566 The effect of stunning and decapitation on broiler activity during bleeding, blood loss and carcass quality. W. D. McNeal* and D. L. Fletcher, *University of Georgia, Athens, GA USA.*

Four experimental trials were conducted to determine the effects of stunning (14 volts, 500 Hz) and decapitation on bird activity during bleeding, blood loss, and carcass quality. Birds were subjected to modified Kosher killing (no stun, unilateral neck-cut), conventional killing (stun, unilateral neck-cut), decapitation without stunning, and decapitation following stunning. During bleeding, the birds were subjectively scored for severity of immediate reaction (0 to 10 s), intermediate activity (10 to 60 s), and late activity (greater than 60 s). Reactions and unconscious activity were scored as none (no visible reaction or only minor muscle quivering), mild to moderate (mild wing flapping and moderate spasmodic motion), or severe (violent wing flapping sufficient to cause major carcass movement or result in possible carcass damage). Birds were weighed before and after killing to determine blood loss. Carcasses were scored for completeness of picking, red wing tips, and red tails. Results showed dramatic differences in the severity of initial response and degree of unconscious activity during bleeding. Traditional Kosher killing resulted in little to mild initial response to the neck cut, followed by rather strong unconscious reactions at about 30 seconds post cut. Conventional stunning and killing showed almost no initial reactions and only mild intermediate or late reactions. Decapitation without stunning resulted in very strong immediate wing flapping and violent activity which steadily diminished in severity and which was almost completely ended by 45 to 60 seconds post-kill. Decapitation following stunning was similar to conventional stunning and killing with the exception of almost no late reactions at any level of severity. Compared to conventional slaughter, decapitation resulted complete cessation of movement after 60 s, a 0.2 % less blood loss (as measured by both the loss of blood and head), and no difference in carcass scores for feather retention, or red wings or tails. These results indicate that decapitation may be an effective means of slaughter following adequate stunning.

Key Words: Broiler stunning, Decapitation, Slaughter technology

567 Different attributes of breast meat quality in broiler great-grandparent lines. N. A. Gonet*, D. A. Sandercock, R. R. Hunter, and M. A. Mitchell, *Roslin Intitute, Roslin, Midlothian, UK.*

Previous studies in our laboratory have shown that broiler great-grandparent lines (GGP) exhibit differences in muscle membrane integrity and stress sensitivity. It is not known if these differences influence meat quality (MQ). This study examined 3 commercial GGP lines in terms of both appearance and physical properties of their breast meat. The 3 lines (A, B and C) which differed according to their genetic origins and recent selection history were compared. Birds were reared under standard commercial conditions. At six weeks of age, all birds were killed in a commercial processing plant, chilled for 24 h at 4°C after which both breast fillets were cut from the carcass, weighed and frozen. Fillets were thawed at 4°C and estimates of water loss (thaw loss) were obtained. Meat color (lightness, redness and yellowness), extent of hemorrhaging and shear strength were also determined. Statistical analyses included (ANOVA and t-tests). Line B had highest body and fillet weights ($p<0.01$) though C had highest %breast meat yield ($p<0.01$). Fillets from lines B and C were the most red in color and exhibited a greater incidence of hemorrhaging ($p<0.001$ vs. A). There were significant differences in meat lightness across the 3 lines ($p<0.001$), line C being the lightest ($p<0.001$) and most yellow in color ($p<0.001$). Line C exhibited greatest water loss on thawing ($p<0.001$). Shear force values were higher in lines A and C compared to line B ($p<0.001$). The results show that differences in MQ attributes can be detected between commercial GGP lines which maybe indicative of genetic differences. Birds with higher %breast meat yields (line C) produced lighter colored, firmer meat with greater water losses. The heaviest line had more tender, redder meat with more extensive hemorrhaging. Understanding cellular mechanisms that lead to these differences in meat characteristics of broiler GGP lines may provide insights into the genetic origins of MQ which can lead to novel methods for genetic selection for improved muscle and meat quality.

Key Words: broiler, meat quality, genetic selection

568 Effect of Dietary Sorghum Cultivars on the Storage Stability of Cooked Broiler Breast and Thigh Meats. D. U. Ahn*[1], M. Du[1], K. C. Nam[1], and G. Cherian[2], [1]*Iowa State University,* [2]*Oregon State University.*

A total of 150 day-old male broiler chicks (50 birds/pen, 3 pen/treatment) were fed corn-soy- flax meal-based diet (Control) with added sorghum at 10%. Two cultivars of sorghum (Ruby Red and Dekalb) were used for the study. Birds were slaughtered at the end of 42-day feeding trial. Twelve birds from each treatment (4 per pen) were randomly selected, and boneless, skinless breast and thigh muscles were collected. Breast or thigh meats were ground twice through a 3-mm plate, and patties were prepared. Patties were individually put in zipper bags, irradiated at 0 or 2.5 kGy, and cooked in a 90C-water bath to an internal temperature of 75C. At day 0 and 5 of storage, the TBARS of cooked patties were analyzed. Vacuum-packaged cooked patties were used to determine time- dependent volatile production during 12-h holding time. Meat from birds fed Dekalb had higher storage stability than those fed the control or Ruby Red diet. Irradiation had significant effect on the TBARS of cooked breast and thigh meats from Dekalb at Day 0. The aldehydes and sulfur compounds of cooked breast meat were lower in Dekalb compared with Cotrol or Ruby Red. The content of total volatiles in thigh meat was not influenced by the dietary treatments. The results indicated that feeding Dekalb sorghum to broiler diet can improve the storage stability of cooked meat.

Key Words: Dietary Sorghum, Cooked Broiler Meat, Storage Stability

569 Antemortem holding temperature effects on broiler processing shrink, yield and breast meat quality. M. Petracci[2], D. L. Fletcher*[1], and J. K. Northcutt[1], [1]*University of Georgia, Athens, GA USA,* [2]*University of Bologna, Bologna, ITALY.*

The influences of antemortem holding temperatures on broiler live shrink, processing yields, and breast meat quality were evaluated. In each of three independent trials, approximately 210 broilers were grown to 45 days using standard production practices. Prior to slaughter, the birds were individually weighed, placed in coops, and held for 12 h without access to feed and water. The coops were randomly divided into one of three groups and held at either 25, 29.5, or 34 C. For processing, the birds were first weighed live just prior to shackling, and the carcasses weighed following picking, evisceration, and chilling to determine live shrink and processing yields. Breast meat was removed at 2 or 24 h post-mortem for pH, R-value, sarcomere length, meat color, cooked yield, and shear value determinations. Birds held at 34 C had the greatest live shrink, 5.7%, compared to 3.9 and 3.2 % for those held at 29.5 or 25 C, respectively. Birds held at 34 C had lower processed carcass yields based on initial catch weight, but when calculated using post-shrink weights, there were no significant differences. For breast meat harvested at 2 h post-mortem, birds held at 25 C had higher R-values, redness, and yellowness values and lower cooked meat yield and shear values. For breast meat harvested at 24 h post-mortem, birds held at 25 C birds had higher pH, R-values, and redness. These results indicate that holding conditions may dramatically effect live bird shrink and yields, but have little effect on subsequent breast meat quality.

Key Words: Live bird holding, Processing yields, Breast meat quality

570 Marination of PSE broiler meat using non-meat binders. L. C. Cavitt* and C. M. Owens, *University of Arkansas, Fayetteville, AR, USA.*

In recent years, the poultry industry has seen a significant increase in the incidence of pale, soft, and exudative (PSE) meat exhibiting characteristics unsuitable for further processing due to excessive variation in meat color, poor meat binding, and decreased water holding capacity. Incorporating different non-meat binders into whole muscle products may be an effective way to improve water holding capacity of PSE meat. In this study, soy protein, whey protein, and modified food starch non-meat binders were vacuum tumbled with PSE and non-PSE meat. A total of 150 fillets (75 pale and 75 normal) were collected from a local processing plant. Meat color (L∗value) and muscle pH were measured on each fillet at 24h postmortem. The fillets were then tumbled with a marinade using water only or water plus NaCl (0.6%), sodium tripolyphosphate

(STP) (0.3%) and either a soy protein isolate (SPI), whey protein isolate (WPI), or modified food starch (MFS) at 2%. Fillets were vacuum tumbled with a 20% marinade (based on meat weight) for 45 min in a 4 C cooler, stored at 4 C overnight, and then cooked. Marination retention and cook loss were determined. As expected, the pale fillets had significantly higher L∗values and lower pH values compared to the normal fillets. Marinades containing the SPI, WPI, or MFS improved water holding capacity compared to either the STP-control or water-only control as indicated by significantly lower cook losses. Furthermore, fillets marinated with MFS had significantly lower cook losses compared to all other treatments. Marinating with the MFS further improved water holding capacity of the pale fillets to the level of the normal colored fillets as indicated by no significant difference in cook loss. These results suggest that using modified food starch in commercial marinade solutions can enhance water holding capacity in broiler breast fillets including those that are PSE.

Key Words: PSE broiler meat, Marinade, Water holding capacity

571 Tenderness of chicken breast fillets processed in a commercial air-chill facility. L. J. Bauermeister*, S. J. Lewis, A. Velsquez, M. Tamayo, A. Aguilar, and S. R. McKee, [1]*University of Nebraska-Lincoln Lincoln, NE.*.

The goal of this study was to determine the optimal deboning time for commercially air-chilled (AC) poultry. Deboning breast fillets from carcasses early post-mortem (PM) has been shown to cause meat toughening. However air chilling may alter rigor development thereby altering the PM aging period needed to prevent meat toughness. Birds from a commercial air-chilled facility were deboned at 2, 4, 6, 8, 10, 12, 14, 16 and 24 hrs PM (n=6 x 2 replications) and stored on ice at 4 C. Immersion-chilled (IC) fillets were purchased at a local grocery store (n=20 x 2 replications) and used as a comparative measure. Samples for pH and shear values were taken at each deboning period and cook loss was also determined. Results indicated pH reached 6.00 by 2 hrs PM, and by 4 hrs PM an ultimate pH of 5.85 was reached. This pH was maintained through 24 hrs PM. The average shear value of AC breast fillets decreased from 2 to 4 hrs PM with shear values of 7.40 kg/g and 4.10 kg/g respectively. Aging prior to deboning past 4 hrs PM did not result in any further improvements in meat tenderness for AC breast fillets. Store bought IC breast fillets had shear values of 10.15 kg/g. Commercial processing facilities often debone at 2 to 4 hours PM. Cook loss was determined after fillets were cooked in cook-in bags to an internal temperature of 76 C and cooled to room temperature before weighing. In general, the average cook loss for AC breast fillets decreased the longer the muscle stayed on the carcass and was lower than the cook loss of the IC fillets. The results of this study suggest that AC breast fillets could be deboned as early as 2 hrs PM without compromising meat tenderness.

Key Words: Air-chilling, Poultry meat quality, Aging on carcass

572 Rigor development and meat quality of large and small broilers and the use of Allo Kramer shear, needle puncture, and razor blade shear to measure texture. L. C. Cavitt*, C. M. Owens, J. F. Meullenet, R. K. Gandhapuneni, and G. W. Youm, *University of Arkansas, Fayetteville, AR, USA*.

In two trials, 150 female and male broilers of different sizes in each sex (large or small) were obtained from a commercial grower and were commercially processed to evaluate rigor development and texture. Breast fillets were excised at 0.25, 1.5, 3, 6, and 24h postmortem (PM). Muscle pH and L∗value was determined for each deboning time. Breast fillets were aged on ice until 24h PM, cooked to 76C, cooled, and then analyzed for texture using either Allo-Kramer (10 blade), needle puncture (2 mm), or razor blade shear (8 mm width) methods. Allo-Kramer tests were performed on intact muscles. Body size or sex had no effect on rigor development or color as indicated by no significant difference in breast muscle pH or L∗value through 6h PM. All three instrumental methods evaluated showed significant shear value differences between samples deboned at 0.25 or 1.5h PM and 3, 6, and 24h PM. A three way analysis of variance using sex, body size, and deboning time as main effects explained a small percentage of variation of the Allo-Kramer shear values (R^2=0.46), needle puncture energy (R^2=0.26) and razor blade energy (R^2=0.46). From these results, it would seem that both Allo-Kramer shear and razor blade tests performed similarly for differentiating breast meat toughness though Kramer shear force and razor blade energy were weakly correlated (r=0.65). While both instrumental tests were perfomed in the same vicinity on each breast, it is possible that variation within the breast would have caused this marginal correlation. Although further studies would be necessary to compare the performance of both tests for assessing poultry meat toughness, the proposed razor blade test has the advantage or requiring no sample preparation (i.e. cutting of a strip of constant dimernsions) other than cooking.

Key Words: Poultry meat, Texture analysis, Rigor development

573 The Effects of Raw Broiler Breast Meat Color Variation on Marination and Cooked Meat Quality. M. Qiao[1], J. K. Northcutt*[1], D. L. Fletcher[1], and D. P. Smith[2], [1]*The University of Georgia,* [2]*USDA-ARS, Russell Research Center*.

Experiments were conducted to determine the effect of raw broiler breast meat color variation on marinated and cooked meat quality. In each of three independent trials, fillets were collected from a commercial deboning line based on breast meat lightness as follows: 30 fillets lighter-than-normal (lightness, $L^* > 53$), 30 normal fillets ($48 < L^* < 53$) , and 30 darker-than-normal ($L^* < 46$) fillets. Within each color division (light, normal, and dark), 3 replicate groups of 10 fillets were individually weighed and marinated (20% marinate, wt:wt). Following marination, fillets were weighed to determine marinate uptake, held for 24 h at 2 C and re-weighed to determine marinate retention, cooked, and weighed again to determine cooked meat yield. The pH was determined on raw, marinated, and cooked samples. Color, moisture, and shear were measured on cooked meat. Results showed that breast meat identified by color differences affected meat pH, marination, marination retention, cooked yield, and texture but had no effect on cooked meat moisture content. Raw meat color differences were retained even after marination and cooking. There were significant negative correlations between meat lightness and pH; however, raw muscle pH did not correlate with final product moisture and shear. A positive correlation was observed between raw muscle pH and meat yield, but a negative correlation was found between pH and marination pickup. These results indicate that the pH variation associated with raw breast meat of different color can affect marination and cooked meat quality.

Key Words: Broiler, Breast meat color, Marination

574 The relationship of chilling time and temperature on quality of turkey pectoralis. C. Z. Alvarado*[1] and A. R. Sams[2], [1]*Virginia Tech,* [2]*Texas A&M University*.

Pale, soft and exudative meat is a growing problem in the turkey industry. The objectives of this study were to determine the relationship between chilling rates and development of PSE-like conditions. At 22.5 wk of age, 96 Nicholas toms were conventionally processed in two trials, chilled for 45 min or 90 min in 0, 10, 20, or 30 C chill water, and deboned at 60 min or 105 min PM. Temperature and pH of fillets were recorded at 15 min PM, deboning, and 24 h PM. At deboning, L* value, cook loss, gel strength, total protein solubility and bound phosphorylase were determined. At 24 h PM, cook loss, gel strength, and L* values were determined. At 15 min PM, there were no differences in pH among treatments. At 60 and 105 min PM, the 30 C chilled carcasses had significantly lower pH compared to 0 C. All carcasses chilled at 30 C had the lowest pH at 24 h PM. In fillets deboned at 60 min PM, L* value and cook loss were significantly higher and gel strength significantly lower in 30 C chilled carcasses compared to 0 C. At 24 h PM, there were no differences in L* value and cook loss in fillets deboned at 60 min PM; however, gel strength was lower at 20 C as compared to 0 C chilled carcasses. Fillets deboned at 105 min PM had significantly lower L* values when chilled at 0 C compared to 10, 20, and 30 C. The 20 C chilled carcasses had softer gels compared to 0 C chilled carcasses, and the 10 C chilled carcasses had higher cook loss compared to those chilled at 0 and 20 C but were not different from 30 C. At 24 h PM, cook loss was significantly lower in carcasses chilled at 0 C compared to the remaining treatments, however there were no differences in L* value and gel strength. There were no differences in total protein solubility among treatments. However, there was a higher amount of bound phosphorylase present at 60 min and 105 min PM in 30 C chilled carcasses compared to the remaining treatments. Therefore, chilling carcasses at higher temperature for longer periods can results in poor meat quality.

Key Words: PSE, Chilling , Turkey

575 Skin Color Evaluation in Broilers Fed Natural and Synthetic Pigments. S. M. P. Castaeda*, E. M. Hirschler, and A. R. Sams, *Texas A&M University, College Station, TX.*

Broiler carcass skin color is important in the USA and Mexico. Because pigments are expensive, this study evaluated the use of natural and synthetic pigments in broiler diets at commercial levels. In two trials, 280 chicks were randomly distributed (20 birds each) into seven treatments according to the pigment class (natural or synthetic) and the inclusion level (ppm of pigments) of yellow (apoester) and red (canthaxanthin) pigments. Two treatments were designed to mimic current commercial practices in the USA and Mexico. The treatments were: control (no pigment); natural-low level, natural-high level, synthetic-low level, synthetic-high level, a common USA level, and a natural-synthetic blend used in Mexico. Diets were started at week 3 and feed consumption, body weight, skin color, and blood pigment level were evaluated weekly from weeks 3 to 7. At 49 d of age the birds were processed and skin color was measured after picking and chilling. The natural pigments had consistently greater skin b∗ values (yellowness) than the synthetic pigments. The high levels produced greater skin b∗ values than the low levels, regardless of source. The synthetic pigments had a slower increase in skin b∗ but reached the same level as the natural-low by 7 wks. There was no difference in skin a∗ values (redness) due to pigment source or level or the age of the bird. By 7 wks, all pigment sources approached plateau levels in the blood but the synthetic pigment diet had higher blood levels of both yellow and red pigments than the natural pigment diets. Processing intensified skin yellowness and reduced skin redness. These data suggest that natural pigments were more efficient at increasing skin yellowness and that there were only small differences between high and low levels for each pigment source. This may allow a reduction in pigment use and feed cost to achieve the same skin acceptance by the consumer. color, pigment, carotenoid, skin, broiler

Key Words: Color, Pigment, Carotenoid

576 Mechanisms of pink color formation in irradiated precooked turkey breast. K. C. Nam*, M. Du, H. Ahmed, S. J. Hur, Y. H. Kim, and D. U. Ahn, *Iowa State University.*

Irradiation produces pink color defect in precooked poultry breast meat. The chemical pigment form of the pink color in irradiated, precooked poultry meat has not been identified. According to our preliminary study, irradiation decreased oxidation-reduction potential (ORP) and produced gas compounds that can act as a sixth ligand of heme pigments. Therefore, we hypothesize that production of certain gas compounds and increased reducing conditions induced by irradiation may be responsible for the red/pink color formation in precooked irradiated turkey breast. The objectives of our study were to characterize color compounds generated by irradiation, and to determine the effects of packaging and storage on color production in precooked turkey breast. Precooked turkey breast muscles were aerobically or vacuum-packaged and then irradiated at 0, 2.5, or 5.0 kGy using a Linear Accelerator. The CIE color, reflectance, ORP, gas production, and lipid oxidation of samples were determined at 0, 7, and 14 days of storage. Irradiation dose-dependent increase of pink color was found in mainly vacuum-packaged samples, and the increased pink color did not decrease during vacuum-packaged storage. Irradiation decreased ORP and produced carbon monoxide (CO) indicating that the pink color of irradiated precooked turkey breast was caused by the decreased ORP and heme pigment-CO complex formation. The reflectance of meat and the absorption spectra of myoglobin solution derivatives supported that denatured CO-myoglobin would be the pigment responsible for the pink color in irradiated precooked turkey breast. Lipid oxidation was not directly related to the pink color intensity of precooked irradiated turkey breast.

Key Words: Irradiated color, Carbon monoxide, ORP, Precooked turkey breast

577 Effects of selected chemicals on red discoloration in fully cooked broiler breast meat . D. P. Smith*[1], J. K. Northcutt[2], and J. R. Claus[3], [1]*USDA Agricultural Research Service, Athens, GA 30604,* [2]*University of Georgia Department of Poultry Science, Athens, GA 30602,* [3]*University of Wisconsin-Madison, Madison, WI 53706.*

Two replicate experiments were conducted to determine effects of selected chemicals on red discoloration in uncured, fully cooked broiler breast meat. Breast fillets and femurs were removed from commercial broilers after chilling. Fillets were finely chopped and the meat was divided into five portions for treatment additives: No additive (Control); 0.3% ascorbic acid; 0.3% citric acid; 200 ppm ethylenediaminetetraacetic acid (EDTA); and, 3% nonfat dry milk (NFDM). One g of bone marrow, prepared by chopping and grinding primary spongiosa from the femurs, was added to the middle of ten g portions of meat, which were then placed into each of five replicate tubes. Tubes were cooked to an internal temperature of 76.6 C, immediately cooled, and meat was removed. Color values (CIE L*, a*, and b*) were measured in triplicate on the meat surface adjoining the marrow. Lightness (L*) ranged from 45.5 to 51.3, redness (a*) ranged from 23.4 to 28.9, and yellowness (b*) ranged from 14.4 to 16.8. Citric acid (a* = 23.4) and EDTA (a* = 23.8) significantly ($P < 0.05$) reduced redness compared to Control values (a* = 27.4). Neither ascorbic acid (a* = 24.8) nor NFDM (a* = 28.9) reduced redness values when compared to Control values, although ascorbic acid redness values were significantly lower than NFDM. These data show citric acid and EDTA significantly reduced redness in this experiment, whereas ascorbic acid and NFDM did not reduce redness values.

Key Words: Cooked breast meat, Red discoloration, Bone marrow

Animal Products in Today's Diet

578 The nutritional contributions of animal products to the US diet - The USDA Food Pyramid and Dietary Guidelines. Donald. J. McNamara, Ph.D.*[1], [1]*Egg Nutrition Center.*

Seems all one ever hears about dietary recommendations is "eat more whole grains, more fruits, more vegetables" and nary a good word about milk, beef, pork, chicken, eggs or the other animal products in the diet. Too many so called nutrition experts put animal products in the "bad food" group based on fat and cholesterol without recognizing the wealth of contributions these products make to a healthy and nutritious diet. There are good reasons why animal products hold important places in the USDA Food Guide Pyramid and in the Dietary Guidelines for Americans, and no matter what the fat/cholesterol-phobic and animal rights activists say, the evidence is clear that the diet is more nutritious, and more enjoyable, with the inclusion of animal products in a balanced diet.

Key Words: Animal products, Nutrition, Dietary guidelines

579 Modified protein diets. E. Hentges*, *National Pork Producers Council.*

Diets higher in protein have gained popularity in the U.S. and other developed countries for several reasons. Hentges will discuss the protein diet effects on insulin resistance, serum lipids, and weight control. He will also discuss the effects this diet has had on the industry and the response from national health organizations.

Key Words: Protein, Diets

580 Designer foods. D.C. Beitz* and T.J. Knight, *Iowa State University.*

Governmental agencies and human health associations have made specific and general recommendations for consumers to improve their health by changing their diet. Animal scientists have responded with a variety of nutritional, genetic, and management tools that can be used to redesign meat, milk, and eggs compared with previously produced products. But, to continue to meet consumer demands and to make animal-derived foods even more appealing, animal scientists must continually strive to modify animal food composition and quality to meet