replacing 2.7% SPC, TRT 4: 2% SRB replacing beef 80s and TRT 5: 2% DRB replacing beef 80s.

Beef 80's with 20% fat was ground through a 5mm plate. Textured wheat protein was hydrated with ½ the formulation water and held for 10 min. Beef 80s, salt, spices, textured wheat protein, the remaining dry ingredients and the rest of the water/ice were mixed in a paddle mixer and mixed for no more than 3 minutes. The mixture was reground through a 2 mm plate, then stuffed into 12 cm diameter fibrous casing and cooked in a smokehouse under steam to an internal temperature of 71.7C. The chubs were stabilized following USDA Appendix B guidelines, sliced and vacuum packaged and stored in a cooler at 4C. The different treatments were evaluated for cook yield by difference in weight before and after cooking/chilling, sliceability (number of intact slices 1.5 mm thick using a Bizerba high speed tabletop slicer set at full speed 2/3 stroke), firmness using a Texture Analyzer equipped with a 1 cm diameter stainless steel probe and a compression cycle set at 30% of the height of a 2.54 cm thick slice and a test speed of 2mm/s. Purge was measured over 12 weeks of refrigerated storage on vacuum-packaged slices. 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 3, TRT 4 and TRT 5 compared to the control. Slicing yields were significantly (P<0.05) higher for TRT 3, TRT 4 and TRT 5 compared to the control. The firmness values were significantly (P<0.05) higher for TRT 3, but not significantly (P>0.05) different for TRT 4 and TRT 5 compared to the control. Number of intact slices were significantly higher (P<0.05) for TRT 2 and TRT 3 compared to the control. Purge was significantly (P<0.05) lower for all treatments after week 2 and week 4 compared to the control.

Conclusion: SRB is a cost-effective, functional, non-GMO, non-allergen, minimally processed ingredient that can replace SPC or meat while improving yield, sliceability and reducing purge in a beef and binder product. SRB offers a more friendly recognizable label compared to other binders that are approved for use in meat products.

Keywords: stabilized rice bran, defatted rice bran, soy replacement, meat replacement

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31: EFFECT OF INITIAL FREEZING RATE AND REPEATED FREEZING/THAWING ON QUALITY AND PHYSICOCHEMICAL CHARACTERISTICS OF PORK PATTIES

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Objectives: Freezing is one of the most effective methods for meat storage. However, repeated freezing/thawing during meat processing could lead to detrimental impacts on quality attributes of final meat products. Fast freezing has been known to reduce quality defects of frozen/thawed meat by minimizing structural damage to muscle related to ice crystal formation during freezing. However, little information is available on how the initial freezing rate would affect the final quality attributes of meat products undergone repeated freezing/thawing process. Therefore, the objective of this study was to evaluate the effect of initial freezing rate of sub-primals and subsequent freezing/thawing on quality characteristics of ground pork patties.

Materials and Methods: At 8 days postmortem, pork ham muscles from each side of pork carcasses (n=6) were removed, cut into four sections, assigned to three initial freezing rates (operating temperatures at -20 °C (slow), -30 °C (medium) or -80 °C (fast)) and unfrozen control, and stored at -18 °C for 3 weeks. After thawing, the ham muscle sections were ground and manufactured for ground patties using a hand-held patty maker. The pork patties were then randomly assigned to three subsequent freezing conditions (unfrozen, air-freezer (-20 °C) or blast freezer (-30 °C)) and stored in -18 °C for 3 weeks. Once patties were thawed in a cooler at 2°C, water-holding capacity, moisture, pH, color (CIE L*, a* and b*), texture profile analysis, 2-thiobarbituric acid reactive substances (TBARS) and thiol content were evaluated. The experimental design was a split-plot design with initial freezing rate (whole-plot) and subsequent freezing conditions of patties (sub-plot) with three independent batches. All data were analyzed using the PROC MIXED procedure of SAS.

Results: Both initial freezing rate and subsequent freezing conditions significantly affected thawing, cooking and total losses of frozen pork patties. Pork patties prepared with the sub-primal section assigned to slow freezing (-20 °C) showed the highest total loss ($P < 0.05$), regardless of subsequent freezing conditions. The initial freezing rate and/or subsequent freezing condition had no impacts on pH, moisture and texture of frozen/thawed pork patties ($P > 0.05$). The pork patties formulated with the sub-primal section assigned to slow freezing (-20 °C) exhibited higher TBARS value but lower thiol content compared to patties made with the muscle sections assigned to medium or fast freezing ($P < 0.05$). Frozen/thawed patties had lower L*, a* and b* values compared to the unfrozen control patties, irrespective of freezing rate and/or subsequent freezing conditions ($P < 0.05$).

Conclusion: This study shows that initial freezing of sub-primals at -20 °C (slow freezing) resulted in increases in total water loss and lipid/protein oxidation of further processed pork patties, regardless of repeated freezing condition of patties. Thus, our findings indicate that the initial freezing rate of sub-primal sections could have a dominant impact on quality attributes of final meat products when undergone subsequent freezing/thawing. Further studies determining effects of different thawing conditions coupled with different freezing rate on meat quality would be warranted.

Keywords: freezing rate, physicochemical characteristics, pork patty

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32: USE OF DEHYDRATED PORK STOCK IN LOW COST BOLOGNA

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Objectives: Protein ingredients are primarily used in meat products to decrease formulation costs, improve product texture, increase cook yield or enhance product flavor. In 2010, a functional protein known as dehydrated pork stock (DPS) was approved by USDA in comminuted and whole muscle meat products such as sausages, meatballs, meatloaf, meat patties and hams. DPS is an allergen-free, functional ingredient which can replace some or all of the traditional binders and allergens in meat products. It contains over 90% protein and can be used to replace meat to provide cost savings. DPS is not considered a "binder" by USDA hence meat processors are able to make "no binder no filler" claims.

The objective of this study was to evaluate quality characteristics of low cost bologna by utilizing DPS to replace meat.

Materials and Methods: Three treatments of bologna were formulated as shown in the table below.

	TRT. 1	TRT. 2	TRT. 3
Pork 20s	22.23	14.23	15.23
Mechanically Separated Turkey	60.00	60.00	60.00
Water	8.10	15.10	14.10
Salt	1.49	1.49	1.49
DPS 941	0.00	1.00	0.00
DPS 941/DPS 1075	0.00	0.00	1.00
Corn Syrup	5.25	5.25	5.25
Potassium Lactate/Sodium Diacetate	1.04	1.04	1.04
Sodium Nitrite	0.01	0.01	0.01
Spice with Sodium Phosphate	1.88	1.88	1.88
Total	100.00	100.00	100.0

Mechanically separated turkey, salt, sodium phosphate, sodium erythorbate and sodium nitrite and half the water/ice was chopped in a bowl chopper to a temperature of 6C. Pork 20s trim and the rest of the dry ingredients and the remaining water were added to the bowl chopper and chopped until the temperature reached 12C. The emulsion was stuffed into a 12 cm diameter fibrous casing and cooked in a smokehouse to an internal temperature of 71.6C. The bologna was chilled following USDA Appendix B guidelines, sliced, vacuum packaged and stored in a cooler at 4C.

Bologna was evaluated for cook yield by difference in weight before cooking/chilling. Firmness was measured on 2.54-cm thick bologna slices using a Texture Analyzer equipped with a 1-cm stainless steel cylindrical probe set to 30% compression and 2mm/s test speed. Interior color was measured using a handheld Hunterlab color reflectance meter set to a D65 light source. Sliceability was measured by the number of intact slices (out of 30) when the bologna was sliced to 1.5 mm thickness using a Bizerba table top automatic slicer set to full speed, 2/3 stroke. Purge was measured over 8 weeks of refrigerated storage on sliced vacuum packaged bologna by measuring the amount of free liquid in the package. Statistical analysis was performed using ANOVA (P<0.05) with StatView for Windows on three replications.

Results: Cook yields were not significantly (P>0.05) different for Trt. 2 and Trt. 3 compared to control.

Firmness values were significantly (P<0.05) higher for Trt. 2, but not significantly (P>0.05) different for Trt. 3

compared to control. Hunterlab interior color (L, a and b) values were not significantly ($P>0.05$) different for any of the treatments. Sliceability was significantly ($P<0.05$) improved for both test treatments compared to control. Purge was significantly ($P<0.05$) lower for both test treatments compared to control over 8 weeks of refrigerated storage.

Conclusion: DPS is a cost-effective, functional, allergen-free protein ingredient which can be used in bologna to increase cook yields, improve texture, sliceability and reduce purge while providing significant cost savings. DPS can be used in modification of current and development of next generation meat products.

Keywords: dehydrated pork stock, natural, functional protein, non-binder

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33: RETAIL MEAT CASE SURVEY-2015

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Objectives: Meat retail space throughout the US is an ever-changing area of the modern supermarket. The objective of this survey was to further investigate the retail trends of the fresh meat case across the US.

Materials and Methods: National and regional supermarkets and club stores (n=114) were surveyed from April to August 2015. Two trained auditors visited each store between the hours of 9 AM and 7 PM, with the typical audit lasting 2 hours. Retail self-service cases were evaluated for the percentage of space allocated to fresh meat of various species (whole muscle beef, ground beef, pork, veal, lamb, chicken, and turkey). Five regions were represented across the U.S.: northeast (NE), southeast (SE), midwest (MW), southwest (SW), west coast (WC). The following traits were recorded for each stock keeping unit (SKU): Species, Region, Natural (NAT), Organic (ORG), Case Ready (CR), and packaging type. NAT, ORG, and CR were recorded as either yes or no, based on the presence of NAT or ORG labeling, or the presence of a USDA mark of inspection containing an establishment number indicating CR. Data were summarized using *R: A language and environment for statistical computing (version: "Fire Safety" 3.2.2)*

Results: Across the United States 15,136 SKU were evaluated. Thirty percent of SKU's was represented by beef, and chicken was the second most prevalent at 22%. The SW region had the highest percentage (34.4%) of beef in the case, while the MW had the lowest prevalence (28.3%) of beef. Chicken presence was very consistent across the MW, SE, and SW (22.3%, 22.2%, and 22.0, respectively) with the NE higher at 25.0% and the WC on the lower end at 20.2%. Ground beef prevalence was more variable, with a range from 9.4% in the NE and 13.35 in the MW. There was nearly a 5% difference from the greatest pork presence in a region (SE, 24.7%) to the lowest (SW, 20.1%).

Natural labeling varied by species across the US. Over 50% of chicken and turkey SKU's were labeled as NAT (62.6% and 51.7%, respectively). The majority of beef, ground beef, and pork packaging did not carry a natural labeling claim (89.4%, 67.6%, and 77.2%, respectively). Organic labeling claims were much less prevalent than NAT. Of the species audited, ORG labeling was observed most often in chicken (7.8%), followed by ground beef (5.4%). Case ready was most common with poultry products, as 93% of chicken and 97.2% of turkey was CR. Ground beef was also commonly found packaged as CR (71.7%) The only species that had a majority of store packaged product was fresh beef cuts (64.0%).

Packaging type was another trait evaluated at all stores. PVC overwrap with a foam tray was the most common (42.2%) packaging type across the US. Most chicken (58.6%) was packaged in SSD/SES packages which contributed to 15.5% SKU's evaluated. Rollstock packaging was the third most used (12.3%) packaging type in the US. Rollstock was most commonly used for pork packaging rollstock (17%).

Conclusion: The data in this study in a small snapshot of retailers' stocking trends. Overall the data is suggesting that an increasing amount of meat in self-service retail cases is case ready. The level of organic products remain below 4% on average, but has still made substantial gains since the last audit. PVC overwrap still remains the preferred package by retailers, but varies by species. More research and education needs to be completed to improve the efficiency of this packaging type to help reduce product waste.

Keywords: Labelling, Packaging, Retail

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34: EVALUATION OF AN ALTERNATIVE SKIN-ON GOAT HARVESTING METHOD ON MEAT YIELD AND PROCESSING TIME

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Objectives: Many Asian cultures such as Taiwanese, Korean and Chinese enjoy bone-in goat meat cubes with skin attached because of the skin's unique texture. With the growing Asian population in the U.S., there is potential to grow the goat meat market to meet the new demand. The high demand for skin-on goat meat is currently not met domestically because of the absence of cultural knowledge of the niche market and the technological knowledge to produce a high-quality skin-on goat meat product. The objective of this study was to develop a standard procedure for the alternative skin-on goat harvest and fabrication process, along with comparing the processing yields and time efficiency between the alternative skin-on and traditional skin-off harvest and fabrication processes.

Materials and Methods: A total of 17 Boer/dairy crossbred goats averaging 26.28 kg and 4 months of age were harvested in two different harvesting techniques: nine with skin left on the carcasses (skin-on) and eight with skin removed (skin-off). In skin-on harvest group, carcasses were scalded and dehaired at 61°C for three minutes to remove most of the hair after stunning and exsanguination. The skin-off harvest group was harvested the same as the traditional lamb harvest, using the fisting technique. All carcasses were fabricated using a bandsaw and cut into 2 in. x 2 in. cubes after 24 hours of postmortem chilling at 2 °C. Cubes from each carcass were placed in individual lug and assessed for consistent quality. Any cube with excessive fat or bones was removed from the batch. Live weight, hot carcass weight, dressing %, chilled carcass weight, and final retail product weight were recorded throughout the harvest and fabrication processes. The harvest time (time spent from stunning to entering the cooler) and the fabrication time (time spent on the bandsaw and removal of inedible products) were also recorded.

Results: The skin-on treatment group had greater dressing % (61.00% vs. 48.38%; $P < 0.01$), % chilling loss (6.53% vs. 3.15%; $P = 0.01$) and % total yield (50.16% vs. 41.36%; $P < 0.01$) compared to the skin-off treatment group. It is interesting to note that the skin-off treatment tended to have greater % retail product yield ($P = 0.07$). This is likely due to the skin-on retail product tended to have more cubes with just skin and fat, which were removed from the batch during the quality check. There were no differences between treatments for harvest time ($P = 0.79$), fabrication time ($P = 0.27$), and total processing time ($P = 0.55$).

Conclusion: The results are encouraging to goat producers and processors who are interested in this ethnic niche of the goat market as the skin-on process requires similar inputs, but generates additional outputs in comparison to the traditional skin-off harvesting. Additional research on consumers' willingness-to-pay and economic analysis for domestic skin-on goat meat product is needed to confirm the sustainability of this product.

Keywords: carcass fabrication, Goat meat, skin-on harvesting, yield

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35: POTENTIAL FOR RICE BRAN WAX AND SOYBEAN OIL OLEOGELS AS A PORK FAT REPLACEMENT IN FRANKFURTERS

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Objectives: The objective of this study was to evaluate the potential of rice bran wax/soybean oil oleogels as pork fat replacements in frankfurters.

Materials and Methods: Frankfurters almost entirely devoid of animal fat were produced using the following lipid replacement strategies: 1) soybean oil (SBO); 2) oleogel made with soybean oil and 2.5% rice bran wax (2.5 RBW); 3) oleogel made with soybean oil and 10% rice bran wax (10 RBW); and 4) oleogel made with soybean oil and 2.5% rice bran wax added later in the chopping step of the frankfurter batter (RBW/LS). Frankfurters produced with pork backfat were used as a control (PF), and all five treatments were targeted to 21% lipid.

Results: Replacing pork fat did not influence emulsion stability or cook/chill yield of the frankfurters. Color L*, a*, and b* values revealed PF to be significantly darker ($P < 0.05$) than SBO, 2.5 RBW, and 10 RBW, and significantly redder ($P < 0.05$) than all other treatments. Texture Profile Analysis showed that PF and oleogel-containing treatments were similar in firmness and springiness, but SBO was significantly different ($P < 0.05$) from PF in these attributes. PF offered less resistance to puncture than all other treatments ($P < 0.05$), as measured by an incisor probe. According to a trained sensory panel, cured frankfurter aroma was not affected by pork fat replacement, but cured frankfurter flavor was significantly reduced ($P < 0.05$) when pork fat was substituted. 10 RBW had higher lipid oxidation values, but these remained consistently low throughout the entire study and were not detected by the sensory panel. Microstructural image analysis revealed that PF and 10 RBW both had a significantly greater ($P < 0.05$) proportion of fat globules larger than 100 μm^2 when compared to all other treatments, indicating that a stronger oleogel may be necessary in order to more closely resemble pork fat after frankfurter processing.

Conclusion: In conclusion, rice bran wax/soybean oil oleogels have potential to produce frankfurters with similar technological quality, instrumental texture values, oxidative stability, and microstructural features as those made with pork fat. Future research should focus on optimizing this technology by examining the behavior of different types of oleogels under different comminution conditions.

Keywords: Fat replacement, Frankfurter, Oleogel, Rice bran wax, Soybean oil

Meat and Poultry Processing, Ingredient Technology and Packaging

36: EVALUATION OF PORK SKIN GELATIN ON RHEOLOGICAL PROPERTIES OF PORK MYOFIBRILLAR PROTEIN GEL AT DIFFERENT SALT CONCENTRATIONS

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Objectives: The aim of this study was to evaluate the pork skin gelatin on rheological properties of myofibrillar protein gel as affected by different salt concentrations.

Materials and Methods: Myofibrillar protein (MP) mixtures were prepared with or without 1.0% of gelatin powder at different salt concentrations (0.15, 0.30, 0.45 M). Gelatin powder was provided by Gel-Tech (Model #Gelatin-G, Busan, Korea). This gelatin powder had 209 bloom of jelly strength and 8 mesh of particle size. Cooking yield (%), gel strength (gf), shear stress (Pa), sodium dodecyl sulfate-poly acrylamide gel electrophoresis (SDS-PAGE), scanning electron microscopy (SEM), fourier transform infrared spectroscopy (%T), sulfhydryl group (A415), and surface hydrophobicity (μg) were measured. The experimental design was 2-way (2x3) analysis of variance and each experiment were performed in triplicate (Table 1).

Results: The addition of gelatin powder increased cooking yield and shear stress, and MP at salt concentration of 0.45 M had higher values of cooking yield and shear stress than the other lower salt concentrations (0.15, 0.30 M). Although gel strength was not affected by adding gelatin ($p>0.05$), MP gel at the salt concentration of 0.45 M increased gel strength as compared to those at 0.15 and 0.30 M ($p<0.05$). Protein bands of SDS-PAGE did not differ among the treatments, regardless of addition of gelatin. In microstructure, MP gels with increasing salt concentration showed compact and wet structures. The quantitative analysis of the changes in band at 1650 cm^{-1} , 1624 cm^{-1} , and 1680 cm^{-1} (α -helix/unordered structures and β -sheet) were decreased with increased salt concentrations. Increasing salt concentration showed low content of sulfhydryl groups. Myofibrillar protein mixtures with gelatin at 0.45 M was lower content of sulfhydryl groups than those without gelatin ($p<0.05$). Surface hydrophobicity of MP at 0.45 M were higher than those of low salt concentrations ($p<0.05$). At 0.15 M and 0.45 M, MP mixtures with gelatin was higher than those without gelatin ($p<0.05$).

Conclusion: These results suggested that MP gel at the salt concentration of 0.45 M was optimum condition for the application of the gelatin in MP systems.

Table 1. Experimental design of this study

Ingredients	mg/ml					
	Control			Gelatin		
	0.15 M	0.30 M	0.45 M	0.15 M	0.30 M	0.45 M
Myofibrillar protein	40.0	40.0	40.0	40.0	40.0	40.0
Buffer solution	10.0	10.0	10.0	9.50	9.50	9.50
Gelatin	0.00	0.00	0.00	0.50	0.50	0.50
Total	50.0	50.0	50.0	50.0	50.0	50.0

Keywords: FTIR, Gelatin, Myofibrillar protein, Salt concentration

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37: CARCASS CHILLING METHOD EFFECTS ON TEXTURE AND CURED COLOR DEVELOPMENT OF COOKED SOW SAUSAGE

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Objectives: To determine the effect of carcass Rinse&Chill® on texture and cured color development of cooked sow sausage in comparison to conventional chilling.

Materials and Methods: Two chilling methods were implemented on carcasses (average hot carcass weight 237.0 kg) from 30-month old sows. Six carcasses were conventionally chilled (C) and six were chilled with Rinse&Chill® technology (RC; MPSC Inc.). RC involved vascular rinsing of residual blood using a cold (3°C) isotonic substrate solution (98.5% water; balance: glucose, polyphosphates, glycerine, and maltose). Carcasses were deboned (30 min postmortem) to obtain lean from three anatomical locations (shoulder, loin, ham) with each location separately ground, salted (1%, w/w), mixed with dry ice, vacuum packaged, and stored (24 h) before being reground. Samples were vacuum packaged, frozen, and stored (-20°C). Thawed samples were mixed with non-meat ingredients (0.5% seasoning, 0.25% sugar, 10% water, 156 ppm sodium nitrite, additional salt 1%), stuffed into cellulose casings (32 mm), and cooked on an electric grill (endpoint 76.6 °C). Color measurements included CIE L*a*b* and reflectance estimators of myoglobin chemical states (deoxymyoglobin, DMb, %R474nm/%R525nm; nitrosylhemochrome, NITHEM, %R650nm / %R570nm). Cooked sausage links were cut (12 mm length, 25 mm diameter) for texture profile analysis (compressed twice, 60%). Cooking loss and pH were also determined. Data were analyzed with PROC MIXED model of SAS (SAS institute) and animal (replication, N=6) served as the RANDOM term.

Results: RC did not affect ($P>0.05$) cook loss, cooked pH, NITHEM, DMb, or instrumental texture. RC resulted ($P<0.05$) in lighter (CIE L*, 57.1) and less red (CIE a*, 16.7) cured cooked sausage than C (CIE L* 55.9; CIE a* 17.2). Sausage manufactured from the shoulder lean had the highest pH ($P<0.05$; 6.26) with no difference between the loin and ham (6.02, 6.01; respectively). Those from the loin had the lowest ($P<0.05$) cooking loss. Sausages that used shoulder lean had the highest ($P<0.05$) reflectance estimator of NITHEM, while sausage from the ham had the highest ($P<0.05$) reflectance estimator of DMb. Sausage from the shoulder and loin were different ($P<0.05$) in yellowness with the ham being intermediate. Sausage from the loin was the most firm ($P<0.05$) followed by the ham and shoulder. The shoulder produced the least cohesive ($P<0.05$) sausage with no difference between loin and ham. Sausages varied ($P<0.05$) in springiness associated with each anatomical location of the lean (ham 0.05) between carcass chilling treatment and anatomical location.

Conclusion: Rinse&Chill® technology produced lighter, less red cooked cured sausage with no other influence on the chemical and physical properties. The lower redness presumably was associated with the removal of more residual hemoglobin. However, this technology did not affect the development of the cured meat pink pigment. Of future value would be to determine the cured color stability of sausages made from carcasses processed with Rinse&Chill technology with respect to the potential impact of differences in myoglobin and hemoglobin content.

Keywords: Carcass chilling method, Color, Sausage, Sow, Texture

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38: EFFECTS OF TEMPERATURE ABUSE ON SHELF LIFE AND COLOR STABILITY ON BEEF PRODUCTS

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Objectives: Meat color is the single most influential purchasing decision for consumers, as they associate freshness and wholesomeness with discoloration. Surface discoloration results in about 15% of retail beef being discounted and about \$1 billion in annual revenue loss. Although several factors can influence beef color, limited information is currently available on the effect of temperature abuse on beef color. Therefore, the overall goal of this study was to evaluate the effects of temperature abuse on shelf-life and color stability in beef products.

Materials and Methods: All master bags (0.4% carbonmonoxide, 30% carbondioxide, and 69.6% nitrogen) were kept in dark storage for 15 d before display at a temperature of -2 – 0°C. Four different treatments were utilized during the 5 d display study: (1) case at -1 – 1°C, 5 d display; (2) case at 3 – 5°C, 5 d display, (3) 8 h temperature abuse at 10°C then 5 d display, case at -1 – 1°C; and (4) 8 h temperature abuse at 10°C and 5 d display, case at 3 – 5°C. Seven trays of strip loin steaks (n = 28) and top sirloin steaks (n = 28) were utilized for each treatment and were randomly assigned to a retail case. Surface color, biochemical, and microbiological qualities were determined during display time. Each sample was visually evaluated for lean color, surface discoloration, and overall acceptability over 5 d by a 6 member trained color panel. For the biochemical analysis, pH, metmyoglobin reducing activity, and oxygen consumption were determined on the steaks before display. At the conclusion of color evaluation, two samples from each treatment were utilized for total aerobic plate count. The data were analyzed using the Mixed Procedure of SAS, and considered significant at a level of $P < 0.05$.

Results: Lean color and overall acceptability were not different ($P > 0.05$) for strip loin and sirloin steaks that were temperature abused prior to display, but lean color and overall acceptability were lower for steaks in warmer retail cases ($P < 0.05$). Sirloin steak discolored more rapidly ($P < 0.05$) than strip loin steaks in all treatments. The total plate counts showed no differences between treatments for sirloin steaks. However, a greater total plate count was noted in strip loin steaks that had not been temperature abused but displayed in a warmer temperature. Oxygen consumption rate, metmyoglobin reducing activity, and pH were not different between treatments.

Conclusion: Temperature abuse prior to retail display had no effect on the lean color, discoloration, or overall acceptability of the product. However, a warmer retail case had significant effect on surface color and overall acceptability of steaks. Temperature abuse prior to display combined with a warmer display case leads to shorter shelf-life.

Keywords: meat color, packaging, spoilage, temperature abuse

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39: UTILIZATION OF PHOSPHATE ALTERNATIVES IN CHUNKED AND FORMED DELI HAM AND MARINATED CHICKEN BREAST

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Objectives: Consumer demand for clean ingredient labels has led to research into natural alternatives to synthetically derived functional ingredients. Phosphates, including sodium tripolyphosphate, have been reported as an undesirable additive in meat products by some consumers. Phosphates are used by meat processors to increase yields, improve texture, and protect flavor. The objective of this research was to determine if the addition of phosphate substitutes including oat fiber, oat fiber with dried vinegar, and whey protein concentrate are viable natural alternatives to phosphate in ready-to-eat (RTE) marinated chicken breast.

Materials and Methods: Broiler breast meat (0.19-0.25 kg per fillet) was marinated with formulations containing 1.0% NaCl and 0.4% sodium tripolyphosphate or a phosphate substitute treatment and water. The treatment variables consisted of positive phosphate, negative phosphate, whey protein concentrate (WPC), oat fiber, or oat fiber with dry vinegar. Treatments were vacuum tumbled at 25 mm hg for 30 min at 8 rpm with 0.91 kg of brine solution and 7.8 kg of chicken breast. Samples were measured for percent pick-up of brine, cooking loss, pH, color, and instrumental tenderness. Sensory evaluation was conducted (n=180 total panelists) to evaluate the appearance, aroma, texture, flavor and overall acceptability of chicken breast treatments. A randomized complete block design with three replications was used to test the effect of adding whey protein concentrate, oat fiber, and oat fiber DV on quality parameters and sensory acceptability of chicken breast. Duncan's multiple range test was utilized to separate the treatment means when significant differences occurred ($P<0.05$).

Results: Phosphate treatments yielded breast meat with less ($P<0.05$) cooking loss and a greater pH than the negative control and phosphate substitute treatments. No differences existed ($P>0.05$) among treatments with respect to brine pick up and shear force. On average, no differences existed ($P>0.05$) in consumer acceptability for appearance, texture and overall acceptability, with all mean values between like slightly and like moderately on the 9 point hedonic scale. Furthermore, 82% of panelists rated the positive phosphate treatment at least like slightly. The oat fiber treatment was liked slightly or greater by 77% of panelists, while 74% of panelists rated the whey protein concentrate treatment at least like slightly or greater. Both the oat fiber with dry vinegar and negative phosphate treatments were like slightly or greater by 68% of panelists. This indicates that formulating whey protein concentrate, and oat fiber into chicken marinades can effectively increase the percentage of panelists that like chicken breast as compared to the negative phosphate treatment

Conclusion:

Whey protein concentrate and oat fiber have potential as phosphate alternatives in marinated chicken breast. Future research should be explored to determine ingredients that can increase negative charges on myofibrillar proteins to maximize yield and functionality for use in conjunction with oat fiber and whey protein concentrate as a potential phosphate replacer in meat systems.

Keywords: Phosphate, natural ingredients, marinated chicken breast.

Meat and Poultry Processing, Ingredient Technology and Packaging

40: OPTIMIZATION OF PROCESSING TECHNOLOGY OF CHILLED FRESHLY PREPARED STEAKS USING UNFATTENED BEEF

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Objectives: Enhancement has been known to improve eating quality of fresh beef, in particular, with low marbled beef or from not fattened cattle. The objectives of this study was to determine the optimal enhancement processing condition to improve the eating quality of freshly prepared steaks with application of tumbling and calcium lactate.

Materials and Methods: The *Longissimus lumborum* muscles of 12 Luxi × Simmental cattle, 18 ~ 24 months (no fattening), were selected and aged for 48 h (pH₂₄ was 5.56 ± 0.03). The muscles were cut into steaks of 3 cm, and tumbled with a brine (1% sodium chloride, 0.4% sugar, 0.4% phosphate and different concentrations (0.016 M, 0.05 M, 0.1M, 0.15M and 0.184 M) of calcium lactate (CAL)), then tray-packaged with the PVC film and stored at 4°C for 7 days. The SF was measured according to the methods of Luo, Zhu, and Zhou (2008).

Purge loss (%) = [(tumbling weight – post storage weight) / tumbling weight] × 100

Cooking loss (%) = [(uncooked weight – cooked weight) / uncooked weight] × 100

% Yield = (final cooked weight / green steak weight) × 100

Response surface methodology was applied to optimize the processing parameters. The design consisted of 20 sets of experiments with 3 replications, and with 5 levels of each independent variable which were coded as -1.682, -1, 0, 1 and 1.682 (Table 1). The range of the experiment and its center point were based on preliminary trials. A central composite rotatable design was used to evaluate the relevance of the three independent variables of tumbling time (X₁), marinade volumes (X₂), and CAL concentration (X₃). The dependent variables were purge loss (Y₁), cooking loss (Y₂), yield (Y₃) and shear force (Y₄). Software SAS 9.2 was used for data analysis.

Table 1 Critical factors in Response Surface Methodology analysis.

Factors	Symbol coded	Levels				
		-1.682	-1	0	1	1.682
Tumbling time (min)	X ₁	20	30	4 5	60	70
Marinade volume (% , v/w)	X ₂	3.3	6	1 0	14	16.7
Calcium lactate concentration (M)	X ₃	0.016	0.0 5	0. 1	0.1 5	0.18 4

Results: Based on the analysis of the effects of variables on purge loss, cooking loss, yield and SF, the optimum condition was determined by superimposing the contour plots of 4 responses. The optimum condition constraints were set as purge loss < 0.6 %, cooking loss < 25 %, yield > 84 %, 3.9 kg < SF < 4.2 kg. The results indicated that the best tumbling time was 60-73 min and the best CAL concentration was 0.15 M. The tumbling time 60 min and 0.15 M CAL was then put into the model which showed the best marinade volume to be 8%.

Conclusion: The optimum process conditions for freshly prepared steaks was: tumbling for 60 min, 8% (v/w) marinade and 0.15M CAL. In these conditions, the SF was 3.94 kg, and the purge loss, cooking loss, yield was 0.40%, 22.76% and 83.56%, respectively, which are well in agreement with the values predicted by the model. The eating quality was much better than other CAL concentrations. This investigation could help meat industries to produce high quality chilled freshly prepared steak.

Keywords: calcium lactate, freshly prepared steak, tenderness, tumbling, water holding capability

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40: IMPACT OF CHLOROPHYLL A ON THE COLOR OF PRE-RIGOR GROUND PORK STORED IN SIMULATED RETAIL DISPLAY

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Objectives: The impact of the photosensitizer chlorophyll *a* (chl *a*) was examined in three independent pre-rigor pork sausage experiments. The objective was to determine the threshold level of chl *a* that accelerated color loss, and to ascertain whether synthetic antioxidants, natural plant extracts, or a combination of both would help delay color loss.

Materials and Methods: In each experiment, 3% water and 0.8% salt were added to pre-rigor pork trim (6 hours post-mortem). In experiment 1, different levels of parsley (0, 513, 1026, 2051, and 3077 ppm) were added to the pork, equivalent to 500, 1000, 2000, and 3000 ppb chl *a*. Chl *a* was measured by UV-Vis spectrophotometer. In experiment 2, each batch of meat was treated with 0.3% FORTIUM® RGT12 Plus Dry (rosemary and green tea extracts). The three treatment conditions were no added sage, 0.0075% oleoresin sage, and 0.15% rubbed sage, to study the impact of chl *a* delivered by sage used in breakfast sausage. In experiment 3, 1539 ppm of ground parsley (1500 ppb chl *a*) was added to each batch of meat, and the treatments were untreated, a synthetic antioxidant blend (0.01% butylated hydroxyanisole (BHA), 0.01% propyl gallate (PG), and 0.01% citric acid (CA)), 0.3% FORTIUM RGT12 Plus Dry (RGT), and 0.3% RGT plus BHA/PG/CA. All of the treatments were replicated (n=2). The treatments were mixed with the pork for one minute, ground through a 4.8 mm plate, and shaped into 150 g patties. The patties were placed on foam trays and covered with oxygen permeable overwrap. They were frozen for 11 days (-18 °C) followed by 12-17 days of simulated retail display (3±1 °C, 1200-1400 lux fluorescent lighting). Instrumental redness (*a**) and photographs were taken periodically during the lighted display period to monitor changes.

Results: The results revealed significant effects of time and treatment ($p < 0.05$) for each experiment. In experiment 1, the patties with 2000 and 3000 ppb chl *a* had lower *a** values ($p < 0.05$) than the 0, 500 ppb, and 1000 ppb chl *a* treatments. The 1000 ppb chl *a* patties had lower *a** values ($p < 0.05$) than the 500 ppb patties, and there was no significant difference between the mean *a** values of the 500 ppb patties and the patties with no added parsley. In experiment 2, the patties with rubbed sage (778 ppb chl *a*) had lower *a** values ($p < 0.05$) than the patties with no sage or oleoresin sage, and there was no significant difference between the mean *a** values of the patties with no sage and oleoresin sage (36 ppb chl *a*). In experiment 3, the patties demonstrated color instability when chl *a* was present at 1500 ppb, even in the presence of natural plant extract and antioxidant ingredients. RGT and RGT + BHA/PG/CA had higher *a** values than untreated ($p < 0.05$), while BHA/PG/CA *a** values were not higher than untreated ($p > 0.05$). RGT *a** values were neither significantly higher than BHA/PG/CA nor significantly lower than RGT + BHA/PG/CA ($p > 0.05$).

Conclusion: This study suggested that pre-rigor pork sausage color stability was moderately affected by chl *a* levels between 500-1000 ppb, and it was significantly affected when chl *a* exceeded 1000 ppb. Although minimizing chl *a* in seasoning blends and limiting light exposure could help extend color life, the use of 0.3% FORTIUM RGT12 Plus Dry extended the simulated retail color life of pre-rigor ground pork containing the level of chl *a* typically found in commercial seasonings.

Keywords: chlorophyll, color, green tea extract, pork, rosemary extract

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42: EVALUATION OF CITRUS FIBER AS A NATURAL ALTERNATIVE TO SODIUM TRIPOLYPHOSPHATE IN ALTERNATIVELY CURED BOLOGNA

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Objectives: Consumers are currently driving the demand for “clean labels” and the elimination of ingredients from their further processed foods that are perceived as unnatural or unhealthy. The meat industry is not exempt from these growing trends and is one of the major industries attempting to meet the consumers demand. Most of the focus has been on eliminating nitrite/nitrate, ascorbate/erythorbate, and phosphates from processed meat. It is well established that cultured celery juice powder and cherry powder can serve as natural alternatives to sodium nitrite and sodium ascorbate/erythorbate, respectively. However, little research has been published on a natural alternative to conventional phosphate in processed meat products. The objective of this research was to evaluate the functionality of citrus fiber as a natural alternative to sodium tripolyphosphate in alternatively cured bologna.

Materials and Methods: Effects of citrus fiber on cook and chill yield, rancidity (TBARS), texture (simplified TPA measuring hardness, adhesiveness, resilience, cohesion, springiness, gumminess, chewiness), color (Hunter L, a, b, on samples in both lighted, simulated retail display (RD) and samples with no light exposure), and sensory properties of an alternatively cured, all-pork-bologna throughout a 98-day shelf life (1°C) was investigated. The bologna (target fat ~27%) was assigned to one of five treatments: positive control (phosphate), negative control (no phosphate/no citrus fiber), 0.50% citrus fiber treatment, 0.75% citrus fiber treatment, or 1.00% citrus fiber treatment. All treatments were replicated three times. Proximate analysis was conducted once for each replication. All other parameters were analyzed at days 0, 14, 42, 70, and 98. Statistical analysis was conducted in SAS using the mixed procedure.

Results: Cook and chill yields, TBARS, Hunter a, L (RD), a (RD), adhesiveness, gumminess, chewiness, bologna aroma, bologna flavor, off flavor, and sensory color (light to dark) were not significantly different across treatments ($P > 0.05$). Hunter L values were significantly different ($P < 0.05$) between the negative control and the 0.50% citrus fiber treatment. The 0.50% citrus fiber samples were slightly darker than the no phosphate control. All three citrus fiber treatments had higher Hunter b and b (RD) values and were significantly different ($P < 0.05$) from the positive and negative controls. This is most likely due to the yellow coloring of the citrus fiber. The hardness of the 1.00% citrus fiber treatment was significantly higher ($P < 0.05$) than all other treatments. Resilience and cohesion for all citrus fiber treatments and springiness for the 0.50% citrus fiber treatment were significantly lower ($P < 0.05$) compared to the positive control. The positive and negative controls were significantly higher than the citrus fiber treatments for moistness ($P < 0.05$) and the positive control had significantly higher texture scores, were firmer, than the other treatments ($P < 0.05$).

Conclusion: Overall, citrus fiber did not negatively affect the physical, chemical, or sensory characteristics of the alternatively cured bologna. These results indicate that citrus fiber has potential to serve as a natural alternative to phosphate in processed meat products.

Keywords: Phosphate, citrus fiber, bologna, sensory

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43: EFFECTS OF GROUND CARDAMOM ON THE FUNCTIONAL PROPERTIES OF RESTRUCTURED GROUND TURKEY

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Objectives: The objectives of this study were to determine the effects of 0, 1.0, 1.5, and 2.0% ground cardamom in a restructured turkey product. The aim was to determine if this ingredient affected the function of an alginate binding system regarding cook yield, pH, texture, water activity, moisture percentage, and water holding capacity.

Materials and Methods: Each treatment contained one pound (454g) raw turkey, 0.6% sodium alginate, 0.6% encapsulated lactic acid, 0.3% calcium carbonate, and 5.0% distilled water. Samples were prepared and stuffed into polypropylene centrifuge tubes within 20 min at 23° C and given at least 12 hours to set in a 4° C refrigerator. Samples were then cooked to an internal temperature of 72° C via water bath and the experiment was replicated three times. The binding strength of each treatment was determined using a Stevens-LFRA Texture Analyzer fitted with a spherical probe to penetrate 1-cm discs of product. One-way ANOVA was used to analyze the data with $P < 0.05$ as the significance level and a Tukey multiple range test was used to separate means.

Results: The addition of ground cardamom within the binding system did affect pH, water holding capacity, and cooking yield of each treatment. As ground cardamom increased, the pH decreased from 6.35 to 6.10 and the cook yield increased by 4% ($P < 0.05$). The 2.0% ground cardamom sample had the highest cooking yield (72.7%) and lowest pH value (6.10). A decreased value in pH across all ground cardamom samples correlated to a decreased value in water holding capacity. This may be explained by competitive interactions between the ground cardamom and the calcium alginate binding system. The cardamom fiber absorbed water adequately to increase cook yield, but did not possess the same water holding capacity as turkey meat bound by calcium alginate. Water activity and moisture percentage appeared to have minimal differences ($P > 0.05$) of up to 0.003 units and up to 2.8%, respectively, across all four treatments. It was observed that 2.0% ground cardamom (166 g) had significantly higher ($P < 0.05$) binding strength than the 1.0% ground cardamom (146 g) treatment.

Conclusion: Overall, this study indicated that adding a fiber-rich spice source enhanced the cooking yield of the product while minimally influencing other characteristics. However, no sensory evaluation was performed to determine whether the differences were desirable. Further research can be performed with sensory evaluation to determine if ground cardamom at different levels affects the appearance, flavor, and overall acceptability of a restructured turkey product.

Keywords: calcium alginate, fiber, meat extender

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44: TEXTURE AND CONSUMER ACCEPTABILITY OF GOAT SAUSAGES MADE WITH BEEF FAT FROM VARIOUS LOCATIONS ON A CARCASS

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Objectives: Chevon is a globally produced lean protein source. However, Western consumers are not accustomed to the effects of 4-ethyl octanoic acid which gives Caprinae meat its musky flavor. Mono-unsaturated fatty acids found at higher ratios in the brisket than in other beef carcass fat depots, produce a brothy beef flavor, while saturated fatty acids form less stable emulsions. Therefore, value-added goat meat products using beef fat have potential of increase palatability and texture for Western markets. The objective of this study was to evaluate the texture profile and consumer acceptability of goat sausages formulated with beef fat from various locations.

Materials and Methods: Subcutaneous fat was obtained from beef carcasses at three different locations: brisket (BF), plate (PF), and round (RF). Goat meat and beef fat were initially course ground using a 12.5mm grinder plate. Sausage formulations consisted of 17.01kg goat meat, 3.40kg beef fat, 907.18ml water, 0.22kg ice, seasoning blend, and curing salts (6.25% sodium nitrite). The control sausage consisted of 1.13kg of beef fat from each beef fat location. Each formulation mixed for 4 minutes and then finely ground using a 9.5mm grinder plate. Meat batter was stuffed into natural hog casing, linked and thermally processed to 71°C. Sausages were chilled for 24h, vacuum packaged and frozen. Frozen sausages were thawed at 5.5°C and assigned a random identification number. Sausages were then reheated to 71°C and cut into 2.54cm pieces. Two pieces were placed in Styrofoam cups and served to 100 panelists. Each panelist evaluated samples for aroma, color, overall opinion, texture of exterior and interior, greasiness, juiciness, and flavor using a 9-point hedonic scale (1=dislike extremely to 9=like extremely). Likelihood of purchasing was rated using a 5-point hedonic scale (1= definitely would not buy to 5=definitely would buy). Texture profile analysis (TPA) variables were evaluated using model TA.XT2. The following variables were determined: hardness, springiness, cohesiveness, chewiness, and resilience.

Results: The consumer panel data indicated a difference ($p < 0.05$) in greasiness. Sausages that contained BF and PF were slightly disliked (4.84 and 4.97) more than sausages made with RF (5.58). The consumer panelists found no differences in other variables evaluated between the treatment groups. The TPA analysis indicated that sausages formulated with RF (6.12kg and 3.61kg) and the control (6.18kg and 3.77kg) were significantly harder and chewier than BF (4.78kg and 2.87kg) or PF (5.14kg and 3.11kg) treatments. Sausages made with BF (86.1%) or PF (86.1%) were also springier than control sausages (85.5%). Sausages made with RF were found to be less cohesive and resilient (68.8% and 36.4%) compared to the other sausages.

Conclusion: The purpose of this study was to expand options in the goat meat market without sacrificing quality by evaluating consumer acceptability and texture profile analysis for goat sausages formulated with beef fat from various locations on a carcass. According to the consumer panel, sausages made with PF and BF were slightly disliked due to greasiness. Texture profile analysis indicated that sausages formulated with RF were found to be harder, chewier, less cohesive and resilient, while sausages made with BF or PF were found to be springier.

Keywords: acceptability, goat, Sausage

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45: THE EFFECT OF CARCASS SORTING SPECIFICATIONS ON BOXED BEEF SUBPRIMAL AND RETAIL CUT VARIATION

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Objectives: Inconsistencies within the boxed beef supply have led to increased cost and variability for consumers. Our goal was to quantify adherence to Institutional Meat Purchase Specifications (IMPS) guidelines and differences in quality and yield parameters including marbling score (MARB), retail yield (RY, %), and Warner-Bratzler shear force (WBSF, kg).

Materials and Methods: Five boxes each of USDA Choice (CH), custom sorted (CS), and Certified Angus Beef (CAB) subprimals (SUB) were utilized: IMPS 112A Lip-On Ribeye Roll, 120 Deckle-Off Brisket, 180 Strip Loin, and 184 Top Sirloin Butt. Six days' of USDA video image analysis data was collected one week prior to CS carcass selection and used to calculate selection criteria ranges for hot carcass weight, calculated yield grade, MARB, ribeye area, and backfat thickness of 790–887 lbs., 2.31–3.22, 316.60–437.73, and 11.24–14.85 in², respectively. Each SUB was cut into 2.54-cm thick steaks, weighed, assessed for adherence to IMPS, trimmed to spec if needed, and reweighed post trimming to calculate RY.

Results: Means of ribeye box weight (BW), SUB weight (SUBW), MARB and WBSF differed across groups ($P \leq 0.01$), with RY being similar ($P = 0.24$). Differences in BW and SUBW indicated CH and CAB were heavier than CS ($P < 0.05$), with CS also having the least MARB ($P < 0.01$). Results indicated WBSF for CH was improved compared to CS ($P < 0.05$). Number of retail cuts and specifications for tail length, subcutaneous fat thickness (SFT), and presence of bone, *ligamentum nuchae*, scoring and intercostal meat (IM) were different across groups ($P < 0.01$). Means of brisket SUBW, MARB, and WBSF differed ($P \leq 0.04$), with BW and RY being similar ($P \geq 0.13$). Differences in SUBW indicated CAB was heavier than CS ($P = 0.04$). All groups differed in MARB ($P \leq 0.01$), with CS having improved WBSF compared to CH ($P = 0.03$). Specifications including visibility of the muscle seam, and presence of the deckle, bone, and scoring differed ($P < 0.01$). Means of striploin BW, RY, MARB, and WBSF differed ($P < 0.04$), with a SUBW trend calculated ($P = 0.08$). Differences in BW indicated CS was heavier than CH and CAB ($P < 0.05$). All groups differed in MARB ($P < 0.01$), with CS exhibiting improved WBSF compared to CH and CAB ($P \leq 0.01$). Although RY differed amongst all groups ($P = 0.04$), only CH and CAB tended to be different ($P = 0.07$). Number of retail cuts and specifications for tail length, SFT, and presence of bone, scoring, and IM were different across groups ($P < 0.01$). Means of Sirloin BW, SUBW, *gluteus medius* MARB, *biceps femoris* weight and MARB, and total RY were different across groups ($P < 0.05$), with *gluteus medius* weight exhibiting a calculated trend ($P = 0.06$). There were no differences in *gluteus medius* WBSF, or *biceps femoris* WBSF ($P > 0.15$). Differences in BW and SUBW indicated CH and CS were heavier than CAB ($P < 0.02$), with all groups being different for total RY. Means of *gluteus medius* MARB indicated CH was improved compared to CS ($P = 0.02$) with a tendency for improvement compared to CAB ($P = 0.07$). *Biceps femoris* MARB for CH and CAB was greater than CS ($P < 0.01$). Number of retail cuts and specifications for non-square cuts at the cranial or caudal ends, *gluteus medius* exposure, SFT and presence of scoring were different across groups ($P < 0.01$).

Conclusion: These results indicate a potential for carcasses to be sorted into more homogenous groups to improve uniformity and adherence to IMPS.

Keywords: Boxed Beef, Marbling, Retail Yield, Uniformity, WBSF

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46: COLOR CHANGES IN HIGH PRESSURE PROCESSED GROUND BEEF WITH DIFFERENT NITROSYLMYOGLOBIN STATES AND WITH OR WITHOUT ADDED REDUCING COMPOUNDS

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Objectives: A major challenge of ground beef processors is the control of *E. coli* O157:H7 and other Shiga toxin producing *E. coli*. High pressure processing (HPP) has emerged as an effective non-thermal pasteurization technique. The use of HPP in raw meat is limited due to color changes. The state of myoglobin and bound ligand can influence myoglobin stability and reducing compounds can improve the color stability of fresh meat. The objective was to determine effects of myoglobin (nitrosyl or nitrosylmet) state and reducing compounds on color stability in HPP treated ground beef.

Materials and Methods: Boneless USDA Select beef top rounds were ground and mixed with cure ingredients, such as, sodium nitrite or celery juice powder and packed under vacuum (VP) or oxygen permeable wrap (OPW) to achieve nitrosylmyoglobin or nitrosylmetmyoglobin. Additionally, reducing compounds (sodium erythorbate or cherry powder) were added to selective treatments.

T1: Sodium nitrite 156 ppm / VP

T2: Sodium nitrite 156 ppm + sodium erythorbate 547 ppm / VP

T3: Celery juice powder (equivalent to 100 ppm nitrite) / VP

T4: Celery juice powder (equivalent to 100 ppm nitrite) + cherry powder (equivalent to 469 ppm ascorbic acid) / VP

T5: Sodium nitrite 156 ppm/ OPW

T6: Sodium nitrite 156 ppm + sodium erythorbate 547 ppm / OPW.

After 48 hours, T5 and T6 were VP just prior to HPP treatment. To each of the treatments above, patties were subjected to HPP treatments: no HPP treatment, 600 MPa for 3 minutes, 600 MPa for 6 minutes, and 450 MPa for 3 minutes. Patties placed in dark stored at 4°C throughout the study. Color was measured (CIE L*, a*, b*, DE) through the vacuum pouch before HPP and on days 3, 7, 12, 14, 19 and 21 storage after HPP. Three independent replications were manufactured on separate days. Statistical analysis (SAS GLIMMIX) was run to see the main effects of ingredient treatment and HPP treatment and their interactions within each day of storage. Means separation was conducted for significant effects ($P < 0.05$) using the Tukey adjustment.

Results: Regardless of ingredient treatment (T1-T6), HPP had a detrimental effect on the color of the beef patties with all three pressure and time combinations. Lightness (L*) increased ($P < 0.001$), a* decreased ($P < 0.001$), b* increased ($P < 0.001$) after HPP. Color change (DE) with respect to non-HPP treated samples was similar for all three HPP treatments. The effect remained the same throughout the course of the study. However, the redness after HPP was retained better by samples treated with reducing agents (T2, T4, T6) than those without reducing agents (T1, T3, T5). Both inorganic and natural sources of nitrite and reducing agents (T1 vs T3 and T2 vs T4) performed similarly to maintain the redness ($P > 0.05$). Nitrosylmetmyoglobin states (T5 and T6) had less change in redness ($P < 0.001$) as compared to nitrosylmyoglobin states (T1 and T2) and this pattern became more profound during storage.

Conclusion: While the addition of nitrite compounds to ground beef did not stabilize color during HPP treatment, reducing compounds may lessen the color change associated with HPP treatment of ground beef.

Keywords: Colorimetry , High pressure processing, Raw ground beef

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47: IMPROVEMENT OF RAW MEAT QUALITY AND PROTEIN FUNCTIONALITY USING HOT-BONED, QUARTER-SECTIONED AND CRUST-FREEZE-AIR-CHILLING(HB-¼CFAC) AND COLD-BATTER MINCING TECHNOLOGY

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Objectives: Cold-batter mincing is an emerging technology that can be used to extract muscle protein without loss of protein functionality. The purpose of this study was to evaluate the combined effects of cold batter mincing and hot-boning, quarter sectioning and crust-freeze air chilling (¼CFAC) on raw meat quality and protein functionality of turkey breast fillets (Pectoralis major). The fillets of ¼CFAC were obtained after air chilling the fillets (hot-boned and quarter sectioned) in a freezing room at -12oC.

Materials and Methods: For each of 4 replications, 48 toms were processed traditionally at Michigan State University Meat Processing Center. After evisceration, the turkeys were subjected to: 1) water immersion chilling (WIC), chill boning (CB), and conventional mincing 2) WIC, CB, and cold-batter mincing after ¼CFAC at -12oC (CB-¼CFAC), and 3) hot-boning, quarter-sectioning, and cold-batter mincing after ¼CFAC (HB-¼CFAC). Statistical analysis was conducted using three factorial design (2 x 2 x 3). Data were pooled due to no interaction among factors. Muscle pH was measured after homogenizing 2.5 g meat in 25 ml of iodoacetate solution and R-value was measured using perchloric acid and phosphate buffer solution. Rheological properties was assessed by oscillatory measurements (storage modulus, G') using the ARES rheometer (TA instrument) with 25 mm diameter parallel plate.

Results: After chilling, the pH and R-value of turkey fillets in HB-¼CFAC were higher and lower, respectively, than those of fillets in CB (P < 0.05). During cold-batter mixing in a bowl chopper at 4,000 rpm, the batter temperature started at sub-zero (-1.5 to -2.1oC), reached 1.5 to 14oC at 6 to 12 min mincing, and ended with 26 to 31oC at 24 min, with high temperatures observed for 2% salt batter than 1% salt batter. During traditional mincing, the batter temperature started at 3 to 4oC, increased by ~10oC every 6 min, and ended with 32 to 35oC with higher temperature seen for 2% salt batter again. Dynamic rheological properties of meat batters indicated that the cold-batter mincing showed elevated G' than traditional mincing regardless of mixing time, indicating that gel-setting temperature was reduced in the cold-batter mincing over the conventional mincing potentially due to the less protein denaturation or protein structural change in a different way. After cooking, higher cooking yield and better protein functionality were observed in the cold-batter mincing especially at 6 min (P < 0.05).

Conclusion: These results indicated that the technology of HB-¼CFAC produced superior raw meat quality and the combination of cold batter mincing and HB-¼CFAC technologies improved protein gelation at 6 min where the batter temperature was not higher than 1.5oC.

Keywords: Cold-batter-mincing, Crust-freezing-air-chilling, Hot-boning, Meat quality and protein functionality, Quarter-sectioning

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48: EVALUATING THE EFFECTS OF OAT FIBER AND MODIFIED CORN STARCH ON THE CHARACTERISTICS OF SMOKED SAUSAGE UTILIZING MECHANICALLY SEPARATED CHICKEN

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Objectives: There is increasingly a demand for affordable, all-natural products in the food service industry. The objective of this study is to evaluate a blend of clean label functional ingredients for use in an affordable smoked sausage for food service.

Materials and Methods: Researchers at Auburn University used texture profile analysis (TPA) and consumer sensory panels to evaluate sausages made with three blends of oat fiber (OF) and modified corn starch (MCS) over 4 weeks of storage. All sausages were made with mechanically separated chicken (MSC; 0.0625% NaNO₂, 1.75% salt) in a hog intestine casing. Treatments included a positive control (0.43% sodium phosphate), negative control (no sodium phosphate, OF, or MCS), 90:10 blend (3.15% OF, 0.35% MCS), 50:50 blend (1.75% OF, 1.75% MCS), and 10:90 blend (0.35% OF, 3.15% MCS). All treatments included 18% water, 1.7% seasoning, 1.3% vinegar, and 0.5% salt. Two trials were conducted to evaluate the treatments. Sausages were formulated and then cooked in a smokehouse in two batches, dividing by trial, in which every treatment was equally represented and uniformly positioned. Five sausages were selected randomly from each treatment for each trial for sensory and 1 sausage was randomly selected for TPA. Following cooking and chilling, sausages were vacuum sealed and stored at 1°C ± 2°C in a cardboard box. Three sensory sausages were reheated in an oven to 79.4°C, cut into 2.54 cm segments, and cut in half lengthwise for sensory analysis while the remaining two were evaluated for objective color and pH using a Hunter Colorimeter and a pH Stab probe. Treatments were given a unique, random 3-digit code. Thirty consumer sensory panelist evaluated juiciness, cohesiveness, flavor, texture, and overall acceptability on a 9-point rating scale. TPA sausages (not reheated) were cut into three 2.54 cm segments and evaluated using a TA-XT2i Texture Analyser and 25 mm cylinder press. Parameters evaluated include hardness, springiness, cohesiveness, gumminess, chewiness, and resilience. Data were analyzed using the least squared means function of Proc GLM procedure of SAS 9.4. Sensory, texture, pH, and color evaluations were performed every 7 days contingent upon microbial and sensory analysis of spoilage.

Results: Sensory panelist found no difference ($P>0.05$) in texture among treatments within the same week or amongst weeks with the exception of 90:10 ($P\leq 0.05$) by week. The treatments with OF:MCS blends were less juicy ($P\leq 0.05$) than controls and were more cohesive ($P\leq 0.05$) within weeks. Adding OF at 3.15% and 1.75% had a negative effect on flavor acceptability and overall acceptability. TPA analysis indicates numerous significant ($P\leq 0.05$) week by treatment interactions for OF:MCS blends for all parameters measured. All treatments experienced an increase in pH between weeks 0 and 1 and a decrease between weeks 2 and 3. No differences ($P>0.05$) were observed for a* over weeks. L* and b* showed differences ($P\leq 0.05$) over weeks.

Conclusion: Sensory properties of the 90:10 and 50:50 blend were lower than other treatments, but the 50:50 blend performed that best for TPA analysis. Further research evaluating the sensory, texture, pH, and color parameters is needed across an additional 9 weeks of product storage in order to make recommendations on the best blend of OF:MCS for an optimal product.

Keywords: Mechanically Separated Chicken, Modified Corn Starch, Oat Fiber

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49: EFFECT OF POTASSIUM SORBATE ADDITION ON GERMINATION AND OUTGROWTH OF CLOSTRIDIUM SPOROGENES PA 3679 SPORES IN LOW COST BOLOGNA TYPE SAUSAGE DURING AMBIENT TEMPERATURE STORAGE

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Objectives: Low cost Bologna type product reaches high production volumes in Brazil and is marketed at ambient temperature.

Previous studies including challenge test with *Clostridium sporogenes* PA 3679 indicated that water activity (*aw*) up to 0.96 prevented spores germination. The objective of this study was to evaluate the efficacy of potassium sorbate addition (0.25%) on limiting germination of *Clostridium sporogenes* PA 3679 in low cost Bologna type product formulated with *aw* 0.96 and 0.965 during 90 days storage at 27°C.

Materials and Methods: The experiment comprised four treatments formulated with mechanically deboned chicken meat (60%), edible offal (2%), pork skin (8%), 80/20 pork trimmings (15%), water (4%), texturized soy protein (3.5%), tapioca starch (5%), 150ppm ingoing sodium nitrite, 500ppm sodium isoascorbate, 0.15% sodium acid pyrophosphate and 0.35% sodium tripolyphosphate. The amount of sodium chloride varied in order to achieve the desired *aw* (0.96 and 0.965). Potassium sorbate was added at 0.25% in the final product. Raw material was comminuted in a bowl chopper. The raw batter was vacuum stuffed in 60mm PVDC impermeable casing. The samples were cooked in a cooking chamber with direct steam until 75°C was reached in the center of the product. Cooling was performed in running tap water until 27°C and the samples were kept in a chamber at 27°C ($\pm 2^\circ\text{C}$) during 90 days. Lactic acid bacteria, Enterobacteriaceae, mesophilic aerobic, sulphite-reducing clostridia (spores and vegetative cells) counts, residual nitrite and pH value were evaluated in three samples of each treatment 24h after processing and at 15, 30, 60 and 90 days. Data (log CFU/g, residual sodium nitrite and pH value) were analyzed using GLM model procedure of SAS as a 2 *aw* (0.96, 0.965) X 2 potassium sorbate amounts (0, 0.25%) X 5 storage time (0, 15, 30, 60, 90) factorial design with repeated measurements. Interactions and main effects were considered significant at $p < 0.05$. Least square means for significant effects ($p < 0.05$) were separated by Tukey's test.

Results: Lactic acid bacteria and Enterobacteriaceae counts were below 1 Log CFU/g during shelf life for all treatments. There was a significant effect ($p < 0.05$) of the interaction *aw* X sorbate X storage on mesophilic aerobic and sulphite-reducing counts (spores and total) and residual nitrite concentration. It was observed that sorbate addition prevented mesophilic aerobes growth and sulphite-reducing clostridia spores germination during 90 days storage at *aw* 0.96 and during 60 days at *aw* 0.965. Regarding residual nitrite, the addition of potassium sorbate decreased nitrite depletion at both water activities until 30 days and marked difference has been perceived at 0.965.

Conclusion: Addition of potassium sorbate may enhance microbial stability of this type of emulsified product and prevent spores germination during storage at ambient temperature. The amount of sodium in the product due to its high amount of sodium chloride required to reach 0.95 may be reviewed especially after other experiments including other shelf life enhancers such as sodium or potassium lactate which are effective at inhibiting different microorganisms.

Keywords: Bologna, *Clostridium sporogenes* PA3679, Residual nitrite, Sorbate