

egg ω -3 content for the flaxseed diet (from 546 to 578 mg/60g egg; $P=0.02$) and for the Linpro diet (from 415 to 438 mg/60g egg; $P=0.07$). As well, an overall decrease ($P=0.01$) in ω -6 to ω -3 ratio (from 1.53 to 1.47) was noted. Enzyme addition increased ($P=0.02$) the NSP digestibility from 17.2 to 24.6%. There was no significant effect of enzyme addition on total tract fat digestibility. Overall, hens fed the Linpro diets had higher ($P=0.02$) fat digestibility than those fed the flaxseed diets (95.6 vs 89.9%). It could be concluded from this study that both dietary ingredient (i.e., Linpro) and diet processing along with enzyme supplementation had positive effects on feed utilization and the production of ω -3-enriched eggs.

Key Words: laying hens, flaxseed, ω -3 eggs

171 Energy releasing effect of an alpha amylase - beta glucanase blend in all vegetable corn soy diets for broiler. A. G. Bertechini¹, S. L. Vieira², J. C. Carvalho¹, J. A. G. Brito¹, and G. O. Figueiredo¹, ¹UFL, Lavras, MG, Brazil, ²UFRGS, Porto Alegre, RS, Brazil.

Enzyme inclusion in broiler feeds has been increasing. Theoretically, enzyme blends can show a larger spectrum to improve nutrient utilization from low digestible substrates. In this study, 960 Cobb X Cobb 500 broiler chicks were placed in 32 floor pens. All birds were fed corn-soybean meal all vegetable diets allocated to 4 different treatments having energy and nutrients to meet or exceed NRC

(1994). A Positive Control was formulated with ME levels as usual in commercial integrations from 1 to 7, 8 to 21, 22 to 35 and 35 to 42 days (2,950; 3,050; 3,150 and 3,200 kcal/kg). A Negative Control was formulated with 3% reduction in ME. This was accomplished by exchanging soy fat from the the Positive Control formulation by an inert. The other two treatments were produced through the supplementation of the Negative Control with 300 and 400 grams of Ronozyme A (200 kilo-Novo alpha-amylase units and 350 fungal beta-glucanase units per gram). Eight replicates of each treatment were used in a Completely Randomized Design. In parallel, a metabolism assay was conducted with broilers placed in steel cages, 10 birds per cage, 6 replicates per treatment. Birds with 24 days of age received the grower feed for 4 days of adaptation and 3 days of total excreta collection. Body weight, feed intake and feed conversion were significantly improved for birds of Positive Control when compared to the Negative Control. The enzyme blend added to the Negative Control demonstrated a complete recovery in performance, similar to the Positive Control. However, differences between the two enzyme levels were not seen. Results from the metabolism assay showed consistency in formulated versus analyzed ME's. Improvements in analyzed ME values of 2,06 and 4,36% were observed after inclusion of 300 and 400 grams of the enzyme blend, respectively. Viscosity of excreta samples collected at 42 days and the yield of carcasses and commercial cuts were not affected by the treatments.

Key Words: broiler, enzyme, amylase

Physiology, Endocrinology, and Reproduction: Physiology

172 Can a novel lighting program for turkey breeder hens delay the expression of photorefractoriness and boost late-season egg production? J. A. Proudman¹ and T. D. Siopes², ¹USDA-ARS, Beltsville, Maryland, ²University of North Carolina, Raleigh.

Turkey breeder hens are commonly photostimulated to lay using a day length of at least 14 h of light (14L:10D), which results in a rapid onset and high peak of egg production. Some lighting programs then increase day length further as the reproductive season progresses. Long day length leads to photorefractoriness (PR) and an end to the breeding season in many hens. We have previously shown that a 12h photoperiod will not induce PR, but it also will not reliably stimulate maximum egg production. In this study, we photostimulated hens with a 16L:8D photoperiod for 8 wk to achieve maximum peak production and then reduced day length to 12L to reduce PR. After 7 more wk, we increased day length to 18L to boost late-season production in hens that remained photosensitive. Control hens received 16L:8D until 15 wk and then 18L:6D until the experiment was terminated at 34 wk. Results showed that hens receiving the experimental photoperiod had a lower incidence of PR than controls over 34 wk of production (10% vs 27%), and that egg production was significantly higher in the experimental group between 17 and 34 wk of lay. However, overall egg production did not differ between groups because 10% of the treated hens ceased laying during the 12 h light treatment period. These hens remained photosensitive and resumed lay when returned to a longer photoperiod (18L). We conclude that a reduction in photoperiod to 12L after 8 wk of conventional photostimulation will reduce PR, extend photosensitivity, and permit a subsequent boost in late-season egg production. Additional studies are needed to achieve a lighting

program that will extend photosensitivity while maintaining egg production in all hens.

Key Words: turkey, photorefractoriness, photoperiod

173 Can typical poor egg production by turkeys during the summer be accounted for by insufficient lighting and reduced photoperiodic drive? T. D. Siopes*, North Carolina State University, Raleigh.

This experiment tested the hypothesis that typical poor egg production during the summer is a consequence of insufficient lighting and reduced photoperiodic drive. Large White turkey breeder hens were photostimulated at 30 wk of age with incandescent light on April 12 for summer (off-season) egg production and continued for 28 wk. The lighting treatments were given in a 2 x 2 factorial arrangement with day length and light intensity as main effects. Day length used was 15L:9D and 18L:6D whereas the intensities were 567 ± 67 and 22 ± 2 lux. All the treatments were within a light controlled building and there were 8 replicate pens of 5 hens for each treatment. Data were collected, by pen, for onset and the rate of lay; BW and feed consumption at 4 wk intervals; EW at 4 wk intervals including the weight of the first 14 eggs laid; livability; and, plasma thyroid hormones for 8 wk post-lighting. The rate of egg production through 28 wk of photostimulation was better in the hens receiving 18 than 15 h of light per day (14 eggs/hen difference) but was similar between the two intensity treatments. The lower number of eggs in the 15 h group was associated with a greater number of photorefractory hens than in the 18 h of light per day group

(39 vs 14%, respectively). Egg weights were similar between the 18 and 15 h of light/day treatment groups but was significantly greater in the low intensity treatment as compared to the high intensity treatment. We may conclude that by increasing photoperiodic drive by increased day length, but not light intensity, there results an improved summer egg production by turkeys and reduced incidence of photorefractoriness. Egg size was best at a reduced light intensity.

Key Words: photoperiod, light intensity, egg production

174 Effect of eyes on reproduction in Formoguanamine injected male chicks. T. Rathinam^{*1}, Y. Obara², J. A. Proudman³, and W. J. Kuenzel¹, ¹University of Arkansas, Fayetteville, ²Meijo University, Nagoya, Japan, ³USDA/ARS/BGPL, Beltsville, Maryland.

A quantitative assessment of the role of photoreceptors in the eye on gonadal system is not clear in avian species. Enucleation studies have shown that eyes have little effect, on subsequent gonadal development. The current study was done to assess the role of eye on reproduction by chemical induction of blindness (elimination of rods and cones), and to analyze the effect of the chemical on encephalic photoreceptors (EPRs). Formoguanamine HCl (FG) has been shown to cause selective blindness in several avian species. Male broilers were raised on a short photoperiod (LD 8:16) and were injected with either FG (200mg) or saline. At 2 wk, FG injected birds were given a feed mixed with Sulfamethazine (SMZ), a compound with progonadal effects (FG+SMZ; n=12). Saline injected birds were either on an SMZ diet (SAL+SMZ; n=12), or a regular ration (SAL+CON; n=12). Photoperiod was shifted to LD 16:8 for 3 wk. Blood samples were collected on days 0, 3, 6 of LD16:8 and assayed for FSH and LH. Based on visual response, the FG+SMZ group was further divided into fully blind (FB+SMZ; n=5) and partially blind (PB+SMZ; n=5) individuals. There was a difference in plasma LH and FSH on days 3 and 6 of SAL+SMZ versus SAL+CON groups. Plasma LH and FSH levels of FG treated birds on Day 6 were different from SAL+CON. Testes weights (mean±SEM) of each group were: SAL+SMZ: 0.65±0.10^a; FB+SMZ: 0.475±0.47^{a,b}; PB+SMZ: 0.452±0.04^{a,b}; SAL+CON: 0.365±0.02^b. There is a 27% reduction in testes weights of FB birds compared to SAL+SMZ. Preliminary neuron (VIP-ir) count results in lateral septal organ, a proposed EPR, showed no difference in cell numbers in SMZ-fed SAL and FG groups (546 and 507 neurons respectively) (n=2) suggesting that FG had no effect on proposed EPRs. Although there is no significant suppression in testes weights from birds lacking retinal photoreceptors compared to controls, the numerical values (27% reduction) suggest that the eyes possibly play a minor role on gonadal development. Supported in part by grant # IBN-0315793 from the NSF to WJK.

Key Words: reproduction, photoreceptor, sulfamethazine

175 The role of the retinal and extra retinal photoreceptors in reproductive activities of broiler breeder hens. I. Rozenboim^{*1}, N. Mobarkey¹, and M. E. El Halawani², ¹Hebrew University of Jerusalem, Rehovot, Israel, ²University of Minnesota, St. Paul.

The role of light in biological activities associated with egg production is well known. The decline in the rate of egg production during the reproductive season of the hen can be the result of incubation behavior as well as photorefractoriness both connected to photostimulation.

Determining the role of the eye and the brain photoreception in the decline in reproductive activities was the objective of this study. Animals: 130 broiler breeder hens at 23 wk of age were divided into nine environmental and light controlled rooms (n=15), equipped with individual battery cages. Three rooms were photostimulated (14L:10D) with full light spectrum (white light; 29 lux; 0.16 W/m²), and served as control. Six rooms were equipped with two lighting systems provided; red (0.16 W/m²) and green (27.5 lux). Upon photostimulation three rooms were photostimulated by increasing red light to 14 h of light (green light remained on 6 h) and the last 3 rooms were photostimulated by increasing green light to 14 h of light (red light remained on 6 h). Reproductive activities were recorded daily, monthly blood samples were collected and plasma level of ovarian steroids, as well as LH was recorded. At 65 wk of age birds were killed, hypothalamic tissue and pituitary were removed and assay for GnRH, GnIH, VIP mRNA levels.

Photostimulation with green light caused a significant delay in the reproductive activities manifested by low egg production and plasma gonadal steroid levels during the 12 wk of photostimulation. Cumulative eggs were the lowest during all the period of experiment. Hens photostimulated with red light had higher egg production, compare to white control and green light treated birds. Photostimulation with red light caused significant elevation in both GnRH and GnIH mRNA level. Retinal photostimulation (green light) together with non-photostimulation of extra-retinal photoreceptors (red light) delayed reproductive activities; where as extra-retinal photostimulation (red light) together with retinal non-photostimulation (green light) accelerated reproductive activities.

Key Words: broiler breeder, photostimulation, photoreception

176 Effect of arginine on blood gases, acid-base balance and plasma corticosterone in broilers. L. L. Hale-McWilliams^{*}, M. Putsakum, S. W. Anderson, A. Corzo, Y. Vizzier-Thaxton, and J. P. Thaxton, *Mississippi State University, Mississippi State.*

Blood gases (pO₂ and pCO₂), acid-base balance as indicated by blood pH, electrolytes (HCO₃⁻, Na⁺, K⁺, Ca⁺², and Cl⁻), and plasma corticosterone (CS) concentration, were determined in 43 d broilers. These broilers (Ross x Ross 708 males) were raised with common feeds up to 21 d of age, and then fed from 21 to 43 d a grower-phase diet either marginal (0.98% digestible arginine; CON) or supplemented with 0.1% L-Arginine (1.08% digestible arginine; ARG). Arginine supplementation improved (P<0.01) the feed conversion of the ARG birds when compared to the CON treatment, thus validating that ARG was dietary marginal. From a hematological standpoint, the only effect attributable to ARG treatment, as compared to CON diets, was a decrease in blood pO₂. Plasma CS levels were separated into high (3,327 to 10,100 pg/mL), medium (992 to 2,947 pg/mL) and low (296 to 943 pg/mL) concentrations, regardless of nutritional status. Blood pO₂ levels were not different among the three CS groups. However, birds that received ARG treatment and possessed high CS levels had the lowest pO₂ of all ARG and CS combinations. Dietary ARG is known to cause increased synthesis of creatine phosphate in growing broilers. Therefore, it is probable that arginine favors assimilation of a metabolic oxygen reserve via formation of creatine phosphate.

Key Words: oxygen, arginine, corticosterone

177 Transcriptional analysis of the liver in juvenile broiler chickens divergently selected for high or low body weight. N. Trakooljul^{*1}, W. Carré¹, X. Wang¹, R. J. Tempelman², E. Le Bihan-Duval³, M. Duclos³, J. Simon³, T. E. Porter⁴, and L. A. Cogburn¹, ¹University of Delaware, Newark, ²Michigan State University, East Lansing, ³Station de Recherche Avicoles, INRA, Nouzilly, France, ⁴University of Maryland, College Park.

The developmental profile of hepatic gene expression was examined in chickens divergently selected for either high growth (HG) or low growth (LG) rate. Body weight in these INRA lines diverges after 3 wk with a greater than 2-fold difference at 11 wk. Furthermore, relative abdominal fat weight of HG birds was 14-fold greater than that in the LG at 11 wk. Liver samples were collected from HG and LG cockerels (6 birds per line) at 1, 3, 5, 7, 9 and 11 wk. Del-Mar 14K Chicken Integrated Systems microarrays were used for a transcriptional scan in liver during juvenile development using a balanced block hybridization design. Log₂-transformed fluorescence intensities were analyzed with a two-stage mixed model. The initial analysis revealed 557 genes that showed a significant interaction between genotype and age. The largest number of differentially expressed genes (357) was found at 7 weeks of age, where 199 genes were up-regulated in the HG line and 176 genes were up-regulated in the LG line. At 9 wk, only 36 genes were up-regulated in the HG line, whereas 17 genes were up-regulated in the LG line. The differential expression of several genes was confirmed by quantitative RT-PCR. Genes that showed significantly higher transcript levels in the liver of HG birds include *CEBPA*, *SULT1*, *CPT1*, *FASN*, *DLAT*, and *HMGCL*. Among hepatic genes with verified higher expression in LG birds were *PTGDS*, *CEBPB*, *SOD*, *AVL-Pr57*, *ANX5*, and *LDH*. The differentially expressed genes include many metabolic enzymes, acute phase proteins, immune factors and transcription factors that could control key metabolic processes and therefore expression of production traits (growth rate and body fat content). Several of these functional genes map to QTL identified in a novel F₂ resource population created from a cross of the HG and LG lines.

Key Words: microarray, functional genes, metabolic pathways

178 Inosine ameliorates the effects of hemin induced oxidative stress in broilers. C. N. Seaman^{*1}, G. Casotti², E. A. Falkenstein¹, J. S. Moritz¹, K. Van Dyke¹, and H. Klandorf¹, ¹West Virginia University, Morgantown, ²West Chester University, West Chester, Pennsylvania.

Previous studies have shown that chronic treatment of chickens with hemin decreases plasma concentrations of uric acid (PUA) and increases oxidative stress whereas the inclusion of inosine produces an inverse effect. The objective of our study was to determine whether inosine could lower the oxidative stress induced by hemin. Four-wk-old broilers were individually banded and divided into four treatment groups (Control, Hemin, Inosine, Hemin/Inosine). Throughout the study control birds (n=10) were injected daily with a buffer solution, while hemin birds (n=10) were injected daily with a 20mg/kg body weight hemin buffer solution. Leukocyte oxidative activity (LOA) and PUA were measured on day eight. Results showed that hemin birds had higher levels of LOA (P=0.0333) and lower PUA (P=0.1174). On day 10, control and hemin birds were subdivided into inosine birds (n=5) and hemin/inosine birds (n=5). These birds were given 0.6M/kg of feed/d of dry inosine. Plasma concentrations of uric acid and LOA were then measured on day 15. Results showed that inosine raised concentrations of PUA (P=0.0001) and lowered LOA (P=0.0044)

as induced by hemin. In a separate study stereological analyses of inosine vs. control birds revealed no anatomical differences in kidney morphology between treatments (P<0.05). The results of these studies support the view that uric acid reduces oxidative stress by functioning as an antioxidant. Uric acid treatment has the potential to decrease the amount of damage generated by free radicals during times of oxidative stress associated with disease states.

Key Words: uric acid, oxidative stress, hemin

179 Patho-physiological changes associated with rapid growth in commercial broilers. S. Nain^{*}, B. Laarveld, and A. A. Olkowski, University of Saskatchewan, Saskatoon, SK, Canada.

This work examines patho-physiological changes in commercial male broilers reared in lowered environmental temperature either fed ad-lib or subjected to a feed restriction regime. The birds were housed in pens with raised perforated floors in an environmentally controlled room. The temperature during the first 7 d was maintained at 34°C followed by a gradual decrease to a level approximately 30% lower than that set for normo-thermal brooding. A total of 83 birds were allocated to an ad-lib fed group and 39 to a feed-restricted group. Feed restriction set at 70% ad libitum commenced at day 7. All birds were monitored several times a day for overt signs of disease. Morbidity and mortality data were collected daily. Basic physiological data evaluating cardiovascular and respiratory function were obtained during the 5th wk of the trial using randomly selected apparently normal birds from each group. There was no mortality in the feed restricted group and all birds remained clinically normal throughout the trial. In the ad-lib fed group 6% and 46% succumbed to sudden death syndrome (SDS) and ascites, respectively. Broilers fed ad-lib had a significantly (P<0.05) lower heart rate (HR: mean 322 BPM) and a higher respiration rate (RR, mean 56) compared to the feed restricted group (HR: 370 and RR, 51). Blood gas analyses revealed marked hypercapnia (pCO₂ 48.3), hypoxemia (pO₂ 38.3) and lower hemoglobin O₂ saturation (69.3%) in the ad lib fed group, as compared to the restricted group (pCO₂: 36.0; pO₂:41.88; and hemoglobin O₂ saturation 71.2%). Ascitic birds showed severe hypercapnia (pCO₂ 58.2), hypoxemia (pO₂ 21.3) and the lowest hemoglobin O₂ saturation (30.6%). We conclude that many individuals in a population of commercial broilers are predisposed to heart failure and that low temperature and rapid growth are important factors precipitating patho-physiological changes in cardiac and respiratory functions in the susceptible broilers.

Key Words: broilers, heart failure, mortality

180 Effect of feeding program during rearing and onset of lay on reproductive performance of broiler breeder females. N. Leksrisompong^{*}, P. W. Plumstead, H. Romero-Sanchez, and J. T. Brake, North Carolina State University, Raleigh.

A study was conducted to evaluate the effects on broiler breeder females of two feed allocation programs during the rearing period followed by two feed increase rates from photostimulation to peak egg production. Twelve replicate pens of 190 females each were randomly assigned to two treatments (sigmoid or line) during the rearing period (1 to 21 wk of age) and two feed increase treatments (slow or fast) from photostimulation to peak egg production in a 2 x 2 factorial design with three replicate pens each. The flock was photostimulated at 21 wk of age when Ross 344 males and Ross 308SF females were

housed and mixed in the production facility. There were no differences in rate of lay but females that had been reared on the sigmoid feeding program exhibited significantly reduced mortality during the laying period that resulted in a significantly increased number of eggs per hen housed (185.3 versus 175.6). Fertility was not affected but fertile hatchability was significantly improved by the sigmoid rearing program (93.1% versus 90.9%) due primarily to fewer early and late dead (not including pipped) embryos. There were no differences due to the two different feed increase programs from photostimulation to peak egg production.

Key Words: broiler breeders, feeding programs, fertility

181 The effects of skip-a-day feeding during the early lay period on reproductive physiology in broiler breeder hens. L. C. Gibson*, A. J. Davis, and J. L. Wilson, *University of Georgia, Athens.*

Skip-a-day (SAD) feed restriction is a common industry management technique that is used from 2 wk of age until 5% egg production in broiler breeders. The current study examined whether SAD feeding after light stimulation to 5% egg production is detrimental to overall reproductive performance. During rearing pullets were weighed weekly, and all pullets were fed on a SAD basis through 20 wk of age. At 21 wk of age, pullets and cockerels were moved into 30 lay pens each having 35 females and 4 males, and provided 14 h of light to stimulate reproduction. From 21 to 26.5 wk, 15 of the pens were provided ED feeding while the remaining 15 pens continued on SAD feeding until 8% egg production. At 26.5 wk, all hens were placed on ED feeding. Blood samples were collected from the hens of one individual pen from each treatment group at 26.5 and 30.5 wk. Bird weight and the coefficient of variation of bird weight were not significantly different between the two treatments from 20 wk of age through 62 wk of age. Plasma progesterone and estradiol concentrations were significantly depressed in the SAD hens at 30.5 wk. Through 62 wk of age hens that were provided ED feeding have a hen-day egg production of 163.0 eggs versus 145.6 eggs from the SAD birds. This significant difference in egg production is based on a consistently lower weekly egg production in the SAD hens throughout the experiment compared to the ED hens. The results suggest that SAD feeding after light stimulation to 8% egg production causes long term reproductive dysfunction in broiler breeder hens.

Key Words: broiler breeder hens, skip-a-day feeding, everyday feeding

182 Changes in the microbiota populations and gastrointestinal tract development of the jejunum and ileum. B. S. Lumpkins*, A. B. Batal, and M. D. Lee, *University of Georgia, Athens.*

The bacterial population in the gastrointestinal tract (GIT) influences a variety of physiological processes of the GIT and exerts a profound effect on the overall health and development of the bird. However, little is known about how the presence of different intestinal bacterial community compositions affects the development of the GIT in chickens. Three 21 d preliminary experiments were conducted to observe changes in the microbiota populations and GIT development of Cobb 500 chicks. In Experiment 1, a corn-soybean meal (SBM) and a corn-fish/poultry by-product meal diet and in Experiment 2, a corn-SBM and a semi-purified corn gluten meal-casein-soy protein concentrate diet were fed to 8 replicate pens of 20 chicks. In Experiment

3, chicks were sexed, allocated to 8 replications of 20 chicks, and each fed a corn-SBM diet. At 4, 7, 14, and 21 d of age, chicks were randomly selected for jejunum and ileum sampling. The bacterial DNA was isolated from the digesta, and denaturing gradient gel electrophoresis (DGGE) was used to examine PCR amplified fragments of 16S ribosomal DNA. In Experiment 1, chicks fed the corn-fish/poultry by-product meal diet had greater jejunum weights and villi height at 4 and 14 d of age compared to chicks fed the control diet, but at 7 and 21 d of age there was no difference in GIT length, weight, villi height or width between treatments. A difference in bands using DGGE was observed between treatments as well as with age, and at 14 and 21 d there was an increase in high G + C bacteria such as clostridium. In Experiment 2, an increase in intestinal length and biodiversity of the microbiota population characterized by more low and high G + C bacteria, lactobacillus and clostridium respectively, were observed in chicks fed the semi-purified diet compared to the corn-SBM diet. In Experiment 3, there were no differences in GIT measurements or the microbiota population due to sex. Based on DGGE analysis, it was observed that the developmental changes of the GIT were related to changes in microbiota populations.

Key Words: microbiota, gastrointestinal tract, denaturing gradient gel electrophoresis

183 Bone fracture incidence in high-producing non-commercial laying hens identified using radiographs. W. D. Clark*¹, W. R. Cox², and F. G. Silversides¹, ¹*Agriculture and Agri-Food Canada, Agassiz, BC, Canada,* ²*Canadian Animal Health Management Services Ltd., Chilliwack, BC, Canada.*

Bone fractures in laying hens are a concern for welfare and for production. Manual dissection has been used to estimate fracture incidence in hens. This study used radiographs to quantify fracture incidence in six lines of non-commercial high-producing laying hens. Euthanyl Forte was used to euthanize 451 hens (n=71 to 78) at 47 wk [White Leghorn-Black (WL-BLK), WL-Blue (WL-BLU)], or at 65 wk of age [Barred Rock (BR), Columbian Rock (CR), Rhode Island Red (RIR), and WL-Burgundy (WL-BUR)]. Carcasses were stored at -20 C and thawed prior to being x-rayed. Radiographs were obtained with birds in lateral (left side down) and dorso-ventral positions. Fractures were classified as new (sharp edges without apparent tissue reaction) or old (edges undefined or callus noted). Damage to bones of the head, neck, and feet was not evaluated and difficulties were encountered in analyzing the ribs, sternal processes, and vertebrae. Contingency chi-square analysis was used to compare lines within age groups. The overall incidence of birds with at least one fracture was 15.7 and 6.6% (65 and 47 wk, respectively) with 88 and 100% of the fractures classified as old. The incidence of hens with fractures in the lines observed at 47 wk was not different (WL-BLK: 6.4%; WL-BLU: 6.8%) and fractures in these lines occurred primarily in the wing and pubic bones. The incidence of hens with fractures in the 65-wk-old birds was 29.5% (RIR), 18.2% (BR), 9.5% (CR), and 4.2% (WL-BUR); (RIR=BR, RIR>CR and WL-BUR, BR>WL-BUR). Fractures occurred primarily in the furculum, pubic bones, and wing bones with more fractures of the furculum for RIR than the other three lines (17.9 vs. 0 to 5.4%), while BR hens had more fractures of pubic bones (14.3 vs. 1.3 to 1.4%). These data show variation in bone fragility and bones susceptible to fracture among the lines studied, and demonstrated that radiographs are a useful means for gathering data on fracture incidence.

Key Words: radiograph, fracture, bone

184 Increased internal radiodensity of humeri in high-producing non-commercial laying hens. W. D. Clark^{*1}, W. R. Cox², and F. G. Silversides¹, ¹*Agriculture and Agri-Food Canada, Agassiz, BC, Canada*, ²*Canadian Animal Health Management Services Ltd., Chilliwack, BC, Canada*.

The humerus is often used to assess skeletal health in laying hens. It usually contains an airsac in the central cavity, but studies have demonstrated that the humeri of some hens do contain medullary bone. This study used radiographs to compare the incidence of increased radiodensity in the central cavity of humeri between lines of high-producing non-commercial laying hens. Hens of six lines (n=71 to 78, 451 total) were euthanized at two ages: 1) 65 wk [Barred Rock (BR), Columbian Rock (CR), Rhode Island Red (RIR), and White Leghorn-Burgundy (WL-BUR)], and 2) 47 wk [WL-Black (WL-BLK), WL-Blue (WL-BLU)]. Hens were euthanized using Euthanyl Forte, stored at -20 C, and thawed prior to being x-rayed. The radiographs were examined for increased radiodensity in the central cavity of the humeri of each hen, the extent of which ranged from a small section

at the distal end of the bone to the entire length. Each humerus was recorded as having or not having increased internal radiodensity. Contingency chi-square analysis was used to compare lines within age groups. Among the older hens, the incidence of birds with at least one humerus with increased radiodensity was highest in the BR and RIR (61.0 and 66.7%, respectively). The incidence in CR (17.8%) and WL-BUR (18.3%) was significantly lower. The incidence in the younger birds did not differ significantly (16.0 and 15.1% for WL-BLK and WL-BLU, respectively). These results demonstrate substantial variation in the occurrence of increased central cavity radiodensity between lines, which can likely be attributed to medullary bone development. This variability, along with the variable amount of the humerus affected, could impact results of humerus bone assessment using methodologies dealing with the whole bone (ash, density, strength) and those such as quantitative computed tomography that use only a small portion of the bone. Caution should be used when using the laying hen humerus to assess skeletal health.

Key Words: humerus, radiograph, medullary bone

Processing, Products, and Food Safety: Processing, Products and Food Safety

185 Effect of combining antimicrobial treatments with in-package pasteurization for control of *Listeria monocytogenes* in ready-to-eat turkey bologna. S. Mangalassary^{*}, I. Y. Han, J. Rieck, and P. L. Dawson, *Clemson University, Clemson, South Carolina*.

Post-cooking contamination of Ready-to-Eat (RTE) meat and poultry products by *Listeria monocytogenes* (LM) is a major food safety problem as well as an economic hardship to the food industry for several years. Various post-processing interventions like in-package pasteurization, high pressure processing, and application of various antimicrobial agents alone or in combination have been tested to eliminate LM from RTE meat surfaces. The objective of this study was to determine the effect of combining nisin and/or lysozyme surface application with in-package pasteurization on the survival of LM on RTE turkey bologna during storage at 4°C. Bologna samples were subjected to surface application of 4 treatments—control (no antimicrobial), nisin (2000IU/ml), lysozyme (10mg/ml), and a combination of nisin and lysozyme (2000IU nisin+10mg lysozyme/ml). Samples were inoculated with 10⁸cfu of the organism and vacuum packaged. A set of 4 treatments were stored without subjecting to in-package pasteurization. Another set of 4 treatments were subjected to in-package pasteurization at 65°C for 1.3 minutes. All treatments were sampled for LM growth at 0day, 1, 2, 3, and 4 weeks of storage. Treatments subjected to in-package pasteurization showed a 3–4 log initial reduction and also a significant reduction over 4 weeks of storage in LM population compared to treatments without pasteurization. Pasteurized control and lysozyme treated samples showed a 2 log reduction over 4 weeks whereas pasteurized nisin and nisin–lysozyme combination treatments showed a 4 log reduction (no viable cells of the organism from 3rdweek). Results of this study indicate that combining nisin and nisin–lysozyme combination treatments with in-package pasteurization is effective in eliminating LM from RTE meat and poultry products. Results would be significant to the industry considering the fact that the reduction in bacterial population was achieved by a relatively short pasteurization time.

Key Words: turkey bologna, antimicrobials, in-package pasteurization

186 Comparison of poultry processing conveyor belts for susceptibility to bacterial attachment and biofilm formation. S. Pitchiah^{*}, C. Z. Alvarado, and M. M. Brashears, *Texas Tech University, Lubbock*.

During processing of poultry products, bacteria from the carcass can attach to wet surfaces which can lead to biofilm formation providing a source for cross contamination for subsequent carcasses. The purpose of this study was to determine susceptibility to bacterial attachment and biofilm formation with and without poultry products of different conveyor belts including polyurethane with mono polyester fabric, acetal (3.2 % open mesh), polypropylene- mesh top (24% open mesh), polypropylene (48% open mesh), stainless steel –single loop (80% open mesh) and stainless steel–balance weave (70% open mesh). Experiment 1 –Surfaces were inoculated with *Salmonella* cocktail (without any poultry product) in BPW to achieve final inoculum level of 5 log CFU/ml. Test surfaces were analyzed by sponge and swab method at 0, 1, 2, 4, 6, 8, 12, 24 and 48 hr. For aerobic plate count, the stainless steel belts (single loop and double loop) showed significant reduction in APC when compared to other belts. Initial attachment (0 hr) of *Salmonella* did not show any significant change in all belt types; however, canvas belts showed a significant attachment over time. Experiment 2 –Attachment of bacteria with poultry products was determined with test chips. Chicken breasts were inoculated with *Salmonella* or *Listeria monocytogenes* culture for one hour and rinsed with PBS. Test chips were immersed in this solution and evaluated (1, 6, 12, 24 and 48 hr). At 1 and 48 hr, attachment of *Salmonella* and *Listeria monocytogenes* was lowest in the stainless steel single loop (0.403 log CFU/cm²), and stainless steel –balance weave (0.364 log CFU/cm²). Experiment 3 –Attachment of *Listeria monocytogenes* to form a biofilm was determined. Initial biofilm formation was very low on the stainless steel belts but by day 4 all belts had biofilm formation. Therefore, stainless steel belts allowed for less growth and attachment of bacteria over time. However, even stainless steel belts must be cleaned and sanitized to prevent biofilm formation over time.

Key Words: poultry processing, biofilm, bacteria