Poster Presentations

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TP335 Correlation and principal component analyses of corn grain from Brazilian Cerrado region. S. I. F. Rodrigues[1,3], J. H. Stringhini*[1,5], C. McManus[1,5], M. N. Oliveira[3], and A. M. Penz Junior[4], [1]*Universidade de Brasilia*, *Brasilia, DF, Brasil*, [2]*Universidade Federal de Goias*, *Goiânia, Goiás, Brazil*, [3]*Asa Alimentos*, *Brasilia, DF, Brazil*, [4]*Nutron Alimentos*, *Campinas, SP, Brazil*, [5]*CNPq researcher*, *Brasilia, DF, Brazil*.

Approximately six and a half thousand samples of corn were taken from trucks, delivered to a feed mill, between 2003 and 2007, in the Federal District, Brazil. These were analyzed to determine physical (damaged, moulded, broken, fragmented, soft, insect damaged, fermented) and chemical properties. Correlation and Principal Component Analyses were performed using SAS® to evaluate the relationships between characteristics. Correlations between physical traits were low (both positive and negative <0.2) and significant ($P < 0.001$). Highest correlations were found between broken and fragment proportions (0.60), fermented and fungus contaminated grain (0.39), as well as broken with most of the other physical traits measured (0.44–0.75). Correlations between chemical traits were higher, in particular with estimated apparent metabolizable energy (ME) and humidity (H), but with nonnitrogen extract (NNE), density (D), crude fiber (CF) and ether extract (EE) they were low to medium (0.10–0.35). Correlations between physical and chemical traits were low, in general <0.10. Principal component analysis separated physical from chemical traits. The first component showed that when humidity was low, ME, NNE, EE tended to be high, and vice versa. Crude protein (CP) did not affect this component. The second component showed that when there were a lot of physical problems with the grain, D, H and ME were low and vice versa. The first 3 principal components explained 50% of the variation between the 21 variables studied. There is a need to carry out a discriminate analysis to further evaluate the relationships between these traits.

Key Words: chemical and physical composition, energy and protein analyses, humidity

TP336 Performance, organ morphology, and abdominal fat of broilers supplemented with a probiotic and garlic as an alternative to antibiotic growth promoters. H. Collazos*, S. Triana, and O. Castro, *Universidad Nacional Abierta Y a Distancia Unad*, *Bogota, Cundinamarca, Columbia*.

The present work evaluated the effect of an antibiotic a probiotic and garlic on performance and organ morphology of broilers. Two hundred and forty Ross chicks were distributed at 21 days in a randomized design with 6 treatments (Controls, 1 level of antibiotic, 2 levels of probiotics and garlic), with 4 replicates of 10 birds. Diets were given to the birds from 21 to 49 days of age, formulated to meet or exceed NRC requirements. Data were collected for weekly weight gain and feed consumption to determine feed conversion. Organ morphology was determined during experiment. Parameters evaluated were: Abdominal fat; for organ morphology were: Intestine pH, weight and length, weights of gizzard, liver, spleen, heart, proventriculus, and pancreas. The results showed that no significant ($P > 0.05$) differences were observed for weight gain and feed consumption, only significant differences ($P < 0.05$) were noted for feed conversion. Highest weight gain occurred in treatment 4 (5% garlic) and best feed conversion also found in treatment 4.Whereas for organ morphology, only significant difference ($P < 0.01$) were noted for proventriculus weight. There were no significant differences ($P > 0.05$) for abdominal fat. Results indicate that probiotics and garlic have the potential to replace antibiotics as growth promotants for broilers.

Key Words: broilers, organ morphology, garlic

TP337 Additive effects between ingredients on ileal amino acid digestibility in broilers. V. Ravindran*, *Institute of Food, Nutrition and Human Health, Massey University*, *Palmerston North, New Zealand*.

The additivity of apparent and true ileal amino acid digestibility values in 3 complete diets based on corn (C), wheat (W), rice bran (RB), soybean meal (SBM) and canola meal (CM) for broilers was investigated. The 3 complete diets contained the following as the main ingredients: C + SBM. W + SBM and C + RB + SBM + CM. The 5 ingredients and the 3 complete diets were each fed to 4 pens of 5 male broilers from day 28 to 35 posthatching. In the case of C, W, and RB, assay diets contained 93.8% of the test ingredient. For SBM and CM, assay diets were based on dextrose and the test ingredient to supply 20% dietary protein. All diets had titanium oxide as the inert marker. On day 35, digesta from the lower half of the ileum was collected and apparent amino acid digestibility coefficients were calculated. Endogenous amino acid flow, determined using enzyme hydrolyzed casein, was used to calculate the true digestibility values. In general, for both apparent and true digestibilities, there were no significant differences ($P > 0.05$) between the determined and predicted values in the C + SBM diet. In the W + SBM diet, the determined and predicted true digestibility values were similar ($P > 0.05$), but the determined apparent digestibility values were higher ($P < 0.05$) than predicted values for some amino acids, including threonine, leucine, isoleucine and valine. In the C + RB + SBM + CM diet, the determined and predicted true digestibility values were similar ($P > 0.05$), but the determined apparent digestibility values were higher ($P < 0.05$) than predicted values for most amino acids. It appears The present results indicate that apparent digestibility values of individual ingredients are not additive when ingredients with low amino acid digestibility and/or antinutritive factors are used in feed formulations.

The data also suggest that true digestibility values are additive and digestible amino acid supply in a complete diet can be predicted from true digestibility coefficients of individual ingredients

Key Words: amino acid digestibility, additivity, broilers

TP338 Effect of shochu distillery by-product on skeletal muscle growth in broiler chickens. T. Kamizono*, T. Tagoyama, A. Ohtsuka, and K. Hayashi, *Kagoshima University*, *kagoshima, Japan*.

Shochu is a Japanese traditional liquor made from sweet potato, rice etc. Shochu is very popular in Japan and thus huge amount of Shochu Distllery By-Product (SDBP) is produced. As drying SDBP is very costly, we are trying to use condensed SDBP (50% water, 3.0kcal GE/g) as a feed additive of the commercial broiler feed. The condensed SDBP made from sweet potato contains crude protein (13%), citric acid (3.6%), polyphenols (2.2%), α-tocopherol (3.4 mg%), and ascorbic acid (440 mg%). The SDBP contains also a growth stimulating substance buthoxybuthylalcohol as reported previously. However, SDBP is not still used effectively as feed. We have previously reported that SDBP can improve not only growth but also meat quality of broiler. Thus SDBP can be used effectively as a feed additive. The purpose of the present study is to show the effect of SDBP on skeletal muscle protein breakdown in broiler using plasma 3-methylhistidine as an index. The experimental diets (isocaloric and isonitrogenous) containing the SDBP at the levels of 1, 2 and 4% were given to 15-day-old broiler chicks. The basal diet and (23% crude protein and 3,040 kcal ME per kg) was made mainly of corn and soybean meal. The diets were given ad libitum during the period from day 15 to day 27. The experiment was undertaken in a temperature-controlled (25 ± 1°C) room with a 12-h light and 12-h dark cycle. The body weight gain and feed intake tended to be increased by 2 and 4% SDBP, but feed conversion ratios were not affected. The breast muscle weight tended to be increased by 2 and 4% SDBP and the ratio of 3-methylhistidine: creatinine in the plasma were significantly increased by SDBP. The results indicate that the SDBP may accelerate skeletal muscle growth by stimulating both skeletal muscle protein synthesis and breakdown in broiler.

Key Words: liquor by-product, feed additive, muscle growth

TP339 The effect of different levels of vitamin E on humeral immunity, and performance in broiler. R. Vakili*[1] and R. Daliri[1], [1]*Islamic Azad University*, *khashmar, Iran*, [2]*Islamic Azad University*, *khashmar, Iran*.

In this research, 240 one-day-old Ross 308 chicks were used in a CRD to investigate the effect of diets containing 4 levels vitamin E (0, 10, 20 and 40 mg/kg) on humeral immunity and performance.In order to study response of Humeral Immunity of broiler chicks, chicks at age of 15, 30 and 45 days were injected i.v. with 0.2 mL of a 5% Saline suspension of sheep red cell (SRBC). Blood samples were collected from each bird at 7 and 14 days after the second and third challenge. Afterwards, the 2-mercaptoethanol sensitive (2MES, presumably IgM) and 2-mercaptoethanol resistant (2MER, presumably IgG), Anti-SRBC antibody titers were determined using a microheamagglutination technique.Chicks were then slaughtered and their bursa of fabricus and their spleens were weighted.The results of this study suggested that vitamin E has no significant effect on performance of broiler chicks such as body weight, feed intake and feed efficiency
($P > 0.05$). There was a significant difference ($P < 0.05$), total Anti-SRBC-titter, mercaptoethanol sensitive antibody (2-ME sensitive), Anti-Newcastle disease virus titter (NDV) in group which was given 40 mg/kg added vitamin E in compare with control group.2-mercaptoethanol resistant (2-ME resistant)and Lymphatic organs (bursa of fabricus and spleen) weight was not under the effect of diet, therefore no significant difference was observed ($P > 0.05$).Theses results indicate that humeral immune responses are directly affected by vitamin E and that excessive vitamin E intake has a detrimental effect on antibody production in broilers.

Key Words: vitamin E, immunity, hemagglutination

TP340 Effects of dietary astaxanthin on gizzard ulceration induced by dietary histamine in broiler chicks. M. H. Oh*[1], C. S. Song[2], and K. M. Chee[1], [1]*College of Life Sciences and Biotechnology, Korea University*, *Seoul, Korea*, [2]*College of Veterinary Science, Konkuk University*, *Seoul, Korea*.

Two feeding trials were conducted to determine if astaxanthin (AX) has a protective effect on gizzard (GZ) ulceration induced by dietary histamine in broiler chicks. AX, one of the xanthophyll pigments in crustacean and salmonids, contains potent antioxidant properties. Due to its powerful antioxidant activity AX has been reported to have potentials to protect gastric ulcer including a variety of illnesses such as cardiovascular diseases, some types of cancer and immune diseases in human or rats. Histamine (H) is one of the dietary factors causing gastric erosion and ulceration in young chicks. The ulceration was reported to progress with increased tissue lipid peroxidation in rats. Young, male, broiler chicks (Ross308) were used for both experiments. In experiment 1, 48 chicks were allotted into 4 treatments (Basal, H, HAX20, HAX100), 3 replications, 4 chicks each. 0.4% HS was added to the diet, and AX, from Phaffia yeast, was added to the HS diet at 20 or 100 ppm. The chicks were fed the diets ad lib for 3 wk. Ingesting the H diets reduced BWG (1.0 vs. 0.75 kg/b), and increased the % BW of proventriculus (PV, 0.4 vs. 1.11) and GZ (1.48 vs. 1.92) in the chicks ($P < 0.05$). AX did not prevent the abnormal responses in body wt, PV and GZ in the chicks caused by the HS. In experiment 2, 36 birds were forced-fed (except control) the AX20, AX100, H, HAX20 and HAX100 diets for 2 weeks to keep the amount of feed intake identical as the control. The overall responses of the birds to the H diets were almost the same as in the experiment 1. The structural changes in the PV by the H were more severe than those in the GZ. The losses of gastric glands in PV were not prevented by the AX. Frequency of GZ ulceration, however, was certainly lowered by the AX without significant differences between the 2 supplementation levels. In conclusion, AX could be used to improve poultry performances under certain stressful conditions.

Key Words: gizzard erosion, histamine, astaxanthin

TP341 Influence of main cereal of the diet and feed form on growth performance and digestive traits of brown pullets from 1 to 120 days of age. M. Frikha[1,2], H. M. Safaa[2,3], D. G. Valencia[2], M. P. Serrano[2], and G. G. Mateos*[2], [1]*Instituto Agronómico Mediterráneo de Zaragoza*, *Spain*, [2]*Universidad Politécnica de Madrid*, *Spain*, [3]*Animal Production Department, Faculty of Agriculture, Cairo University*, *Egypt*.

A trial was conducted to study the effect of the main cereal of the diet and feed form on productive performance and digestive traits of brown pullets from 1 to 120 d of age. There were 4 dietary treatments arranged factorially with 2 cereals (corn vs. wheat) and 2 feed forms (mash vs. 2-mm pellets). Each treatment was replicated 6 times (24 pullets placed in 2 adjacent cages per replicate). From 46 to 120 d of age all the diets were offered as mash; therefore they differed only in the cereal used. Type of cereal had little effect on pullet performance. Pelleting improved feed intake (27.24 vs. 25.69 g; $P \leq 0.001$) and BW gain (10.89 vs. 10.28 g/d; $P \leq 0.001$) from 1 to 45 d of age but feed-to-gain ratio was not affected. From 1 to 120 d of age, pullets that were fed pellets from 1 to 45 d had higher BW gain (12.35 vs. 11.98 g/d; $P \leq 0.001$) than pullets that were fed mash. Pullets fed corn had heavier relative weight (RW, %BW) of the gizzard (3.74 vs. 3.17%BW; $P \leq 0.001$) at 45 d of age than pullets fed wheat. Also, at this age, pelleting reduced the RW of the digestive tract (12.91 vs. 14.60%BW) and the gizzard (2.72 vs. 4.19%BW; $P \leq 0.001$), and the relative length of the small intestine (237.5 vs. 255.0 cm/Kg BW; $P \leq 0.01$) and the ceca (21.3 vs. 25.1 cm/Kg BW; $P \leq 0.01$). The effect of feed form on RW of the gizzard and relative length of the small intestine was maintained at 120 d of age ($P \leq 0.01$). At 120 d of age, gizzard pH was not affected by type of cereal but was higher in pullets that were fed pellets during the prestarter phase (3.99 vs. 3.46; $P \leq 0.01$). We conclude that wheat can be used successfully in pullet feeds and that feeding pellets from 1 to 45 d of age increases BW at 45 and 120 d of age. Pelleting reduces the RW of the upper gastrointestinal tract which might have some effects on performance of the pullets early in lay

Key Words: diets, brown pullet performance, digestive traits

TP342 Effects of pure isomers of conjugated linoleic acid (CLA) on egg quality of laying hens. E. Muma*[1], E. Valkonen[2], M. Näsi[1], M. Griinari[1], and J. Valaja[2], [1]*University of Helsinki*, *Helsinki, Finland*, [2]*MTT Agrifood Research Finland*, *Jokioinen, Finland*.

Conjugated linoleic acid(CLA) is a natural food component which yields health-promoting or therapeutic effects in the diet.Eggs are a good channel by which we can improve the human dietary CLA intake. However, inclusion of CLA in poultry diets results in egg quality changes.Moreover, comercially produced CLA is usually a mixture of different positional and geometrical isomers.This compounds the over all effects on egg quality.

The purpose of this study was to delineate the effect of each isomer of CLA and the extent to which they contribute to enrichment and inhibition of the Δ^9-desaturase enzyme.

Experimental diets to supply 0.1,0.2 and 0.3 g/h/d, respectively, of 5 different CLA isomers were fed to 100 hens for 14 days.There was one control and daily feed intake was monitored.Sample eggs were analyzed for egg quality and also fatty acid composition by gas chromatography.

Effects on feed intake were not significant. However, effect on fatty acid composition was strongest in eggs from hens on 10,12 CLA diets. We concluded that eggs are easily enriched and that 10,12 CLA had the strongest effect on the fatty acid profile which also has implications on egg quality.

Key Words: CLA, egg quality, desaturase inhibition

TP343 Growth performance of broiler chickens fed diets containing shea nut (Vitellaria paradoxa, Gaertn.) meal fermented with *Aspergillus niger*. H. K. Dei*[1], S. P. Rose[2], A. M. Mackenzie[2], and R. Amarowicz[3], [1]*University for Development Studies*, *Tamale, Ghana*, [2]*Harper Adams University College*, *Newport, United Kingdom*, [3]*3Institute of Animal Reproduction and Food Research of the Polish Academy of Sciences*, *Olsztyn, Poland*.

Shea nut meal is an agro-industrial by-product of the shea fat industry in West Africa. The objective of this experiment was to determine the effect of shea nut meal fermentation using *Aspergillus niger* on growth performance of broiler chickens. Two shea nut meal samples (expeller and solvent-extracted) were fermented using *Aspergillus niger* (0.25 g of spores per kg shea nut meal in 2 parts of water) in a closed plastic container for 8 days. Each sample replaced wheatfeed in a maize-soybean meal diet at 100 g/kg and fed to 128 Ross 308 male broiler chickens (22–36 d). There were 8 replicates per diet and 4 birds per replicate in cages. Treatments means were compared using ANOVA. Total soluble phenolics in the experimental diets were in decreasing order of 5.8 g/kg (unfermented meal), 4.9 g/kg (fermented solvent-extracted meal), 3.6 g/kg (fermented expeller meal) and 1.9 g/kg (wheatfeed). Broilers fed the fermented meals exhibited higher ($P < 0.001$) growth performance than those fed the unfermented meal. There was no significant difference between broiler growth performances of the 2 fermented shea nut meal samples. However, the growth performance of broilers fed all shea nut meal based diets was lower ($P < 0.001$) than that of broilers fed the control diet. Mean weight gain and feed efficiency of broilers fed the fermented meals were 78 and 84%, respectively, of that of broilers fed the control diet. The fermentation of shea nut meal using *Aspergillus niger* has the potential to improve the nutritive value of shea nut meal for poultry, but requires further development.

Key Words: *Aspergillus niger*, shea nut meal, broiler chicken

TP344 Essential oils can substitute growth promoter antibiotics in broiler chicken. N. Mathlouthi[1,4], T. Bouzaïenne[2], I. Oueslati[4], F. Recoquillay*[3], M. Hamdi[2], and R. Bergaoui[4], [1]*Ecole Supérieure d□Agriculture du Kef*, *Le Kef, Tunisia*, [2]*Institut National des Sciences Appliquées et de Technologie de Tunis*, *Tunis, Tunisia*, [3]*Phytosynthèse*, *Riom, France*, [4]*Institut National Agronomique de Tunisie, Laboratoire de Recherche en Economie en Agroalimentaire*, *Tunis, Tunisia*.

Essential oils can be used as a substitute for growth promoter antibiotics. They are natural compounds and they will improve the poultry product image for consumer. The present study was designed to evaluate the in vitro antimicrobial activity of the commercial essential oils Enterocox (Phytosynthèse, France) and its effects on growth performances of broiler.

The disc diffusion method was applied for the determination of antimicrobial activities of essential oils contained in Enterocox. In vivo, a total of three hundred and seventy-five, 1-day-old male broilers (Arbor Acres) were assigned to the basal diet (T), the basal diet supplemented

with 10 mg antibiotics/kg diet (AB) and the basal diet supplemented with 1,000 mg of Enterocox/kg diet (ENT) until 42 days of age. Body weight and feed intake were determined.
In vitro, Enterocox had antimicrobial effects on *E. coli*, *Salmonella indiana*, *Listeria innocula*, *Staphylococcus aureus*, *Bacillus subtilis*, *Enterococcus faecalis* and *Lactobacillus plantarium*.
In vivo, throughout the entire trial period (1–42 days), the body weight is significantly ($P < 0.05$) increased in birds fed ENT diet compared with those fed T (2,143.08 vs. 2,066.25 g). Broiler chickens fed ENT diet had a better ($P < 0.05$) feed:gain ratio than those fed T diet (1.822 vs. 1.901). There were no differences in body weight (2,140.06 vs. 2,143.08 g) and feed:gain ratio (1.793 vs. 1.822) among broilers consuming AB and ENT diets. Moreover, the birds fed AB diet had the lowest ($P < 0.05$) feed intake (3,709.2 g) compared to those fed T (3,833.4 g) and ENT (3,803.4 g) diets.
Essential oils contained in Enterocox can substitute growth promoter antibiotics because they allow the same performances in broiler chickens.

Key Words: essential oils, antimicrobial activities, broiler chickens

TP345 Optimising feed inclusion levels of a multistrain probiotic in broiler nutrition. K. C. Mountzouris[1], P. Tsirtsikos[1], R. Beltran*[2], M. Mohnl[3], G. Schatzmayr[3], and K. Fegeros[1], [1]*Agricultural University of Athens, Department of Animal Nutrition*, *Athens, Greece*, [2]*BIOMIN USA Inc*, *San Antonio, TX*, [3]*BIOMIN GmbH*, *Herzogenburg, Austria*.

Probiotics are live microbial feed supplements that belong to zootechnical feed additives. An assessment of current literature indicates that apart from microbial species composition, animal response to probiotics could be dose related.
The aim of this work was to investigate the feed optimum inclusion level of a commercial multistrain probiotic (Biomin® Poultry5Star, BIOMIN GmbH) in broiler nutrition. A total of 525 one-day-old male Cobb broilers were allocated in 5 experimental treatments for 42 days. The experimental treatments received a corn-soybean basal diet (BD) and were: C (BD no additions), P1 (BD + probiotic at 10^8 CFU/kg feed), P2 (BD + probiotic at 10^9 CFU/kg feed), P3 (BD + probiotic at 10^{10} CFU/kg feed) and A (BD + avilamycin at 2.5 mg/kg feed). Each treatment had 3 replicates of 35 broilers.
Body weight (BW), feed intake (FI) and feed conversion ratio (FCR) was determined on weekly and overall basis. Overall, treatment P1 performed better than the rest in terms of BW gain and FCR. Treatment A (2,230 g) was intermediate and not different from P1 (2,293 g) or from P3 (2,167 g), P2 (2,163 g) and C (2,165 g). FCR value for treatment P1 (1.78) was significantly better from treatments C (1.86) and P3 (1.88).
Our study indicates that probiotic inclusion at 10^8 CFU/kg feed, could be optimum for enhancing growth promotion.

Key Words: probiotics, broiler chickens, feed additives

TP346 The potential of Near Infrared Reflectance Spectroscopy (NIRS) to predict nutritional values of the major co-products of the bioethanol industry. C. Gady, P. Dalibard, and P. A. Geraert*, *ADISSEO France SAS*, *Antony, France*.

Near Infrared Reflectance Spectroscopy (NIRS) is based on the absorption of the infrared rays by organic matter. A sample can partially or selectively absorb this radiation and then revealed information about its organic molecular composition. This feasibility study was conducted to investigate the potential of NIRS to predict nutritional values of DDGS (distillers dried grains with solubles) from the bioethanol industry.
Twenty-two samples (8 wheat DDGS and 14 corn DDGS) were analyzed for TAA and evaluated for true ileal amino acid digestibility (AAD) using caecectomized cockerels. Same samples have been analyzed for their absorbances from 400 to 2,500 nm with a NIRSystem model 6500 (FOSS, Sweden). Correlations between spectral characterizations and reference data were developed using partial least squares (PLS) regression technique. Spectral data were primarly subjected to a derivative math treatment 1,4,4,1 or a 2,5,5,1 and a Standard Normal Variates and Detrending scatter corrections. Correlations were calculated using a single database combining both wheat and corn DDGS due to the balanced distribution of the population.
Calculated regressions showed good correlations. They respectively explained from 95.3 to 98.7% of the variation measured in TAA. Corresponding standard deviations (SD) of the models ranged from 0.006 for tryptophan to 0.035% for lysine. Except for tryptophan digestibility ($R^2 = 0.66$), calibrations explained from 80.2 to 93.2% of the variability measured in amino acid digestibility. Models were associated to SD going up to 1.865 for methionine digestibility to 5.397% for lysine digestibility.
This feasibility study demonstrated that NIRS is a promising tool for the prediction of nutritionally relevant parameters for wheat and corn DDGS. Because its accurate capability in characterizing specific nutritional value batch per batch on line, NIRS could be a method of choice for qualifying the current and the evolving DDGS qualities.

Key Words: DDGS, near infrared spectroscopy, amino acids digestibility

TP347 Liquid methionine hydroxy analog HMTBA has anti fungal activity in in vitro tests. Y. Mercier*[1], M. A. Le Bras-Quere[2], M. Paugam[2], and P. A. Geraert[1], [1]*ADISSEO France S.A.S., CERN*, *Commentry, France*, [2]*Université Européenne de Bretagne Université de Brest*, *Plouzané, France*.

Fungal contamination can affect feed quality for broilers through mycotoxins such as aflatoxin which drastically lower bird performances. The liquid methionine hydroxy-analog is not only an efficient source of methionine to balance amino acid requirement but also exhibits organic acid properties. The aim of this experiment was to test the effect of increased doses of methionine hydroxy analog (HMTBA; Rhodimet™AT88) on the various fungal species cultivated in vitro. Five field fungal strains were tested with increasing doses of HMTBA from 0 to 0.4% (w/w) in a classical PDA (Potato Dextrose Agar) media. All plates have been seeded with 3 spots of approximately 100 spores and incubated at 25°C during 7 days. After the incubation period for all fungus species, the growth diameter has been measured and compared relative to the control group growth. On the 5 field fungi strains, the growth diameter inhibition observed with the maximum level of HMTBA (0.04%) range from 47 to 76% for *Aspergillus fumigatus* and *Fusarium graminearum*, respectively. Considering an usual feed inclusion level of HMTBA around 0.20%, the growth diameter inhibition observed was, respectively, 31, 36, 49, and 26% for *Aspergillus flavus*, *Aspergillus fumigatus*, *Fusarium verticillioides* and *Penicillium aurantiogriseum*, respectively. The effect of HMTBA on growth of *Fusarium graminearum* appeared only at the 0.25% dose rate, but morphological changes were already observed from 0.1% with reduction of the sporulation area size. Furthermore, the

sporulation area appeared almost completely inhibited by 0.3% HMTBA for *Fusarium graminearum* and *Aspergillus fumigatus*.
The results obtained in the present study clearly indicate that HMTBA presents inhibiting effects on field fungi under in vitro condition. This inhibitory effect on growth is further accompanied by inhibition of sporulation for some strains which allows to lower fungi dissemination.

Key Words: methionine hydroxy analog, feed safety, fungi

TP348 Effects of two mushroom extracts on broiler performance and microbial ecology during coccidiosis. L. Mazuranok[1], D. Bravo*[1], H. Panneman[2], C. Ionescu[1], and M. Naciri[3], [1]*Pancosma Research*, *Geneva, Switzerland*, [2]*Dr. Van Haeringen Laboratorium BV*, *Wageningen, The Netherlands*, [3]*INRA*, *Nouzilly, France*.

The trial was conducted to evaluate the effects of 2 mushroom extract dosages: shiitake (S1, S2) and reishi (R1, R2), in comparison to a non-infected nontreated group (NINT) and an infected nontreated control (INT) 1) on the performance of broiler chicks reared to 28 days in cages, 2) on the parasitological status and 3) on their microbial profile, during an infection with *Eimeria acervulina*. The performance of S1, R1 and R2 were not statistically different of NINT and INT. Only S2 improved performance statistically. The 4 treatments improved statistically lesion score but did not modify oocyst excretion. A similarity index for each treatment was not consistent because of the huge individual differences. However, microbial profile was compared by peaks and the bacteria were identified. It showed that NINT had a relatively low number of peaks with limited height. Compared to NINT, INT group showed probably an increase of Actinobacterium species as S1. This phenomenon is highly limited by R1 and R2. Then, *Lactobacillus kefiranofaciens* seemed to decrease in R1 and S1 but is unchanged in control groups. Finally, *Lactobacillus gasseri*, a beneficial bacteria, decreased drastically in INT, S1 and S2, was unchanged in R2 and could be promoted by R1, compared to NINT.

Key Words: *Eimeria acervulina*, shiitake, reishi

TP349 Nutritional variability of major co-products of the bioethanol industry. C. Gady, P. Dalibard, and P. A. Geraert*, *Adisseo France SAS*, *Antony, France*.

Several factors either native grain quality or process conditions can influence the final quality of DDGS (distillers dried grains with solubles) issued from the conversion of cereals into bioethanol. Main objectives of this work were to determine both nutritional characteristics and variability of corn and wheat DDGS.
Twenty-two DDGS samples (8 wheat DDGS and 14 corn DDGS) were obtained from 6 different countries in the world. All samples have been analyzed for proximate and Total Amino Acids (TAA). In vivo evaluations of true ileal Amino Acid Digestibility (AAD) have been performed using caecectomized roosters. Digestibility coefficients have been corrected by endogenous amino acid values determined with a protein free diet.
Wheat DDGS were classified as low and standard according to their protein content whereas corn DDGS showed an additional high-protein type. Important variations were observed among wheat DDGS in total lysine and threonine and among all TAA of corn DDGS with the exception of total cystine. Coefficients of variation showed also similar variability within standard class of both wheat DDGS (18 and 17% for lysine and threonine) and corn DDGS (28 and 15% for lysine and methionine). Origin of the grains, processing conditions and disposition of solubles, potentially reflected the variations. Differences emphasized with respect to the AAD. Lysine and cystine digestibilities of the high-protein class of corn DDGS are improved by +15 and +16 points comparing to standard type. Low and standard class of corn DDGS also showed similar low digestibilities ranging from 42 to 70% for lysine and 41 to 70% for cystine. Wheat DDGS showed particularly low lysine and cystine digestibilities, from 26 to 54% and from 49 to 60%, respectively. These variations and the lower digestibilities might mainly reflect heat damage and could also be influenced by yeast and enzyme residual activities.
According to these substantial variations, DDGS must be well characterized to optimize their nutrient contribution to monogastric diet formulation.

Key Words: DDGS, amino acids, digestibility

TP350 Effect of various combinations of carbohydrases for broilers fed corn/SBM-based diets. N. E. Ward*[1], J. Wilson[1], S. Williams[1], and G. Mathis[2], [1]*DSM Nutritional Products Inc.*, *Parsippany, NJ*, [2]*Southern Poultry Research*, *Athens, GA*.

Evidence continues to accumulate to support the beneficial effect of carbohydrases in poultry diets, specifically corn/SBM formulations typical of U.S. commercial production. Some enzymes target specific ingredients, depending on which major substrates are present.
This study was designed to test commercial enzyme products in a corn/SBM-based diet with 3% poultry by-product meal, when enzymes were added alone or in combination with other enzyme products. Mixtures were in combination with a particular enzyme product designed to improve soybean meal utilization. Nine (9) treatments were fed to male Cobb × Cobb broilers reared in floor pens from day 1 to day 47 in a completely randomized block design. Performance (body weight, feed intake, mortality) was determined on days 21, 35 and 47. Enzymes were added to a diet formulated to be 132 kcal/kg feed (60 kcal/lb) less than the positive control, and all treatments were replicated 8 times with each pen starting with 50 birds. Trt 3 Ronozyme® AX was pelleted with the feed, while all others were applied as a liquid postpelleting. All enzymes were added at rates commensurate with product recommendations.
On day 21 (days 35 and 47 data to be collected), the positive control was superior ($P < 0.05$) to the negative control for body weight and F/G. Pellet stable Ronozyme AX improved ($P < 0.05$) body weight, as did Roxazyme® G2(L). Trts 5 and 8 failed to increase body weight. Based on gain, trts 3 and 4 provided the equivalent of 60 kcal/lb feed, while trts 5, 6, 7, 8, and 9 provided 34, 48, 48, 40 and 43 kcal/lb feed. Feed conversion was improved ($P < 0.05$) in the enzyme trts, relative to the negative control. F/G of birds fed Ronozyme AX was improved ($P < 0.05$) over enzyme trt 5. Mortality was similar across all trts.
The combinations of enzyme trts failed to provide any additional benefit as compared to the individual products. These data are consistent with the ability of Ronozyme AX to survive pelleting in that AX significantly improved body weight and F/G during the initial 21 day period.

Table 1. 21-day performance of broilers fed enzymes added to corn/SBM diet

Treatment	Description	Average body weight, kg	Feed intake/pen, kg	F/G
1	Positive control	0.674[a]	52.89	1.486[d]
2	Negative control	0.624[b]	52.74	1.594[a]
3	Ronozyme® AX	0.684[a]	54.18	1.497[cd]
4	Roxazyme®G2	0.683[a]	54.63	1.513[bcd]
5	Product A	0.652[ab]	52.88	1.542[b]
6	Product B	0.664[a]	53.73	1.522[bcd]
7	Trt 3 + Trt 6	0.664[a]	53.48	1.528[bcd]
8	Trt 4 + Trt 6	0.657[ab]	53.61	1.536[bc]
9	Trt 5 + Trt 6	0.660[a]	53.33	1.512[bcd]

[a–d]Different superscripts within a column indicate a difference ($P < 0.05$).

Key Words: corn/SBM diets, carbohydrase, Ronozyme, Roxazyme

TP351 Nutritional evaluation of a high-protein corn distillers dried grains with solubles (HP corn DDGS) in broilers and evaluation of NSP-enzyme effect on energy digestibility. C. Gady, P. Dalibard, and P. A. Geraert*, *Adisseo France SAS*, *Antony, France*.

The present study was conducted to measure the Apparent Metabolizable Energy (AME) of a high-protein corn distillers dried grains with Solubles (HP corn DDGS) in broilers and to evaluate the effect of a fungal NSP-enzyme produced by *Penicillium funiculosum* (Rovabio™ Excel) on its energy digestibility. The trial was performed including 15% of HP corn DDGS in a corn soya based diet and comparing to a control diet. The effect of enzyme supplementation was also measured on both diets. AME was determined using the European Reference Method with ad libitum feeding and total excreta collection (Bourdillon et al., 1990). 12 individually caged Ross male birds per treatment were used. They received the experimental diets, from 12 to 22 days of age, prior to the energy balance performed between 19 and 22 days of age. The diets were formulated to provide 3,060 kcal/kg, 21% crude protein, 1.12% lysine, 0.53% methionine, 0.89% sulfur amino acids, 0.82% threonine and 0.25% tryptophan.

AME of the control corn soybean based diet was close to the the targeted value (3,061 vs. 3,060 kcal/kg). By contrast, the diet containing 15% of HP corn DDGS was much lower (2,887 kcal/kg) demonstrating that the HP corn DDGS energy value had been overestimated. Both body weight gain and feed intake were similar between treatments ($P > 0.1$) and then not affected by the inclusion of 15% HP corn DDGS. AME of this HP corn DDGS was recalculated by comparing to control diet and estimated to be around 1,770 kcal/kg.

The NSP-enzyme supplementation increased AME of the control corn-soybean meal diet by 68 kcal/kg and was only marginally increased with the 15% HP corn DDGS inclusion to 71 kcal/kg. Such an effect has to be further evaluated according to the quality of the DDGS.

Key Words: DDGS, NSP-enzyme, energy digestibility

TP352 Nutritional evaluation of corn distillers dried grains with solubles (DDGS) in layers and potential benefit of NSP-enzyme supplementation on energy digestibility. C. Gady, P. Dalibard, and P. A. Geraert*, *Adisseo France SAS*, *Antony, France*.

The present study was conducted to measure the Apparent Metabolizable Energy (AME) of a corn DDGS (distillers dried grains with solubles) and to evaluate the effect of a fungal NSP-enzyme produced by *Penicillium funiculosum* (Rovabio™Excel) on its energy digestibility in layers. Trial was performed including 10 and 20% of the corn DDGS in a corn wheat based diet and compared to a control diet. The effect of enzyme supplementation was also measured in the 3 diets. Dietary AME was determined using the European Reference Method with ad libitum feeding and total excreta collection during 1 week on ISA Brown laying hens at 38 weeks of age (Lessire et al., 1995). One layer was placed per cage with 12 replicates per dietary treatment. The diets were formulated to provide 2,700 kcal/kg, 17% crude protein, 0.89% lysine, 0.38% methionine and 0.90% sulfur amino acids.

The AME obtained with the control corn wheat based diet was close to the targeted value (3,089 vs. 3,106 kcal/kg DM). The corn DDGS AME was recalculated by comparing control diet to both 10 and 20% inclusion diets and averaged 2,452 kcal/kg DM. The AME of the control diet was only increased by 34 kcal/kg DM by enzyme supplementation, which is lower than expected for such a matrix. This may be explained by the lower feed intake of the layer hens fed with the enzyme-treated diet compared to the control one (99.5 vs. 104.4 g/hen/day) whereas feed intake were similar between other treatments ($P > 0.1$). Both feed conversion and egg weight were similar and then not affected by the inclusion of corn DDGS in the diets. Even if there is no significant difference, the improvement of energy digestibility by NSP-enzyme supplementation was greater for diets containing 10 and 20% corn DDGS: 43 and 58 kcal/kg DM, respectively, and suggest a potential benefit of carbohydrolase addition depending on the quality of the DDGS.

Key Words: DDGS, NSP-enzyme, energy digestibility

TP353 Evaluation of distillers dried grains with solubles (DDGS) in broiler diets formulated isocaloric at typical industry levels or formulated for optimum density with constant 1% poultry oil. Z. Wang*, S. Cerrate, C. Coto, F. Yan, F. Perazzo, A. Abdel-Maksoud, and P. Waldroup, *University of Arkansas*, *Fayetteville*.

Increasing production of ethanol from corn is providing greater amounts of DDGS. This study evaluated use of DDGS levels higher than normally used. Diets were formulated containing 0, 15, or 30% DDGS of known composition. In one series, diets were isocaloric at typical industry energy level; amount of oil increased as percentage DDGS increased. In a second series, diets were formulated for optimum density with 1% added poultry oil. Pellet quality was similar for diets with 0 or 15% DDGS but decreased markedly at 30% DDGS; the decline in quality was less when a constant 1% oil was added. In isocaloric diets, body weight declined significantly in birds fed diets with 30% DDGS compared to those fed 0 or 15%; in optimum density diets there was no significant difference in BW among birds fed 0, 15, or 30% DDGS. Feed conversion increased as DDGS levels increased but feed intake, caloric intake, and caloric efficiency were not significantly affected by DDGS level or by formulation method. Breast meat yield, as a percent of BW, was not significantly affected by DDGS level or by method of formulation. These data indicate that successful use of high levels of DDGS is related to formulating on digestible amino acid basis, knowledge of nutrient composition, and improving pellet quality.

Key Words: energy formulation, distillers by-products, pellet quality

TP354 Effects of five plant extracts on broiler performance during coccidiosis. L. Mazuranok[1], B. Bravo*[1], C. Ionescu[1], and M. Naciri[2], [1]*Pancosma Research*, *Geneva, Switzerland*, [2]*INRA*, *Nouzilly, France*.

In Europe, coccidiostats and anticoccidial should be prohibited in 2012 as feed additives. In such a context, different solutions should be examined to maintain performance and reduce coccidiosis losses. That's why this trial was conducted on broiler chickens to evaluate the effects of 5 plant extracts at 2 different dosages each: reishi, shiitake, berberin, turmeric and chilli pepper, in comparison to a noninfected nontreated group (NINT) and an infected nontreated control (INT) at day 7, 14, 21 - 1) on broiler performance and 2) on parasitological status - during an infection with *Eimeria acervulina*. 1) All types of plant extracts improved body weight at 21 days numerically (from +0.3% for berberin group to +3.6% for shiitake group vs. INT). Moreover, they all improved lesion score at 18 days either numerically as for berberin, chilli pepper groups (−5.2%, −19.2%, respectively) or statistically as for reishi, shiitake and turmeric groups (−34.4%, −44.4%, −34.4%, respectively). At 21 days, the lesion score decreased numerically, whatever the plant extract dose, for all plant extracts except for Reishi groups where it decreased significantly ($P < 0.01$).

Key Words: plant extracts, *Eimeria*, performance

TP355 Effects of dietary levels of calcium and nonphytate P in broiler starter diets on live performance, bone development, and growth plate conditions in male broilers fed a corn-based diet. C. Coto*[1], F. Yan[1], S. Cerrate[1], Z. Wang[1], P. Sacakli[1], P. Waldroup[1], J. Halley[2], C. Wiernusz[2], and A. Martinez[2], [1]*University of Arkansas*, *Fayetteville*, [2]*Cobb-Vantress, Inc.*, *Siloam Springs, AR*.

A study was conducted to evaluate the effects of dietary levels of calcium (Ca), nonphytate P (NPP), phytase (Phy) and 25-hydroxycholecalciferol (25-OH) on live performance and bone development in male chicks fed a corn-based diet. Dietary treatments consisted of a 2 × 2 × 4 × 4 factorial arrangements with 2 levels of supplemental phytase (0 or 1,200 FTU/kg), 2 levels of 25-OH (0 or 69 µg/kg), 4 levels of Ca (0.20% less than a 2:1 ratio of Ca to NPP; 2:1 ratio of Ca to NPP; 0.20% Ca greater than a 2:1 ratio of Ca to NPP; 0.40% Ca greater than a 2:1 ratio of Ca to NPP) and 4 levels of NPP (0.35, 0.40, 0.45 and 0.50%) for a total of 64 treatments. The primary diet was supplemented with a vitamin mix containing 5,500 IU of cholecalciferol. Each diet was fed to 6 replicates per treatment, each pen having 6 birds. At 18 d birds were weighed, feed consumption determined and all birds killed for bone measurements. Toes from all birds within a pen were removed and ashed. Tibiae from both legs were removed and scored for incidence and severity of tibial dyschondroplasia and for incidence of Ca or P rickets. Ca: NPP ratios and Ca levels similar or higher than NRC (1994) recommendations appear necessary for adequate bird performance. Phy supplementation improved FCR, whereas the addition of 25-OH to diets already containing 5,500 IU/kg of cholecalciferol had a negative effect on FCR due to a possible hypercalcemia condition. Bone development was improved by increasing NPP and Ca levels. Moreover, supplementation with 25-OH was effective in reducing leg abnormalities. Addition of 25-OH helped to relieve leg problems when suboptimal Ca levels were supplied while Phy supplementation was effective for this purpose when high Ca levels were given. These additives could be seen as a strategy to alleviate problems with suboptimal Ca: NPP ratios.

Key Words: leg abnormalities, Ca:P ratios, bone development

TP356 Improved nutritional value of feather meal by dietary supplement of versazyme. J. C. H. Shih*[1], B. E. Spencer[1], and J. J. Wang[2], [1]*North Carolina State University*, *Raleigh*, [2]*BioResource International*.

Versazyme (VZ), the commercial product of keratinase, has been demonstrated as an effective feed additive that improves body weight gain (BWG) and feed conversion ratio (FCR) of broiler chickens fed a corn-soy diet. Since it improved protein digestibility, VZ could spare up to 10% (e.g., 2% out of 21%) crude protein (CP) from soybean meal (SBM) in feed, indicating the feed cost reduction. Feather meal (FM) is a potential protein source. Previously, keratinase activity was shown to be able to partially hydrolyze feathers into a more digestible FM. However, the effect of dietary supplement of VZ on the digestibility of FM in feed has never been studied. In a recent experiment, we formulated a starter diet with 21% CP and lysine and methionine to meet 100% each requirement. The experimental design was in a 2 × 2 arrangement to include the corn-soy control diet (CS) vs. experimental diet (FM), in which 5% SBM protein (24% of total protein) was replaced by FM protein, with and without VZ at 0.1% level. VZ (300,000 EU/g) in dry powder form was mixed directly into the feed. A total of 192 day-old male broiler chicks were used, with 6 replicates each treatment and 8 birds each replicate (4 × 6 × 8). Feed and water were available ad libitum. Brooding temperatures and lighting cycle are controlled as the standard program. At day 21, birds and feeds were weighed and BWGs and FCRs were statistically analyzed. The results were as follow. VZ increased significantly BWG in both the CS (from 736 to 781 g) and FM (from 691 to 740 g) groups. VZ also decreased FCR in both the CS (from 1.39 to 1.35) and FM (from 1.45 to 1.42) groups, but not statistically significant. Overall, both VZ and protein (CS vs. FM) effects were significant ($P < 0.008$). It is interesting to point out that the FM+VZ group grew as well as the CS control, though the CS+VZ was the best as expected. More analyses, including the intestinal keratinase activity and amino acid ileal digestibility, are in progress. In summary, the test results indicated that dietary supplement of VZ had the effect of upgrading the nutritional value of FM in broiler chickens on starter diet.

Key Words: feather meal, keratinase, protein nutrition

TP357 Assessment of the interassay repeatability of ileal amino acid digestibility in wheat fed to broilers. A. Bandegan*[1], W. Guenter[1], D. Hoehler[2], and C. M. Nyachoti[1], [1]*University of Manitoba*, *Winnipeg, Canada*, [2]*Evonik Industries*, *Kennesaw, GA*.

It is now well accepted that the use of ileal amino acid (AA) digestibility coefficients in formulating poultry diets provides a better estimate of AA availability and prediction of bird performance. However, digestibility estimates are affected by various factors including assay conditions. To assess the repeatability of the broiler ileal digestibility assay and to validate the assays as used in our laboratory, ileal AA digestibilities in a sample of wheat were determined in a series of 4 independent assays. In each assay, day-old male Ross broiler chickens were fed a commercial starter diet from d 1 to 15 of age and the test diet from d 15 to 21. The test diet contained wheat as the sole source of protein and chromic oxide (0.3%) as digestibility marker and was balanced for minerals and vitamins to meet requirements. Within assay, the diet was assigned to 6 replicate cages, each with 6 birds. On d 21, ileal digesta were sampled for determining apparent ileal digestibility (AID) coefficients. Except for methionine for a difference ($P < 0.01$) was seen between 2 assays, there were no differences ($P > 0.10$) in the AID of CP and all other AA

among assays. The interassay coefficient of variation ranged from 0.92 to 4.92% for glutamic acid and lysine, respectively. The lowest and highest AID values (%) for methionine, methionine+cysteine, lysine, and threonine were 88.7, 87.8, 77.8, and 76.6 and 92.3, 89.6, 81.2, and 77.9, respectively. It was concluded that the AID coefficients of CP and AA in wheat are highly repeatable among broiler ileal digestibility assays.

Key Words: interassay variability, apparent ileal digestibility, amino acids, wheat, broilers

TP358 Effects of dietary supplementation of Allzyme SSF® on the performance of chicks fed wheat-based diets. J. L. Pierce*, T. Ao, A. J. Pescatore, A. H. Cantor, K. A. Dawson, and M. J. Ford, *Alltech-University of Kentucky Nutritional Research Alliance*, *Lexington, KY*.

Allzyme® SSF is a natural fermentation product that improves the utilization of fibrous feed by chicks. A 14-d trial using 160 1-day-old chicks was conducted to investigate the effects of Allzyme SSF® on the performance of chicks fed a soft red winter wheat based diet. Dietary treatments were: 1) wheat-soy basal diet containing 3,050 kcal ME / kg and 0.45% available phosphorus; 2) Diet 1 + 200 g Allzyme SSF® / Ton; 3) Low nutrient wheat-soy basal diet containing 2,975 kcal ME / kg and 0.35% available phosphorus; 4) Diet 3 + 200 g Allzyme SSF® /Ton. The wheat contained 11% crude protein. Eight replicate cages of 5 chicks were randomly assigned to each of 4 dietary treatments. Chicks were housed in starter cages in an environmentally controlled room with an ad libitum access to feed and water. Chicks fed the low nutrient wheat-soy basal diet had lower ($P < 0.01$) weight gain during both the 1–7 d and 1–14 d periods and lower gain to feed ratio in the 1–14 d period compared with other treatment groups. Dietary supplementation of Allzyme SSF® in the low nutrient wheat-soy basal diet significantly increased ($P < 0.01$) weight gain of chicks during both the 1–7 d and 1–14 d periods and tended to increase (by 8.7%) gain to feed ratio of chicks during the 1–14 d period. Data from this trial indicate that supplementation of Allzyme SSF® in wheat based diets for chicks can improve energy and phosphorus utilization.

Key Words: wheat, chick, enzyme

TP359 Performance of male broilers fed diets formulated to meet different nutrient recommendations. F. Yan*, C. Coto, Z. Wang, S. Cerrate, S. Watkins, and P. Waldroup, *University of Arkansas*, *Fayetteville*.

Nutrient recommendations for broilers by different groups vary widely. Brazilian recommendations suggest higher amino acids than Ross and Cobb breeder guidelines, especially during the early starter and grower periods, with Ross recommendations higher than Cobb. Two trials compared recommendations for broilers up to 49 day of age. Three series of diets were formulated to meet Cobb, Ross, or Brazilian standards with an energy value commensurate with 2% supplemental poultry oil. Feeding periods were those suggested in various guidelines. Amino acids were adjusted to % per Mcal basis. Ca and nonphytate P levels followed respective recommendations. Each of the 3 diet series was fed to 12 replicate pens of 50 Cobb 500 males in trial 1 and 6 replicate pens of 25 Cobb 500 males in trial 2. Birds were weighed at 14, 28, 42, and 49 d. Feed conversion, calorie conversion, mortality, and conversion of protein, Lys, and TSAA were determined for each weigh day. Five birds per pen were processed at d 50 to determine dressing percentage and parts yield.

Birds fed Brazil and Ross diets were significantly heavier than those on Cobb diets at all ages with no significant difference in body weight between those fed Brazil and Ross diets at 14, 28, and 49 d. Feed conversion by birds fed Cobb diets was worse than others up to 28 d; however, no significant difference was observed among the 3 series for 0–42 and 0–49 d periods. Birds fed Brazil diets had better calorie conversion up to 42 d but no significant differences were observed among treatments at 49 d. Birds fed the Cobb diets had significantly better conversion of protein and lysine than birds fed Brazil or Ross diets; Birds fed Cobb and Ross diets had significantly better TSAA conversion than those fed Brazil diets. Birds fed Brazil diets had significantly greater breast yield than those fed Cobb or Ross standards with no significant difference between those fed Cobb or Ross standards. Cost of feeding the various diets will influence choice of recommendations.

Key Words: broilers, nutrient requirements, nutrient efficiency

TP360 Effect of pellet diameter in broiler prestarter diets on subsequent performance. S. Cerrate*, C. Coto, Z. Wang, F. Yan, and P. W. Waldroup, *University of Arkansas*, *Fayetteville*.

Different sized pellet dies and 2 levels of dietary energy density during the prestarter period were used in broiler diets formulated to meet typical commercial standards. In the first study, birds reared in battery brooders were offered 2 types of diets, 0.5 or 2.5% poultry oil from 0 to 14 d; each type of diet was assigned different feed forms such as mash continuously through the study, pellet diameters of 1/16-in., 3/32-in., 1/8-in., or crumble diets from 0 to 7 d followed by crumble diets to 14 d and pelleted diets to 35 d. In the second study birds reared in floor litter were assigned the same treatments as the previous study except the poultry oils were supplied from 0 to 42 d of age. During the first 7 days birds fed the 1/16- or 3/32-in. pellets or crumble diets had higher body weight than did birds fed the other feed forms; however, this positive effect was dissipated as the birds grew older. The feed intake had almost the same tendency as the body weight. The feed conversion at 7 d was improved as pellet size was reduced. Birds given the mash feed during the whole period had lower body intake and intake than those birds fed other feed forms. The body weight and feed conversion at 35 and 42 d were improved as the level of poultry oil increased. Improvement in feed conversion by birds fed diets with 3/32-in.- and 1/8-in.-diameter pellets or crumble diets at 7 d and mash or 1/8-in.-diameter die diets at 42 d was observed as the dietary energy level increased. These data indicate that pellet diameters of 1/16 or 3/32 in. can be beneficial during the prestarter period and can be more useful with 2.5% poultry oil.

Key Words: prestarter diets, pellets, dietary energy

TP361 Effects of feeding reduced levels of trace mineral proteinates (Bioplex®) to brown layer pullets during development. T. Ao*, J. L. Pierce, A. J. Pescatore, A. H. Cantor, K. A. Dawson, and M. J. Ford, *Alltech-University of Kentucky Nutrition Research Alliance*, *Lexington*.

An experiment was conducted to evaluate the effects of feeding reduced levels of trace mineral proteinates (Bioplex®, Alltech, Inc.) on pullet

growth and development. Eight replicate groups of 16 replacement pullets, 1-day of age, were assigned to each of 5 dietary treatments using a randomized complete block experimental design. Pullets were housed in cages and given ad libitum access to feed and tap water. Treatments consisted of feeding corn- and soybean meal-based starter and grower diets alone (control), supplemented with Cu, Mn, Fe and Zn at 25, 50 or 100 per cent of the NRC (1994) requirements in the form of proteinates or 100% of the NRC requirements in the form of inorganic salts. Body weight and feed consumption were measured every 4 weeks. At 16 wk of age, the trial was ended. The birds were weighed individually for the measurement of uniformity. Two birds from each cage with a total of 10 birds from each treatment were randomly selected and euthanized for collection of liver, tibia, and femur samples for the analysis of Cu, Mn and Zn. There were no differences among all dietary treatments in body weight, feed intake, uniformity, and liver mineral content. Tibias and femurs from birds fed control diet with no mineral supplementation had significantly lower ($P < 0.01$) Zn and Mn concentrations than those from birds fed other treatment diets. Tibias and femurs from birds fed the 100% level of supplementation as Bioplex® had the highest Zn concentration among all treatment groups. Tibias and femurs from birds fed the 25% level of supplementation as the proteinates had the same mineral concentration as those from the birds fed 100% level of supplementation as inorganic salts. The results from this trial indicate that 25% NRC level of supplementation as the proteinates in pullet diets has no negative influence on performance and tissue mineral concentration in comparison with 100% NRC level of supplementation as inorganic salts.

Key Words: pullets, trace minerals, proteinates

TP362 Evaluation of various carbohydrase enzymes in broiler chicks. P. L. Utterback*[1], C. M. Parsons[1], and N. E. Ward[2], [1]*University of Illinois*, *Urbana*, [2]*DSM Nutritional Products*, *Parsippany, NJ*.

An experiment was conducted using 360 Ross male broiler chicks. At day-old, chicks were weighed and allotted to 6 dietary treatments. Twelve replicate groups, each containing 5 chicks, were assigned to each treatment. The first treatment was a corn-soybean meal-15% DDGS diet containing 21% protein, 2,950 kcal ME_n/kg, and no enzymes. This served as a negative control. Treatments 2–6 contained various combinations of enzymes added to the corn-soybean meal-DDGS diet. These enzymes included different combinations of xylanase, cellulase, β-glucanase, pectinase, and, amylase. All diets were fed from 0 to 21 days of age. Weight gain, feed intake, gain to feed ratio and ME_n were measured at Day 7 and 21. At the end of week 1, no significant differences ($P > 0.05$) were found among the treatments for any of the measured parameters. At 21 days, there were no significant differences in weight gain, feed intake, or gain to feed ratio among treatments; however, there were significant differences among treatments for the ME_n values at Day 21. All diets containing enzymes had significantly higher ($P < 0.05$) ME_n values than that of the negative control diet which contained no enzymes. There were also some significant differences ($P < 0.05$) in ME_n values among the different enzyme treatments. The average increase in ME_n for the 5 enzyme treatments was 69 kcal/kg DM. The results of this study indicate that enzyme treatments increased the ME_n of a corn-soybean meal diet containing 15% DDGS.

Key Words: enzymes, broiler chicks, metabolizable energy

TP363 Utilization of whole corn germ in broiler chicks feeding. R. B. Lima[1], C. B.-V. Rabello[2], J. Ludke[3], J. H. V. Da Silva*[1], and D. F. Figueiredo[1], [1]*Universidade Federal da Paraíba*, *Areia, Paraíba, Brazil*, [2]*Universidade Federal Rural de Pernambuco*, *Recife, Pernambuco, Brazil*, [3]*Centro Nacional de Pesquisa de Suínos e Aves*, *Santa Catarina, Brazil*.

In nutrition assays testing alternative ingredients for poultry, a common observation is that these feeds hardly can be used in feeding programs for superior performance broiler chickens, if considering a low energetic density of most of these ingredients, except for those with high oil and fat concentrations, which are poorly used by birds at the initial period of development. The effect of a partial substitution of conventional ration by whole corn germ on zootechnical performance and carcass characteristics of broiler chicks from the first to 21st days was verified. Three hundred and seventy-five Cobb male chicks were distributed in a completely randomized design with 5 treatments, 5 replicates and 15 birds per experimental unit. Treatments consisted on a corn-soybean meal-based control diet and 4 inclusion levels (4, 8, 12, and 16%) of whole corn germ. Corn germ inclusion in the diets increased EE up to 12.46%. Birds and feed were weighed at days 1, 6, 11, 16, and 21. At the end of experimental period, 2 birds of each unity were slaughtered. Feed intake, weight gain, feed:gain ratio, carcass yield, relative weight of noble cuts and edible viscera and percentage of abdominal fat. There was a negative linear effect on WG ($Y = 980.72 – 3.285X$, $R^2 = 68.18\%$) and FI ($Y=1,251.88 – 3.832X$, $R^2 = 71.42\%$) and a positive linear effect on gizzard relative weight ($Y = 1.62 + 0.02X$, $R^2 = 58\%$). The remaining parameters were not affected by treatments, emphasizing feed:gain ratio (1.27Â ± 0.036) and abdominal fat percentage (1.35Â ± 0.260), which reveals the efficiency of whole corn germ utilization by these accelerated growth rates animals. Utilization of whole corn germ up to 16% in initial feeding for broiler chicks of superior performance produced satisfactory effects, taking into account weight gain, feed:gain ratio and abdominal fat results.

Key Words: lipids, carcass yield, performance

TP364 Comparison of digestible lysine needs in the starter period when fed diets formulated to ideal ratios or added alone. F. G. P. Costa*[2], Z. Wang[1], C. Coto[1], S. Cerrate[1], F. Yan[1], and P. W. Waldroup[1], [1]*University of Arkansas*, *Fayetteville*, [2]*Federal University of Paraiba*, *Areia-PB, Brazil*.

The methods by which amino acid needs are provided to the chicken vary in practice. Recently it has been the vogue to formulate diets on what is commonly described as ideal amino acid ratio in which lysine is considered as the base amino acid and other amino acids are maintained in minimum ratio to lysine. The objective of this study was to evaluate needs for digestible lysine in diets for the young (0–14 d) male broiler while maintaining a ratio of other amino acids to lysine, or increasing only synthetic lysine. The ratios suggested by Rostagno et al. (2005) were used as the basis for formulation of diets for broilers 1 to 14 d of age. All diets were formulated to contain 1.03, 1.13, 1.23, 1.34, 144, and 1.54% digestible lysine with dietary ME level of 3,030 ME kcal/kg. Initial base diets were also supplemented with Lys from Lysine HCl to the highest Lys level. Diets were pelleted and each fed to 12 pens of 5 male broilers. Birds were group weighed at 1 and 14 d of age. When the Lys level was increased with other amino acids in a ratio, BW gain and FCR improved as Lys level increased to about 1.3%. However, when Lys level increased by adding Lysine HCl alone, performance tended to

decline, especially at levels greater than 0.10% Lys. This suggests that the increased performance when all amino acids were increased might be the result of a deficiency of amino acid other than Lys, and that a possible Lys:Arg antagonism resulted when Lys alone was added.

Key Words: broilers, amino acid balance, lysine

TP365 Evaluation of male broiler performance from 7 to 42 days old feed a diet with hydrolysed feather meal. M. A. C. Holanda[1], M. C. M. M. Ludke[1], J. V. Ludke[4], M. C. R. Holanda[2], J. H. V. Silva*[3], A. A. G. Costa[1], and C. B. V. Rabello[1], [1]*UFRPE*, *Recife, Pernambuco, Brasil*, [2]*UAG*, *Garanhuns, Pernambuco, Brasil*, [3]*UFPB*, *Areia, Paraíba, Brasil*, [4]*Embrapa Suínos e Aves*, *Concórdia, Santa Catarina, Brasil*.

The aim of the experiment was to evaluate hydrolyzed feather meal inclusion levels (0, 2, 4, 6, and 8%) in broiler diets from 7 to 42 day. There were used 480 one-day-old, male pullets of COBB lineage. The experiment were conducted at Poultry Laboratory of UFRPE in Recife, Pernambuco State, Brazil, from September 14 to October 26, 2007. There were used 5 isonitrogenous and isocaloric experimental diets, from 7 to 21 days of age, with 22% crude protein (CP) and 3,050 kcal metabolizable energy (ME)/kg and from 22 to 42 days with 19% of CP and 3,250 kcal ME/kg. Diets were formulated on digestible amino acids basis using the levels proposed by Rostagno et al (2005). The experimental design were established in randomized blocks with 5 treatments and 6 repetitions resulting in 30 plots containing 16 birds in each. The birds were managed as suggested by the Manual of COBB Lineage and were weighed for uniformity of the parcels at 7 days of age (trial beginning) and then at weekly intervals, for weight and feed consumption records. At 42 days of age 2 broilers per plot representing the average weight of their box were slaughtered for carcass and main cuts evaluation. Average weight gain, feed consumption, feed-to-gain ratio, carcass, chest, thigh, drumstick, and abdominal fat weights were, respectively, 2,684 g, 4,882 g, 1.821 g/g, 2,070 g, 696 g, 282 g, 342 g, and 45.8 g. In spite of using isonutritious diets the inclusion of hydrolysed feather meal resulted in linear reduction of weight gain, worsenig of the feed-to-gain ratio, linear reduction in carcass and chest weights and increasing of abdominal fat. It is stated that at high performance levels the use of hydrolyzed feather meal in broiler diets had detrimental effects.

Key Words: feed-to-gain ratio, weight gain, alternative feeds

TP366 The effects of a phytogenic feed additive versus an antibiotic feed additive on oxidative stress in broiler chicks and electron spin resonance. T. Settle*[1], J. Moritz[2], S. Leonard[3], E. Falkenstein[4], and H. Klandorf[5], [1]*West Virginia University*, *Morgantown*, [2]*West Virginia University*, *Morgantown*, [3]*National Institute of Occupational Safety and Health and Centers for Disease Control*, *Morgantown, West Virginia*, [4]*West Virginia University*, *Morgantown*, [5]*West Virginia University*, *Morgantown*.

Phytogenic feed additives are plant-derived products used in poultry feeding to improve overall performance of broilers. Although the precise mechanism by which the increased growth rate is realized remains uncertain, these products have antioxidant components that are known to reduce oxidative stress. In this study, 588 one-day-old Cobb 500 chicks of mixed sex were fed 1 of 4 diets and housed on either dirty or clean litter for 3 wk. Litter was analyzed for microbial content and provided evidence of a possible microbial challenge. Treatments included starter diet with no additive and housed on clean litter, a starter diet with no additive and housed on dirty litter, a starter diet with a 0.05% inclusion of BMD (bacitracin methylene disalicylate), or a starter diet with a 0.05% inclusion of Biostrong 505 plus®. The study was designed around a random block assignment of treatments allocated to groups of 21 birds per pen. Blood samples were obtained from chicks at 18 days of age for measurement of leukocyte oxidative activity by a bioluminescence technique. Results of the study showed that chicks in the treatment groups fed either the phytogenic additive or the antibiotic had lower levels of oxidative stress ($P \leq 0.05$). Analysis the Biostrong 505 plus® by Electron Spin Resonance (ESR) showed that it effectively scavenged hydroxyl radicals but not superoxide radicals. The BMD showed the capability of scavenging both hydroxyl and superoxide radicals. These studies suggest that one of the mechanisms by which phytogenic feed additives act in the gut is by quenching free radical production, thus permitting more nutrients to be allocated toward growth instead of repair.

Key Words: oxidative stress, phytogenic additive, electron spin resonance

TP367 Age effect on nutrient digestibility of corn by-products determined in broiler chickens. R. B. Lima[1], C. B-V. Rabello[2], J. Ludke[3], J. H. V. Da Silva*[1], and D. F. Figueiredo[1], [1]*Universidade Federal da Paraíba*, *Paraíba, Brazil*, [2]*Universidade Federal Rural de Pernambuco*, *Pernambuco, Brazil*, [3]*Centro Nacional de Pesquisa de Suínos e Aves*, *Santa Catarina, Brazil*.

Several studies have demonstrated the influence of bird age on the digestive and absorptive processes, resulting in different recommendations on diet elaboration. This study observed the age effect on apparent (AME_n) and true metabolizable energy nitrogen corrected (TME_n) values and dry matter (DMMC) and crude energy metabolizability coefficient (CEMC) of corn gluten meal (CGM), corn gluten feed (CGF) and corn starch through total excreta collection method. Eight hundred and forty broilers were distributed in a completely randomized design with 4 treatments and 5 replicates. Treatments consisted in 4 ages: 1 to 10, 11 to 21, 22 to 32, 33 to 42 days, using 10, 8, 6, and 4 birds per replicate, respectively, for the ages mentioned above. In parallel, a group of birds was kept in fasting for 36 h for each treatment. Diets were based in 40% of substitution of reference diet (corn-soybean) by CGF and CS, except for CGM, with 30% of substitution. Average ages (5, 15, 25, and 35 days) were used as independent variable for regression analysis. DMMC had a positive linear trend ($P < 0.01$) for CGF ($Y = 11.27 + 0.414X$, $R^2 = 0.96$), a quadratic ($P < 0.01$) for CS ($Y = 71.087 + 1.170X - 0.0235X^2$, $R^2 = 0.95$) and not significant for CGM. CEMC presented quadratic effect ($P < 0.05$) for CGF ($Y = 9.88 + 0.65X - 0.008X^2$, $R^2 = 0.98$) and for CS ($P < 0.01$; $Y = 38.0875 + 0.89X - 0.0155X^2$, $R^2 = 0.99$), and not significant for CGM. AME and AME_n of tested ingredients ranged from 0.989 to 4,773 and from 0.939 to 4,682 kcal/kg of natural matter, respectively. Values of TME_n of GCF and CS presented linear behavior ($P < 0.01$) according to the age. There was no significant difference on TME_n among treatments for broilers fed CGM, suggesting that birds have similar ability in using proteic feed in every productive phase. It was observed that there was an age effect on nutrient digestibility for most of the studied ingredients.

Key Words: AME_n, TME_n, feedstuff

TP368 Evaluation of a fine-limestone, low-energy molt program. E. Donahue*[1], A. Johnson[1], G. Brant[1], C. Stahl[2], and K. Bregendahl[1], [1]*Iowa State University*, *Ames*, [2]*North Carolina State University*, *Raleigh*.

An experiment was conducted to determine the effects of 2 premolt Ca treatments (trt) and 3 molt trt in 792, 85-wk-old laying hens (3 hens/cage; 413 cm^2/hen). The experimental design was a randomized complete block design with a 2 × 3 factorial arrangement of trt with 44 replications. The 1-wk premolt Ca trt consisted of a layer diet (16% CP; 2,776 kcal/kg AME_n; 4.6% Ca; 0.4% nonphytate P) with limestone supplied as either 1:0 or 1:1 fine:coarse (0.14 vs. 2.27 mm diameter), followed by a 4 wk molt with either 75:25 wheat middlings:corn (WM; 2,198 kcal/kg AME_n), 50:50 soybean hulls:corn (SH; 2,217 kcal/kg AME_n), or a 7-d feed withdrawal followed by skip-a-day feeding for 3 wk (FW; 2,817 kcal/kg AME_n). All hens were fed a layer diet for 22 wk postmolt (16% CP; 2,880 kcal/kg AME_n; 4.1% Ca; 0.4% nonphytate P). Egg production (EP) was measured daily and feed intake (FI), egg weight (EW), and egg mass (EM; EP × egg weight) were measured weekly. Data were analyzed by ANOVA and Ca differences were assessed by the main effect of Ca trt and molt trt by Fisher's least significant difference ($P \leq 0.05$ was significant). Egg specific gravity did not differ at any time. Premolt, the Ca trt did not affect EP (63.7%), FI (97.9 g/d), EW (65.6 g), or EM (42.6 g/d). During molt, fine and coarse Ca differed in EP (8.4 vs. 10.3%), but not in FI (36.4 g/d). For the first 2 wk postmolt, the Ca trt did not affect EP (5.0%) or FI (91.8 g/d). Over the next 20 wk, fine and coarse Ca differed in EP (72.6 vs. 69.8%), FI (104.7 vs. 103.2 g/d), and EM (50.9 vs. 48.8 g/d), but not in EW (67.4 g). During molt, the WM, SH, and FW hens differed in EP (12.1, 8.9, and 7.2%) and FI (48.9, 34.0, and 26.1 g/d). The WM hens had higher EP (13.2%) compared to FW and SH hens (both 0.9%) and had no effect on FI (91.8 g/d) during the first 2 wk postmolt. For the next 20 wk, SH hens had lower FI (102.6 g/d) compared to FW and WM hens (104.7 g/d), but EP (71.2%), EW (67.4 g), and EM (49.8 g/d) did not differ. In conclusion, regardless of molt method, a premolt fine Ca trt was efficient at inducing molt by quickly lowering EP and increasing postmolt EP without increasing egg size.

Key Words: feed withdrawal, laying hens, molt

TP369 Maximum dietary content of corn distillers dried grains with solubles for laying hens: Nitrogen balance and egg production. S. Roberts*[1], L. Pineda[2], B. Kerr[3], and K. Bregendahl[1], [1]*Iowa State University*, *Ames*, [2]*Wageningen University*, *The Netherlands*, [3]*USDA/ARS*, *Ames, IA*.

An experiment was conducted to determine the maximum inclusion of corn distillers dried grains with solubles (DDGS) in laying-hen diets. Four diets were formulated with 0, 23, 46, or 69% DDGS, along with corn, soybean meal, meat and bone meal, vegetable oil, $CaCO_3$, DL-Met, and 1% Celite (source of acid-insoluble ash). Diets contained 2,850 kcal/kg ME_n, 0.73% true digestible TSAA, 0.84% true digestible Lys, 4.5% Ca, and 0.40% nonphytate P. Forty-eight Hy-Line W36 hens at 49 wk of age were housed 2 per cage with each cage assigned to 1 of the 4 diets according to a completely randomized design. Hens were fed the treatment diets for 8 wk after the DDGS inclusion was incrementally increased over 4 wk. Egg production was recorded daily and feed consumption was measured twice per week as feed disappearance. Eggs collected over a 48-h period within each week were used for egg weight measurement with egg mass calculated as egg weight × egg production. During week 10, excreta was collected twice daily for 3 consecutive days. Data were analyzed by ANOVA with $P \leq 0.10$ considered significant. When the main effect of diet was significant, linear and quadratic orthogonal polynomial contrasts were used to evaluate treatment differences. Means ± pooled SEM are presented. Daily N consumption (2.8, 3.2, 3.7, and 4.2 ± 0.1 g), excretion (2.0, 2.1, 3.4, and 2.9 ± 0.1 g), and retention in body and eggs (0.8, 1.1, 1.3, and 1.3 ± 0.1 g) increased linearly ($P \leq 0.01$) for the 0, 23, 46, and 69% DDGS diets, respectively. Apparent fecal N digestibility was not different among the diets (29.7, 33.7, 35.5, and 29.9 ± 3.3%; $P = 0.53$). Egg production decreased linearly (90.9, 90.4, 90.2, and 84.8 ± 1.7%; $P = 0.03$) and egg weight increased linearly (61.8, 62.4, 64.5, and 65.2 ± 0.8 g/egg; $P < 0.01$) for the 0, 23, 46, and 69% DDGS diets, respectively. Egg mass was not different among the diets (55.9, 56.5, 59.0, and 55.5 ± 1.4 g/d; $P = 0.38$). When diets are formulated on a true-digestible AA basis, high inclusions of DDGS may be used without compromising egg output. Long-term effects of very high dietary content of DDGS are unknown.

Key Words: DDGS, laying hen, nitrogen balance

TP370 Level of calcium supply and the size of limestone in the morning and afternoon for laying hens. J. H. V. Da Silva*, J. A. De Araújo, J. M. B. De Sousa, C. C. Goulart, and F. G. P. Costa, *Universidade Federal da Paraíba*, *Paraíba, Brazil*.

An experiment was conducted in the Division of Nutrition Research in the Birds of Campus of Bananeiras, Brazil, with the objective to evaluate the scale and size of the source of calcium (Ca) in the performance and behavior of food of birds. 432 Dekalb White laying hens were used with 25 weeks of age. The birds were distributed in a completely randomized design, with 12 treatments with 6 replicates of 6 birds. A control diet was formulated to meet or exceed the nutritional requirements for laying. We used 3 levels of calcium and size fine (FL) and coarse limestone (CL). The treatments (T) were: T1 = 3.92% Ca + FL; T2 = 3.92% Ca + CL; T3 = 4.02% Ca +FL; T4 = 4.02% Ca + CL; T5 = 4.12% of Ca+FL; T6 = 4.12% of Ca+CL. In these 6 treatments was supply same diet all day. T7 = 3.92 am and 4.12% pm of Ca +FL; T8 = 3.92 am and 4.12% pm of Ca + CL; T9 = 4.02 am and 4.12% pm of Ca + FL; T10 = 4.02 am and 4, 12% pm of Ca + CL; T11 = 4.02 am and 3.92% pm of Ca + FL and T12 = 4.02 am and 3.92% pm of Ca + CL. From 7 to 11 treatments had 2 levels of calcium that met the supply respectively at the morning and afternoon. The Ca level of diet was controlled by the addition of limestone to replace the inert (sand washed). The variables studied were eggs producing (EP), feed intake (FI), egg weight (EW), egg mass (EM), egg mass conversion (EMC) and egg dozen conversion (EDC), egg-shell specific gravity (EG), egg-shell thickness (EST) and unit Haugt (UH). The T1 (3.92%Ca+FL) improved EP ($P < 0.05$) and FI. The T6 (4.12%Ca+CL) and again T1, influenced better EM ($P < 0.05$). The EMC and EG were better ($P < 0.05$) in the T4 (4.02%Ca+CL). There were no significant effects of treatments for the others variables. It is recommended the addition of 3.92% Ca + FL in the entire day to better EP and EM.

Key Words: White egg, performance, feed behavior

TP371 Evaluation of chick quality as affected by parental diet. C. S. S. Araujo*[1], L. F. Araujo[1,2], M. T. Kidd[1], S. Hubbard[1], D. Everett[1], and C. McDaniel[1], [1]*Mississippi State University*, *Starkville*, [2]*Universidade de Sao Paulo*, *Pirassununga, SP, Brazil*.

A good-quality 1-d-old chick is a crucial link between the hatchery and the broiler farm. High hatchability and a low spread of hatch are the most important objectives. Therefore, the objective of this research was investigated chick development, and early growth rates of chicks from broiler breeders fed supplemental vitamins, and minerals. Ross 708 breeders received a control diet (vitamin and mineral premix devoid of Se) or diets containing supplemental vitamin B (vitamin B_{12}, 60 µg/kg; D-biotin, 500 µg/kg; folic acid, 4 mg/kg; niacin, 80 mg/kg; D-pantothenic acid, 25 mg/kg; vitamin B_6, 10 mg/kg; riboflavin, 25 mg/kg), vitamin D (1 kg of HyD/ton), and vitamin E 120 IU/kg, the combination of the 3 vitamins, Se (0.3 mg/kg), Zn (30 mg/kg), Mn (40 mg/kg) from organic sources, the combination of the 3 minerals and an additional diet containing combination of all vitamins and minerals. All 10 dietary treatments were supplied in mash form. Breeders were housed in a floor pen facility with 80 pens (8 replications/treatment). Each pen was equipped with 1 feeder, nipple drinkers, and 1 nest. Each pen contained 3 females which were inseminated before eggs were collected. A total of 900 eggs (90 eggs per treatment) were obtained and set at 36 wk of age. Chick quality characteristics included BW, hydration, navel condition (open navel, small navel, and large navel), wet chicks, wicks, dried yolk, red hocks, and mechanical trauma. At hatch, 750 straight-run chicks were weighed and wing banded, and chick quality was assessed. No significant differences were noted among treatments for dehydration, open navels, large navels, green, wicks and mechanical traumas. However, progeny from breeders fed supplemental Mn showed lower percentage of small navels than chicks from hens fed control and supplemental diets (vitamins D, E, and Se). Birds from breeders fed control treatment had higher incidence of red hocks. Also, chicks from hens supplemented with Mn had no incidence of dried yolks on feathers in comparison to chicks from all other treatments.

Key Words: broiler breeders, minerals, vitamins

TP372 Determination of apparent metabolizable energy of plant based ingredients for turkeys. B. Jayaraman*[1], J. L. MacIsaac[2], and D. M. Anderson[1], [1]*Nova Scotia Agricultural College*, *Truro, NS, Canada*, [2]*Atlantic Poultry Research Institute*, *Truro, NS, Canada*.

A study was conducted to determine apparent metabolizable energy (AME_n) of plant-based ingredients using 240 day-old turkey poults. A basal starter diet was fed to birds from 0–7 days of age whereas from 8 to 13 days of age, the birds were fed with either a basal starter diet or a basal starter diet supplemented with 30% test ingredients [extruded soybean meal (EXSBM), full-fat soybean (FFSB), full-fat canola (FFC), canola meal (CM), corn gluten meal (CGM)] or 15% soybean oil (SO) or canola oil (CO). All the diets were mixed with celite at 0.8% as an inert marker. The basal grower diet was fed from 14 to 21 days and from 22 to 28 days, the birds were fed with the basal grower diet or the grower diet supplemented with 30 or 15% test ingredient as mentioned in the starter period experiment. The results revealed that the AME_n values of SO, CO and EXSBM increased ($P \leq 0.05$) with the age of the birds (9, 815, 9,491, 1,997, 10,842, 11,175, 3,599 kcal/kg; 14 and 28 days; SO, CO, EXSBM, respectively). There were no changes ($P > 0.05$) in AME_n at both ages for FFSB, FFC, CM and CGM (3,844, 3,847, 2,350, and 4,710 kcal/kg, respectively) and the AME_n of oils were found to be higher than other groups.

Key Words: apparent metabolizable energy, soy-, canola-, and corn-based ingredients, turkeys

TP373 Effect of broilers breeder nutrition on progeny bone density. C. S. S. Araujo*[1], L. F. Araujo[1,2], M. J. Q. Louzada[3], M. K. Kidd[1], A. Corzo[1], and J. Benoit[1], [1]*Mississippi University State*, *Starkville*, [2]*Universidade de Sao Paulo*, *Pirassununga, SP, Brazil*, [3]*Universidade Estadual Paulista*, *Aracatuba, SP, Brazil*.

Bone mineral density is one of the most important factors to measure bone quality. It is a biophysical parameter, and has been used in poultry production as a tool to assess bone quality because it is a reliable and noninvasive method. It is possible analyze bone density using radiological means and the technique for determining bone mineralization degree is called Optical Densitometry in Radiographic Images (ODRI). This experiment was conducted to evaluate bone density of progeny from broiler breeder fed diets containing different sources of vitamins and minerals. Ross 708 breeders received a control diet (vitamin and mineral premix devoid of Se) or diets containing supplemental vitamin B (vitamin B_{12}, 60 µg/kg; D-biotin, 500 µg/kg; folic acid, 4 mg/kg; niacin, 80 mg/kg; D-pantothenic acid, 25 mg/kg; vitamin B_6, 10 mg/kg; riboflavin, 25 mg/kg), vitamin D (1 kg of HyD/ton), and vitamin E 120 IU/kg, the combination of the 3 vitamins, Se (0.3 mg/kg), Zn (30 mg/kg), Mn (40 mg/kg) from organic sources, the combination of the 3 minerals and an additional diet containing combination of all vitamins and minerals. All 10 dietary treatments were supplied in mash form. Breeders were housed in a floor pen facility with 80 pens (8 replications/treatment). Each pen was equipped with 1 feeder, nipple drinkers and 1 nest. Each pen contained 3 females which were inseminated before eggs were collected. A total of 450 eggs (45 eggs per treatment) were obtained and set at 26 wk of age. Five chicks per treatment at d 1 were euthanized and their tibias were collected to evaluate bone density. The ODRI was utilized to analyze bone density. Progeny from broiler fed supplemental vitamin B showed better bone density compared with the vitamin D treatment. Furthermore there was no significant difference between the control, Se, Zn, minerals, and the combination of all vitamins and minerals. Bone density in progeny is affected by broilers breeder diets and the effects of B vitamins should be studied further.

Key Words: bone density, minerals, vitamins

TP374 Influence of different dietary copper sources on eggshell quality, efficacy of phytase and phosphorus retention in laying hens. A. Y. Pekel*, G. Demirel, M. Alp, and N. Kocabagli, *Istanbul University*, *Istanbul, Turkey*.

This study was conducted to determine the effects of low available phosphorus (aP) diets (0.11%) containing supraoptimal amount of copper (250 mg/kg) from different Cu sources [copper sulfate (CuSUL), copper lysine (CuLYS), copper proteinate (CuPRO)] on eggshell quality, phosphorus retention and efficacy of microbial phytase (Natuphos®).In the first experiment, total 120 Lohmann Brown hens aged 40 weeks (8 cages/diet, 3 birds/cage) were used to evaluate the eggshell quality. In the second experiment, 40 of those hens, which were used in the first

experiment, were placed individually into 50 × 45 × 40 cm cages to determine the phosphorus retention and efficacy of phytase. There were no significant differences among the groups in terms of eggshell thickness, eggshell weight, damaged egg ratio and specific gravity at the end of the first experiment. Feed consumption of the hens fed the CuLYS diets was significantly ($P < 0.01$) less than the hens fed diets that were not supplemented with copper and hens fed diets supplemented with CuPRO in the second experiment. The inclusion of microbial phytase to a low aP (0.11% aP) diet effectively supported and allowed the nearly same eggshell quality and P retentions compared to the control (0.24% aP) diet. These results suggest that feeding diets low in P (0.11% aP) together with microbial phytase (300 FTU/kg) and copper from CuPRO and CuSUL (250 ppm) will not affect eggshell quality. But, the use of supplementary copper to provide 250 mg/kg from the source of CuLYS in laying hen diet that containing 0.11% aP and 300 FTU kg phytase was concluded to decrease P retention ($P < 0.05$) so it seems that copper lysine possibly has a negative effect on the efficacy of phytase.

Key Words: laying hen, phosphorus, copper source

TP375 Phytase supplementation in laying hens fed different levels of dietary zinc. D. Savietto*[1], L. F. Araujo[1,3], C. S. S. Araujo[1], O. M. Junqueira[2], L. C. G. S. Garibaldi[1], and G. A. Gomes[4], [1]*Universidade de Sao Paulo*, *Pirassununga, SP, Brazil*, [2]*Universidade Estadual Paulista*, *Jaboticabal, SP, Brazil*, [3]*Mississippi State University*, *Starkville, MS*, [4]*Globoaves*, *Toledo, PR, Brazil*.

This study examined phytase supplementation in laying hens fed different levels of dietary zinc on external egg quality. Two hundred forty Bovan white layers from 25 to 41 weeks of age were utilized, and the eggs collected on the last day of the 4 periods of 28 days were used to evaluate egg weight, egg specific gravity, and eggshell thickness. A factorial experiment with 3 levels of phytase (0, 300, 600 FTU/kg), 3 levels of zinc sulfate (34, 49, 64 mg/kg), and a control with 79 mg/kg of dietary Zn was carried out. A basal corn-soybean meal diet with 18% CP, 2,800 cal/kg of ME and 3.64% of calcium were suplemented with zinc sulfate and phytase to achieve the calculated levels. There was no interaction between treatments and control for egg weight. The addition of phytase did not affect egg weight. Eggshell thickness was affected significantly by treatments in the third period only (34 mg Zn/kg-0.52 mm; 64 and 49 mg Zn/kg-0.53 mm). A positive effect on eggshell thickness was observed when increasing levels of phytase (0, 300, and 600 FTU/kg resulted in 0.52, 0.53, and 0.55 mm, respectively). The phytase enzyme did not improve the external egg quality regardless of the levels applied in this study.

Key Words: egg quality, phytase, zinc

TP376 Levels of available phosphorus and phytase units in diet of broiler chicks from 22 to 42 days of age. J. H. V. Da Silva*, J. Jordão Filho, M. L. G. Ribeiro, F. G. P. Costa, and J. A. De Araújo, *Universidade Federal da Paraíba*, *Paraíba, Brazil*.

A small number of research studies have been carried out to study the effects of phytase units (PU) and available phosphorus (aP) on the performance of broilers from 22 to 42 days of age. Two experiments were conducted in the Nutrition Research Station in Bananeiras, Brazil, to evaluate the effect of aP and PU in diets for broilers from 22 to 42 days of age. In experiment 1 (E1), 488 Ross-308 strain birds were used, fed 5 levels of aP (0.286; 0.326; 0.366; 0.406; 0.446; and 0.486%) and 2 PU (0 and 600). In experiment 2 (E2), low (0.30%), adequate (0.40%) and high (0.50%) levels of aP were combined with 4 levels of PU (0; 500; 1,000; and 1,500). 1,080 Ross-308 broilers were allocated on floors with wood shavings litter. We utilized a completely randomized design in both studies. In the first experiment a 6 × 2 factorial arrangement was used, and in the second trial a 3 × 4 factorial arrangement was used. In E1, there is no interaction among the levels of aP and PU on performance and carcass characteristics. However, the carcass and wing yields showing quadratic effect with max values of about 0.40% for aP, the wing weight and drumstick yields and weights improved linearly when levels of aP increased in the diets. In the E2, the Pectoralis major yield decreased up to 0.40% of aP and FI diminished with the addition of 1,000 PU in the diet. We observed an interaction on weight gain (WG) and feed conversion ratio (FC). When the diet had 0.30% aP, the PU increase improved WG and FC linearly, but with 0.40% of aP the PU increase affected both variables negatively. As PU increased, there was no effect on WG when aP content was 0.50%, but FC improved up to 950 PU in the diet. The aP increase improved WG up to 0.41% aP and FC up to 0.39% aP. With 500 PU, the increase of aP improved FC up to 0.40%, but with 1,500 PU the increase of aP up to 0.50% resulted in the worse FC. In E1, carcass and wing yields increased up to 0.40% of aP and 600 PU improved carcass, drumstick, and wing weights. In E2, an increase up to 1,500 PU in the low-aP diet improved the performance of broilers. From 22 to 42 days of age, the aP dietetic requirements of broilers chicks were about 0.40%, or 4 kg/1,000 kg of diet.

Key Words: carcasse yield, enzyme, mineral

TP377 Bone characteristics in laying hens fed different levels of dietary zinc and phytase. L. C. G. S. Garibaldi*[1], L. F. Araujo[1,3], C. S. S. Araujo[3], M. J. Q. Louzada[2], and D. Savietto[1], [1]*Universidade de Sao Paulo*, *Pirassununga, SP, Brazil*, [2]*Universidade Estadual Paulista*, *Aracatuba, SP, Brazil*, [3]*Mississippi State University*, *Starkville*.

A trial was conducted using 240 Bovan white layers from 25 to 41 weeks of age. This study examined phytase supplementation in laying hens fed different levels of dietary zinc on bone density and bone strength. Diets were formulated to contain 3 reduced levels of zinc sulfate (34, 49, 64 mg/kg) and 3 levels of phytase (0, 300, and 600 phytase units per kilogram feed). An additional diet with 79 mg/kg of dietary Zn was used as a positive control. Four birds per treatment were euthanized and their tibias were collected to evaluate bone density and bone strength. Optical densitometry in radiographic images was utilized to analyze bone density and 3-point bending to analyze bone strength. Bone density was significantly influenced by a reduction of levels of dietary zinc as compared to the control. The layers fed with diet control (79 mg/kg of dietary Zn) improved bone density. The addition of phytase did not affect this characteristic. Concerning bone strength, neither phytase supplementation nor levels of dietary zinc affected this parameter. These results demonstrate that increasing phytase levels from 300 to 600 phytase units per kilogram feed provided no additional benefit on bone density and bone-breaking strength.

Key Words: bone density, bone strength, phytase

TP378 Phase feeding in a small-bird production scenario: Impact on growth and uniformity. V. B. Brewer*, C. M. Owens, and J. L. Emmert, *University of Arkansas*, *Fayetteville*.

Phase feeding (PF) has been effective at maintaining broiler growth while reducing production cost, but the impact on different broiler strains grown in a small-bird production scenario has not been assessed. An experiment was conducted to determine the effects of decreasing dietary amino acid (AA) levels every other day using the PF approach. Three strains of commercial broilers were fed a diet containing average industry nutrient levels from 0 to 18 d. From 18 to 32 d, birds were fed 1 of 2 dietary treatments: diets with average industry nutrient levels, or diets with phased levels of AA. For PF, diets were prepared that contained Lys, SAA and Thr levels matching the predicted requirements for birds at the beginning (high nutrient density) and end (low nutrient density) of PF. Pelleted high and low nutrient density diets were blended to produce rations containing AA levels that matched the predicted PF requirements over 2-day intervals, and diets were switched every other day during PF. Treatments were replicated in 6 pens; each pen contained 15 males and 15 females (30 birds per pen). Weight gain, feed intake, and feed efficiency were calculated. Differences ($P < 0.05$) among strain body weights were noted on d 0, 18, and 32; differences ($P < 0.05$) between male and female broilers were observed on d 18 and 32. Within strain, female body weight, as a percent of male bodyweight, decreased with age; the decrease was less dramatic for one strain. There appeared to be strain differences in body weight CV at 32 d. Weight gain, feed intake, and feed efficiency were affected by strain ($P < 0.05$). These parameters were improved ($P < 0.05$) by PF. Compared to the industry diet, PF appeared to lower the 18 to 32 d weight gain CV for females of 2 strains and the males of one strain. These results suggest that different strains may vary in their response to PF, although improved performance was noted in each strain. Also, PF may be effective at improving uniformity, but this response may be dependent on strain and gender.

Key Words: broilers, phase feeding, uniformity

TP379 Effects of replacing the antibiotic growth promoter by whole cells or cell wall components from *Saccharomyces cerevisiae* in the diet of broiler chickens. M. L. Angeles[1], S. Gomez*[1], E. Ramirez[1], X. Pastrana[2], and M. J. Guerrero[2], [1]*CENIDFyMA–INIFAP*, *Ajuchitlán, Queretaro, Mexico*, [2]*EMVZ–Autonomous University of Queretaro*, *Queretaro, Mexico*.

The objective of this study was to evaluate the growth performance, digestibility of nutrients, brush border digestive enzyme activities, villi morphology and mucin concentration in goblet cells in broiler chicken fed diets with and without an antibiotic growth promoter and a *Sacharomyces cerevisiae* derived MOS plus culture (MOS+CSc) or the whole cell (WcSc). Sixty Ross B308 chicks from 35 to 49 days of age individually allocated were used. Birds were randomly distributed in 6 treatments in a factorial arrangement of 2 levels of bacitracyn: 0.0 or 50 g/ton (BAC0 and BAC50) and 3 forms of yeast: No yeast (NY), MOS+CSc and WcSc. Feed and water were offered ad libitum. At the end of the trial all birds were killed and the ileal content was collected to determine ileal nutrient digestibilities using chromic oxide as internal marker. Also, ileal samples were taken for villi morphology analysis, staining of goblet cells and to determine maltase and sacarase activities. Results were subjected to varianza analysis. The digestibility of dry matter and nitrogen were lower with BAC0 and were lower with NY ($P < 0.05$). The sacarase specific activity was lower with MOS+CSc and WcSc combined with BAC0 and in the rest of the treatments sacarase activity was similar (interaction, $P < 0.05$). The height of villi was greater but the thickness of villi was lower ($P < 0.10$) in BAC0. The thickness of villi was also lower ($P < 0.05$) in NY. The depth of the crypts was lower and the villus height:crypt depth ratio was greater with BAC0 combined with NY (interaction, $P < 0.05$). Acid mucins were lower with NY and neutral mucins were greater with BAC50 combined with MOS+CSc (interaction, $P < 0.05$). In summary, the addition of bacitracyn, whole yeast or MOS plus a yeast culture to the diet of finishing broilers improved the digestibility of nutrients, and had, on the whole, similar effects on the structure and function of the small intestine epithelium.

Key Words: bacitracyn, yeast whole cell, yeast cell wall components

TP380 Maternal dietary conjugated linoleic acid (CLA) in a low-fat laying hen diet delays embryonic lipid assimilation and growth during late incubation. V. A. Leone*, S. P. Worzalla, A. J. Murdoch, and M. E. Cook, *University of Wisconsin*, *Madison*.

Yolk lipid utilization by the chicken embryo drastically increases around day 13 of incubation when embryos weigh approximately 7 grams. Previous work suggested that embryonic mortality begins to peak after the final phase of incubation in embryos obtained from hens fed conjugated linoleic acid (CLA). CLA has been shown to inhibit fat uptake by adipose tissue through inhibition of Lipoprotein lipase (LPL), and to inhibit intestinal Acyl CoA:cholesterol acyl transferase (ACAT) activity. ACAT has been shown to be a key enzyme in the yolk sac membrane of embryos for cholesterol ester formation, which is important for the hydrolysis/re-esterification of yolk lipids during transport to the embryo. A study was conducted to decipher if maternal CLA alters lipid transport from the yolk to the developing embryo during the last 8 days of development when lipid assimilation in the embryo is heightened. Hens (48) were randomly assigned to diets (12 hens/treatment) containing 0.5% Canola Oil (Lo CO), 0.5% CLA (CLA, CLA-80, 40% c9, t11, 40% t10, c12), 3.5% Canola Oil (Hi CO) or 3% Canola Oil + 0.5% CLA (CO+CLA) in a 2 × 2 factorial. After 14 days, hens were artificially inseminated once weekly for 90 days. Eggs were collected daily, held at room temperature, and incubated once weekly. Incubated eggs were removed on d13, d15, d17, d19, and d21. Embryos and yolk sacs were removed and weighed. Embryos obtained from the CLA treatment group were significantly lighter (roughly 5%, $P \leq 0.05$) than embryos obtained from the Lo CO, Hi CO, or CO+CLA on d13, d15, d17, d19, and d21, while remaining yolk was 5% heavier from the CLA group in comparison to Lo CO, Hi CO, or CO+CLA. No differences were observed between Lo CO, Hi CO or CO+CLA. Yolk absorption and utilization are impaired in embryos obtained from mothers fed 0.5% CLA in a low-fat diet and embryonic mortality during this stage may be "embryonic starvation." Supplementing the maternal diet with canola oil prevented CLA-induced "embryonic starvation."

Key Words: conjugated linoleic acid, embryo, lipid

TP381 Effect of selenium supplementation on egg production of broiler breeder hens. A. H. Cantor*, A. J. Pescatore, J. L. Pierce, M. J. Ford, T. Ao, W. D. King, H. D. Gillespie, M. A. Stovall, and L. M. Macalintal, *Alltech/University of Kentucky Nutrition Research Alliance*, *Lexington*.

The effect of selenium supplementation of low-selenium semi-purified diets on egg production of broiler breeder hens was evaluated. Commercial broiler breeder pullets, 1 day of age, were housed in floor pens. At 6 weeks of age, hens were given age-appropriate low-Se basal diets alone, or supplemented with 0.3 ppm Se as either sodium selenite or selenium yeast (Sel-Plex®, Alltech Inc., Nicholasville, KY). The basal diet consisted of corn, corn starch, soybean meal, torula yeast and vitamins and minerals. The vitamin supplement provided 10 IU of vitamin E per kg diet. Five pens of pullets were assigned to each dietary treatment. At 22 wk of age, the number of hens was reduced to 13 per pen and photostimulation was initiated. Treatments were continued through 40 weeks of the breeding period. Birds were limit-fed according to the breeder management guide recommendations. The unsupplemented breeder basal diet contained 0.02 ppm Se. Egg Se concentration was significantly higher for the Se yeast treatment than for the selenite treatment (0.25 vs. 0.19 ppm). Egg Se levels for these treatments were significantly higher than that for the basal treatment (0.04 ppm). Although some periodic differences were noted in egg production, dietary treatments did not result in a significant effect on overall production during the 40-week period. The results suggest that the rate of egg production was not sensitive to the low-selenium diets, possibly because the diets were supplemented with vitamin E.

Key Words: selenium, broiler breeder, egg production

TP382 The effect of dietary protein level and digestibility and *Clostridium perfringens* infection on the growth performance of broiler chickens. G. P. Widyaratne*, A. Van Kessel, and M. D. Drew, *University of Saskatchewan*, *Saskatoon, SK. Canada*.

A total of 640 broiler chickens were used to evaluate the effect of ileal digestible protein level (high and low), dietary protein digestibility (high and low digestible) and *Clostridium perfringens* infection on growth performance, in a 2 × 2 × 2 factorial arrangement of treatments. The birds were fed 4 different ideal protein-balanced, isocaloric diets (1.24 and 1.04% ileal digestible Lys and 3,050 and 3,150 kcal/kg on days 1–14 [starter] and 15–35 [grower], respectively). The dietary treatments consisted of 2 protein levels (HP: 20 and 18% and LP 18 and 16% ileal digestible crude protein in starter and grower periods, respectively) and 2 protein digestibility levels (HD: 88% and LD: 82% mean ileal crude protein digestibility). The birds were reared in 2 successive groups under identical conditions and on d15 to 19 each bird in one group was fed approximately 1/3 of their ADFI inoculated with 2 mL of an 8-h broth culture of *C. perfringens* and the other group received feed mixed with sterile broth. The majority of the infected birds were dull, depressed, and diarrheic during first 7 d after challenging but mortality did not differ between the 2 groups. However, the infected birds grew significantly slower and had significantly higher FE than uninfected birds in grower period. (91.6 vs. 88.4 and 1.59 vs. 1.63 for ADG and FE, respectively). Low protein digestibility significantly decreased ADFI (43.3 vs. 45.2 and 142.8 vs. 147.1) and FE (1.31 vs. 1.35 and 1.60 vs. 1.63) in starter and grower periods, respectively. There was a significant protein × digestibility interaction in the grower period for ADFI and significantly higher for birds fed the LP:HD diets than those fed LP:LD diets while there were no differences between the HP:LD and HP:HD diets. Low dietary protein level significantly elevated the FE of growers (1.63 vs. 1.60). The results suggest that *C. perfringens* infection suppresses growth performance of broilers, irrespective of dietary protein level or protein quality. Feeding low protein diets formulated with highly digestible proteins optimized FE without affecting weight gain.

Key Words: protein, digestibility, broilers

TP383 Gene expression profiles of laying Single Comb White Leghorn chickens fed diets containing blood meal. J. Tyus II*[1,2], S. Nahashon[1], N. Adefope[1], D. Wright[1], and T. Payne[1,2], [1]*Institute of Agricultural and Environmental Research, Tennessee State University*, *Nashville, TN*, [2]*Department of Agricultural Sciences, Tennessee State University*, *Nashville, TN*.

Alternative protein sources, such as blood meal (BM), may reduce the cost of feeding poultry. The effect of feeding Single Comb White Leghorn (SCWL) chicks diets containing BM as protein source on the expression of genes associated with nutrient utilization was evaluated. SCWL chicks were fed diets containing BM with (+) and without (–) supplemental isoleucine from hatch to 10 weeks of age (WOA). Diets were corn-based with the protein sources being 100% soybean meal (control), 100% BM (BM+/–), 50% SM + 50% BM (SMBM+/–), and 50% alfalfa meal + 50% BM (AMBM+/–). Feed and water were provided ad libitum. Primers were designed to amplify genes coding for fatty acid synthase (FAS), liver glucokinase, pyruvate kinase (PK), insulin, pancreatic glucokinase, pancreatic polypeptide, secretin, trypsin, trypsinogen, growth hormone releasing hormone (GHRH), thyroid stimulating hormone (TSH), and corticotrophin releasing hormone (CRH). Complementary DNA from the liver, pancreas, small intestine, hypothalamus, and pituitary of experimental birds was used in qRT-PCR. The chicken 18s ribosomal RNA was used as internal control. Amplicons were ligated into PCR-TRAP Cloning Vector, cycle-sequenced, and their homology with sequences in the GenBank databases was evaluated using the BLAST search. Sequence alignments yielding homology of ≥90% confirmed specificity of oligonucleotide primers. Expression of genes encoding FAS, insulin, and GHRH was significantly higher ($P < 0.05$) in birds fed diets supplemented with isoleucine than those fed diets without supplemental isoleucine. Birds fed SMBM+ diets also had higher expression of the genes coding for CRH, PK, and TSH than other treatment groups. This suggests an enhancement of the mechanisms involved in nutrient uptake and metabolism by complementation of SM and BM. A positive correlation between growth performance and gene expression suggests that BM may be partially substituted for SM in diets of SCWL chicks, however with supplementation of isoleucine, which is deficient in BM.

Key Words: blood meal, Single Comb White Leghorn, gene expression

TP384 Quality and safety characteristics of poultry meat and eggs sold in the state of Kuwait. S. F. Al-Zenki*, H. M. Al-Mazeedi, S. N. Al-Hooti, T. Al-Atti, and H. F. Alomirah, *Kuwait Institute for Scientific Research*, *Kuwait City, Kuwait*.

The microbiological quality and safety of poultry and eggs sold in the State of Kuwait were examined. A total of 102 poultry meat were

analyzed by standard enumerative tests for aerobic plate count (APC), fecal streptococcus (KEA media), *Listeria monocytogenes* (PALCAM media) and *Staphylococcus aureus* (Baird Parker media), while standard enrichment techniques were used to isolate and identify *Campylobacter* and *Salmonella* spp. Similarly, a total of 170 composite egg samples (5 eggs each) were analyzed for aerobic plate count (APC), yeast and molds (OGYEA media), coliforms (VRB media), *Listeria monocytogenes*, *Staphylococcus aureus*, and the presence of *Salmonella* spp. Results showed that all locally produced poultry meat had APC counts less than 5 log CFU/g. The majority of samples had fecal *Streptococcus* counts less than 2 log CFU/g (75%). *Listeria monocytogenes* and *Staphylococcus aureus* counts ranged from less than 2 log CFU/g to less than 3 log CFU/g with over 90% of the samples analyzed having counts less than 2 log CFU/g. Out of the poultry meat samples analyzed, 59 and 39% of the samples exceeded the microbiological limits set for the presence of *Campylobacter* and *Salmonella*, respectively. All of the 170 composite egg samples (local as well as imported) had APC counts less than 5 log CFU/mL. Furthermore, in all of the locally produced and imported eggs examined, the yeast and molds, *Listeria monocytogenes* and *Staphylococcus aureus*counts were below the detection limit (<1 log CFU/mL). However, 2 and 4% of the local and imported eggs, respectively, exceeded the microbiological standards set for coliforms (>3 log CFU/mL). The pathogen, *Salmonella* spp. was not detected in any of the egg samples analyzed. These results indicate that locally produced poultry meat could be considered a potential source of pathogens such as *Campylobacter* and *Salmonella* and that the presence of coliforms in eggs at levels higher than the recommended limits (>3 log CFU/mL) shows that improving the hygienic conditions at the farm, processing plant and sale outlets can greatly ameliorate the quality and safety of poultry and poultry products sold in the State of Kuwait.

Key Words: poultry, eggs, safety

TP385 Impact of genotype on carcass, meat quality, and sensory attributes for turkeys raised with outdoor access. A. C. Fanatico*[1], J. L. Emmert[2], J. F. Meullenet[2], and C. M. Owens[2], [1]*National Center for Appropriate Technology*, *Fayetteville, AR*, [2]*University of Arkansas*, *Fayetteville*.

Consumer interest is growing in specialty poultry products, including alternative turkey genotypes such as heritage turkeys, which are slow-growing standard breeds generally raised in production systems with outdoor access. A trial was conducted to assess impact of genotype on parts yield, meat quality, and sensory attributes. A commercial fast-growing genotype (Fast) and a slow-growing genotype (Slow) (all females) were raised for 14 weeks and approximately 26 weeks, respectively. Placement dates were staggered in order to achieve a similar final body weight on day of processing. Forty turkeys of each genotype were raised on a small commercial farm in a shed with access to outdoor yards and were provided the same diets. Turkeys were processed at a small facility and stored at 1°C. Sixteen turkeys of each genotype were deboned at 2 d postmortem for meat quality analyses. Descriptive analysis of fresh breast and thigh meat of Fast and Slow turkeys was conducted by a trained panel, while consumer analysis included an additional treatment, a retail turkey (injected with marinade). Carcasses of Fast turkeys were heavier than those of Slow ($P < 0.05$). Breast yield was higher ($P < 0.05$) for Fast compared to Slow while leg yield was higher for Slow ($P < 0.05$). Breast meat of Slow had lower pH and was less pale and more red than Fast ($P < 0.05$). The descriptive panel found few differences in flavor of breast meat although Fast had more intense cooked meat flavor and Slow had more intense aftertaste of blood/metal ($P < 0.05$). The panel found more differences in texture. Breast meat of Slow was more hard, cohesive, and fibrous than Fast ($P < 0.05$). However, in instrumental (MORS) analysis, Slow was more tender than Fast ($P < 0.05$). In most categories of consumer trials, Retail and Fast were preferred over Slow, including appearance and texture. For breast meat, overall liking was higher for Retail than Fast and Slow ($P < 0.05$), and liking of flavor was higher for Retail than Slow ($P < 0.05$). These data indicate differences in yield, meat quality, and sensory attributes between commercial fast-growing and specialty slow-growing turkeys.

Key Words: turkey, slow-growing, meat quality

TP386 Effects of shackle line speed on broiler carcass microbiology and presentation scores. J. K. Northcutt*[1], W. D. McNeal[2], and K. D. Ingram[3], [1]*Clemson University*, *Clemson, SC*, [2]*Meyn America, LLC*, *Ball Ground, GA*, [3]*USDA-ARS*, *Athens, GA*.

The USDA-FSIS Inspectors use 9CFR 381.76 (ii) (a) for controlling broiler processing line speeds. Consequently, broilers on eight-inch centered shackle lines typically operate at 105 BPM. Processing establishments use carcass presentation scores to demonstrate process control (PIC). This study evaluated effects of broiler processing line speed on carcass microbiology and presentation scores. Experiment 1 was conducted on 2 eight-inch centered shackle lines (2 replications). Line 1 (control) was not altered (105 BPM). Line 2 was changed to 140 BPM (treatment). Prechill carcasses were removed from each line, rinsed in 400 mL of buffered peptone water, and rinses were evaluated for levels of *Escherichia coli*, coliforms, and *Campylobacter* or incidence of *Salmonella* using cultural and BAX PCR analysis. Plant personnel conducted presentation scores. Experiment 2 was conducted by altering one processing line (105 to 140 BPM) and allowing equilibration before sampling (24 replications). In experiment 1, no significant difference was observed between control and treatment lines for numbers or incidence of bacteria, but the processing lines were slightly different. Data from experiment 2 also showed that levels of *E. coli* (1.6 $\log_{10}$ cfu/mL), coliforms (1.8 $\log_{10}$ cfu/mL), and *Campylobacter* (0.9 $\log_{10}$ cfu/mL) were the same regardless the line speed. *Salmonella* incidence was 5.2% (10/192 positive) for both control and treatment line speeds. Carcass presentation scores were slightly higher for the 105 BPM (4.7) line speed compared to the 140 BPM (4.7) line speed; however, both speeds were operating within the acceptable margin (total score <24). Data from this study demonstrates that commercial carcasses may be processed on eight-inch centered shackle lines at 140 BPM without compromising carcass microbiology or carcass presentation scores. These data resulted in a letter of no objection issued by USDA-FSIS regarding faster (140 BPM) processing line speeds for eight-inch centered shackle lines.

Key Words: poultry processing, carcass microbiology, processing line speeds

TP387 Effect of sponges and gas-charged incubators on recovery of *Campylobacter* from broiler rinses. J. E. Line*, *USDA, ARS*, *Athens, GA*.

Campylobacter spp. are microaerophilic and capnophilic microorganisms. Methods to increase exposure of *Campylobacter* to appropriate

microaerobic conditions could theoretically improve recovery of stressed cells. The porous nature of a sponge greatly increases the sample surface area exposed to microaerobic conditions when soaked in enrichment broth. We compared recovery of *Campylobacter* from retail chicken carcass rinses (n = 30) in bags with and without added sterile sponges. The semi-permeable bags containing the samples and an equal volume of 2× Bolton Enrichment Broth were flushed and filled with Campy-gas (5% O_2, 10% CO_2 and 85% N_2) and were placed in incubators under similar microaerobic or ambient atmospheric conditions. Results indicate that adding sponges to the enrichment bags had no significant effect on *Campylobacter* recovery. Likewise, there was no statistically significant difference in the percentage of positive samples recovered from gas-charged bags placed in microaerobic or ambient incubators.

Key Words: *Campylobacter*, broiler, sponge

TP388 The effect of edible coatings on shell egg quality under refrigerated conditions. A. Biladeau and K. Keener*, *Purdue University*, *West Lafayette, IN*.

Less than 0.1% of shell eggs are exported. Increasing the shelf life of shell eggs may increase exported egg sales. The objective of this study was to determine whether edible coatings will maintain egg quality longer. Four edible coatings were applied to fresh shell eggs and the eggs were stored for 12 weeks in refrigerated storage. The 4 coatings applied were paraffin wax, mineral oil, soy protein isolate (SPI), and whey protein isolate (WPI). Quality measurements in duplicate were taken over the storage period. Quality measurements recorded were Haugh units (HU), pH, albumen CO_2 content, and vitelline membrane strength (VMS). In each time period 15, 5, 5, and 10 eggs were tested for HU, pH, CO_2, and VMS, respectively. A t-test with a $P < 0.05$ was used to determine statistical significance. At week 0, there was no difference between any coating and HU ranged from 81.4–83.7. After 6 weeks of storage, Haugh units were significantly higher in oil (76.1) and wax (74.5) than the uncoated eggs (68.6). At 12 weeks, HU of coated eggs were significantly higher (70–73) than the uncoated (65.6). At week 0, albumen pH had no difference between any coating and pH values ranged from 8.2–8.6. At 4 weeks, the albumen pH of oil (8.2) was significantly lower than all other coatings and equal to uncoated eggs. At week 0, CO_2 content was the same for all coatings except WPI (1.97) and oil (2.05) this difference was most likely due to variation in eggs. After 1 week, CO_2 content maintained higher for the 12-week study for oil (2.07 mg CO_2/g albumen) and wax (1.96 mg CO_2/g albumen) than the uncoated (1.65 mg CO_2/g albumen). Oil eggs had a higher CO_2 content for all 12 weeks than wax eggs though not always significantly. After 2 weeks the SPI (1.8 mg CO_2/g albumen) was significantly higher than the control (1.6 mg CO_2/g albumen). Initially, VMS was equal for all eggs, but after 8 weeks oil (0.015N), and wax (0.014N) maintained significantly higher force than the uncoated (0.011N). The HU quality measurements show egg coatings provide an improved quality. The VMS remained high for coated eggs. Results from this study, suggest that shelf life of shell eggs can be extended using edible coatings.

TP389 Evaluation of bioluminescent bacteria (*Vibrio fischeri*) for detection of antibiotic residues and novel antimicrobial compounds. J. K. Hargis*[1], A. D. Wolfenden[2], M. J. Morgan[2], and G. Tellez[2], [1]*Fayetteville High School*, *Fayetteville, AR*, [2]*University of Arkansas*, *Fayetteville*.

As detecting antibiotics and other microbial residues in food products becomes more essential, tests for doing so need to be more efficient. Widely used methods for screening for unknown antibiotics and microbial residues require incubation over night. Presently, the potential use of bioluminescent bacteria culture (*Vibrio fischeri*: VF) has been evaluated. It was hypothesized that with introduction to antimicrobials, VF would dim or cease to glow and be a much quicker assay than previously known methods. After growing conditions were optimized (for both growth and light emission), 2 detection systems were evaluated. First, increasing increments of known antibiotics were added to a suspension of VF (~10^9 cfu/mL) in appropriate broth. After the addition of the antibiotics, sequential pictures were taken, but due to the constant need of oxygen for VF to emit light, this process was ineffective. The second method tried was growing the culture on 1.5% agar plates and then challenging them with paper discs impregnated with selected antibiotics. Zones of inhibition were visible after 3 hours and after about 18 hours were clearly noticeable. Zone of inhibited growth was documented by incremented pictures and compared to standard zones of inhibition. The VF zones were larger than normal (up to 6.9-fold) and may be useful for screening plant, bacterial, or fungal extracts which could have been missed using conventional assays. Ongoing research will evaluate the potential for utilize this assay for both discovery research and detection of antimicrobial contaminants in foods and feeds.

Key Words: antimicrobial, antibiotics, antibiogram

TP390 The effect of edible coatings on shell egg functionality under refrigerated conditions. A. Biladeau and K. Keener*, *Purdue University*, *West Lafayette, IN*.

In the United States approximately 56 million dozen shell eggs were exported in 2006 (most recent data). This amounts to less than 0.1% of shell egg production. Increasing the shelf life of shell eggs may increase exported egg sales. The objective of this study was to determine whether shell egg functionality could be maintained during extended storage by applying an edible coating. Four edible coatings were applied to fresh shell eggs, and the eggs were stored for 12 weeks in refrigerated storage. The 4 coatings applied were paraffin wax, food grade mineral oil, soy protein isolate (SPI), and whey protein isolate (WPI). Functionality tests in duplicate were taken over the storage period. Functionality measurements included foam volume, angel food cake volume, and emulsion stability. For each time period, functionality measurements were done in triplicate. Emulsion stability was measured by centrifuging mayonnaise and measuring oil separation. A t-test with a $P < 0.05$ was used to determine statistical significance. At week 0, the foam volume of uncoated eggs (9.1 mL/g) was greater than all coated eggs. At week 12 the uncoated, wax, and SPI (6.8 mL/g) were equivalent and greater than the WPI (6.2 mL/g) and oil (6.7mL/g) which were equivalent. At week 0, the angel food cake volume was equivalent between coated and uncoated eggs. For all eggs, angel food cake volumes decreased over 12 weeks of storage with the oil having the largest decrease (26.9 mL) followed by WPI (23.1 mL), SPI (21.8 mL), uncoated (18.4 mL) and finally wax (16.7 mL). At week 12, the wax (287.7 mL) and uncoated (286.0 mL) eggs were equivalent. Emulsion stability decreased with storage, but did not show consistent differences between coatings. The average emulsion stability measured over the 12 weeks were uncoated (0.0076 mL oil), oil (0.0079 mL oil), wax (0.0079 mL oil), SPI (0.0091 mL oil), and WPI (0.014 mL oil), respectively, with oil, wax, and uncoated being equivalent at week 12. The functionality data suggests that shell eggs with wax coating have functional properties equal to

uncoated over 12 weeks of storage, whereas all other coatings showed a decrease in functionality.

TP391 Using automated rep-PCR to determine the genotypic relatedness of *Salmonella* isolates recovered from an integrated broiler operation. P. N. Anderson*[1], J. A. Byrd[1,2], M. E. Hume[1,2], K. Stringfellow[1], C. Hernandez[1], and D. J. Caldwell[1], [1]*Texas A&M University*, *College Station*, [2]*USDA-ARS, Food and Feed Safety Research Unit*, *College Station, TX*.

Salmonella is the leading cause of gastroenteritis in humans. The consumption of poultry meat and eggs has been documented as a primary vehicle for salmonellosis. Integrated poultry operations are potential environments for the contamination of broilers with *Salmonella*. The objective of this study was to determine the genotypic relatedness of isolates recovered throughout an integrated broiler production operation. Two trials were conducted and 2 commercial houses were sampled in each trial. Ceca, litter, drag swabs, boot covers, litter, feed, and water were sampled on d 0, 14, 28, and 42. At processing, the sampling sites were live bird wash (LB), ceca, pre- and postevisceration, and postchill immersion. Forty-seven *Salmonella* isolates were recovered throughout the study, 18 and 29 in Trials 1 and 2, respectively. Most of the positive isolates were detected at processing (20/47), and very low *Salmonella* frequency was found in the feed (1/47) and farm water (0/47). Fifteen distinct genotype patterns were revealed following automated rep-PCR analysis. Isolates from the 2 studies were distantly related at 70.5% similarity coefficient (SC). Most of the LB isolates (11/13) in Trial 2 were related with a 93.1% SC. In addition, 50% (5/10) drag swab and boot cover isolates in Trial 2 were clustered at 91.4% SC, and combining 2 isolates from Trial 1 lowered the SC to 85.5%. Interestingly, there was great similarity (94.0% SC) between some *Salmonella* isolates detected at the farm and at processing. In conclusion, our findings support previous data that controlling *Salmonella* at the farm level could reduce pathogen load at the processing plant.

Key Words: rep-PCR, *Salmonella*, integrated poultry operation

TP392 The microbial and quality properties of poultry carcasses treated with peracetic acid as an antimicrobial treatment. L. J. Bauermeister*, J. W. J. Bowers, J. C. Townsend, and S. R. McKee, *Auburn University*, *Auburn, AL*.

Salmonella spp. and *Campylobacter* spp. continue to be prominent food safety concerns for the poultry industry and consumers alike. Peracetic acid (PAA) has been approved as an antimicrobial for use in poultry chillers. To validate its effectiveness, 100 poultry carcasses (per replication × 2) were inoculated with both *Salmonella* (6 log cfu/mL) and *Campylobacter* (6 log cfu/mL) and were randomly allocated into chill water containing chlorine (30 ppm) or PAA (25, 100, or 200 ppm). Results indicated that PAA concentrations as low as 25 ppm were effective in reducing *Salmonella* spp., while PAA levels of 200 ppm were effective in reducing *Campylobacter* spp. when compared with the chlorine treatment. A sensory study was also conducted with another set of 200 carcasses (not inoculated, per replication × 2). Birds were treated with water, chlorine (30 ppm), or PAA (100, 150, or 200 ppm). Sensory panels and microbial data were collected weekly on randomly sampled carcasses that were stored at 4°C for 21 d. The PAA-treated carcasses at 150 and 200 ppm had an extended shelf life compared to those treated with water or chlorine. Specifically, on d 15, the only treatments that could be served to sensory panelists were the carcasses treated with 150 or 200 ppm PAA. The carcasses treated with water, chlorine, or 100 ppm PAA had off-colors, off-odors, and high microbial counts. These results suggest that PAA may be an effective antimicrobial when used in poultry chiller applications and higher levels (>150 ppm) may extend product shelf life.

Key Words: peracetic acid, shelf life, antimicrobials

TP393 Control of *Listeria monocytogenes* on further processed turkey deli loaves using organic acids as postcook dips. J. Johnson*[1], C. Z. Alvarado[1], M. Berrang[2], S. R. McKee[3], L. D. Thompson[1], and M. M. Brashears[1], [1]*Texas Tech University*, *Lubbock*, [2]*USDA-ARS*, *Athens, GA*, [3]*Auburn University*, *Auburn, AL*.

Most major outbreaks attributed to *Listeria monocytogenes* (LM) involve postprocessing contamination of turkey deli loaves. This study evaluated the anti-listerial effects of organic acids used as postcook dips on turkey deli loaves. Two trials were conducted to analyze LM levels on days 0, 7, 14, 21, 28, 42, and 56. Treatments included sodium lactate (SL; 3.6%), potassium lactate (PL; 3.6%), sodium citrate (SC; 0.75%), a combination of SL and sodium diacetate (SDA; 0.25%), and a combination of SL/PL/SDA. Deli loaves were formulated with 1.5% sodium chloride and 0.45% sodium tripolyphosphate. Slices were surface inoculated with a high inoculum level (10^5 log CFU/mL) of Streptomycin resistant (1,500 μg/mL) LM before immersion treatment. A high inoculum was used to determine differences in lag phase due to the effectiveness of the organic acid application. Positive (inoculated) and negative (noninoculated) control slices were immersed in sterile water. All slices were stored at 4°C. Data was analyzed using GLM procedure of SAS and Duncan's Multiple Range Test was used to determine treatment differences within sampling d. The SL/SDA and the SL/PL/SDA treatments had signifcantly lower LM counts when compared to the other treatments through d 56. Also, the SC treatment was significantly higher than the positive control after day 28. There were no significant differences between the positive control and the other treatments during the sampling times. Therefore, the combination organic acids used as postcook dips for turkey deli loaves were effective in extending the lag phase and controlling LM growth.

Key Words: *Listeria monocytogenes*, organic acid, deli loaves

TP394 Multihurdle approach to controlling *Listeria monocytogenes* in further processed turkey deli loaves. T. Lloyd*[1], C. Z. Alvarado[1], M. Berrang[2], S. R. McKee[3], L. D. Thompson[1], and M. M. Brashears[1], [1]*Texas Tech University*, *Lubbock*, [2]*USDA ARS*, *Athens, GA*, [3]*Auburn University*, *Auburn, AL*.

The growth of *Listeria monocytogenes* (LM) in further processed meat products has become a major concern and an important food safety issue. The poultry industry has incorporated interventions such as organic acids in marinades to inhibit the growth of LM. In this study, organic acids were utilized in the raw product and as a postcook dip to determine their inhibitory effect on the growth of LM in turkey deli loaves. The turkey deli loaves were processed, cooked, cooled, inoculated with

Streptomycin-resistant LM, dipped in organic acids treatments, and sampled on days 0, 7, 14, 21, 28, 42, and 56. Treatments were potassium lactate (PL) in the raw product with sodium lactate (SL) sodium diacetate (SD) dip, PL with SL/PL/SD dip, SL with SL/SD dip, and SL with SL/PL/SD dip. Positive (inoculated) and negative (noninoculated) controls dipped in distilled water were also included. There was no difference ($P > 0.05$) among any of the organic acid treatments in the turkey deli loaves at any time points. Therefore, all the treatments increased the lag phase of LM and extended the shelf life of the product. However, the positive control levels were significantly higher than all the organic acids treatments on days 7, 14, 21, 28, 42, and 56 indicating the use organic acids decreased the growth and extended the lag phase of LM. Therefore, a multi-hurdle approach to using organic acids can provide processors with a successful method of extending the lag phase of LM in ready-to-eat poultry products.

Key Words: turkey, *Listeria monocytogenes*, deli loaves

TP395 Will intake of eggs/egg products have benefits for hypertension management? J. Wu* and K. Majumder, *University of Alberta*, *Edmonton, AB, Canada*.

Egg proteins are excellent sources of bioactive peptides. Recent studies have shown that egg protein-derived angiotensin converting enzyme (ACE) inhibitory peptides could significantly reduce blood pressure in both hypertensive animals and human subjects. Hypertension is one of the major risk factors contributing to the development of coronary heart diseases and afflicts approximately 27.6% individuals in North America and 44.2% in Europe. However, it is not clear if the consumption of regular table eggs (boiled eggs, fried eggs) and commercial egg products could have potential benefits for hypertension management. In the study, prepared egg products were digested in a simulated hydrolysis process using pepsin followed by pancreatic enzymes at the pH of the small intestine. The generation of potential ACE inhibitory activity was computed by in silico digestion of various egg proteins by gastrointestinal enzymes; the activities of individual peptides were predicted by our recently reported ACE inhibitory peptide models. In silico gastrointestinal enzymatic proteolysis of major egg white proteins showed that lysozyme, ovalbumin, ovomucin, ovomucoid, and ovotransferrin generated 9, 15, 20, 2, and 19 peptides, respectively, with predicted IC50 values less than 10 μM, of 2 peptides having IC50 values less than 1 μM. Similarly, potentially active peptides from low density lipoprotein, high density lipoproteins, phosvitin, and livetin were determined. The existence of the predicted, potent peptides from the simulation would be further verified by using HPLC-MS. Our results showed that intake of egg products might contribute to the benefits of hypertension management through the generation of bioactive peptide in the gut.

Key Words: egg, simulated digestion, bioactive peptides

TP396 Evaluation of co-incubation of oxygen-dependent bioluminescent *Vibrio fischeri* in sealed plates to support growth of selected anaerobic bacterial isolates. H. E. Jackson*, M. J. Morgan, and B. M. Hargis, *University of Arkansas*, *Fayetteville*.

While numerous laboratories worldwide desire the occasional ability to identify and quantify CFU of anaerobic bacteria, many lack sufficient demand or resources to maintain this capability through traditional anaerobic culture methodologies. Presently, we evaluated the ability of a high oxygen-demand aerobe to deplete oxygen levels sufficiently to allow co-incubated anaerobes to grow on sealed bi-plates. The marine endo-symbiotic bacterium *Vibrio fischeri* luminesces by production of the enzyme luciferase. Preliminary experiments indicated that suspensions of *V. fischeri* in appropriate broth were capable of intense luminescence after oxygenation with air. However, within 30 seconds of cessation of oxygenation, bioluminescence was markedly diminished, which others have linked to oxygen consumption. Thus, we evaluated the potential for a heavy culture of *V. fischeri*, on one-half of a sealed standard Petri dish bi-plate, to sufficiently reduce oxygen levels to allow growth of selected anaerobes. The bi-plates were made one-half blood agar and the other half bioluminescent agar. *V. fischeri* was inoculated on the bioluminescent agar half of the plate and allowed to grow for 24–36 hours at 23°C prior to inoculation with anaerobic species. Preliminary experiments indicated that these plates retained viability and luminescence for at least 2 weeks, when held at 6°C. After inoculation of anaerobes, plates were sealed by application of vacuum grease around the lid's inner rim. Typically, more than 20 hours incubation at 23°C were required for cessation of visible bioluminescence. Nevertheless, these plates were found to support the growth of various anaerobic species, including *Clostridium perfringens*, *C. septicum*, *C. bifermentans*, *Prevotella* spp., and *Lactobacillus* spp. Due to the time required to generate an anaerobic environment, this technique may not be useful for the recovery of all strict anaerobes. Nevertheless, this method for creating an anaerobic environment to culture anaerobic organisms is economically attractive and useful for selected purposes.

Key Words: anaerobes, *Vibrio fischeri*, luminescence

TP397 Prophylactic supplementation of caprylic acid in feed reduces *Salmonella* Enteritidis colonization in commercial broiler chicks. K. J. Anup*[1], A. B. Sangeetha[1], S. C. Anu[1], M. A. R. Amalaradjou[1], M. J. Darre[1], M. A. Khan[1], T. A. Hoagland[1], D. T. Schreiber[1], A. M. Donoghue[2], D. J. Donoghue[3], and K. Venkitanarayanan[1], [1]*University of Connecticut*, *Storrs*, [2]*PPPSRU, ARS, USDA*, *Fayetteville, AR*, [3]*University of Arkansas*, *Fayetteville*.

Salmonella Enteritidis (SE) is a major food-borne pathogen for which chickens serve as the reservoir host. Reducing the intestinal carriage of SE in chickens would decrease contamination of poultry meat and eggs with the pathogen. In this study, we investigated the prophylactic efficacy of feed supplemented with caprylic acid (CA), a natural, GRAS status, 8-carbon fatty acid present in breast milk and coconut oil, for reducing SE colonization in chicks. One hundred commercial, day-old chicks were randomly divided into 5 groups of 20 birds each: CA control (no SE, CA), positive control (SE, no CA), negative control (no SE, no CA), 0.7 or 1% CA. Water and feed were provided ad libitum and on day 7 birds were inoculated with 6 log CFU of SE by crop gavage. Six birds from each group were sacrificed on days 1, 7, and 10 after challenge and SE populations in the crop, cecum, small intestine, cloaca, liver and spleen were enumerated. The study was replicated twice. Supplementation of CA at 0.7 and 1% consistently decreased SE populations recovered from the treated birds in comparison to those from positive control chicks. SE counts in the cecum, small intestine, cloaca, liver, spleen and crop of CA-treated chicks were substantially lower ($P < 0.05$) than those of control birds on days 7 and 10 after challenge. Feed intake and body weight did not differ between the CA and control groups. The results suggest that prophylactic supplementation of CA in the feed can effec-

tively reduce SE colonization in day-old chicks and may be a potential treatment for reducing pathogen carriage in poultry.

Key Words: caprylic acid, chicken, *Salmonella* Enteritidis

TP398 Texture of frankfurters manufactured from chicken thigh and enriched with plant-based fat sources. R. Currie*[2], K. Doncaster[1], and B. Rathgeber[1], [1]*Agriculture & Agri-Food Canada*, *Kentville, NS, Canada*, [2]*Nova Scotia Agricultural College*, *Truro, Canada*.

Poultry products enriched with plant-based fat sources were formulated to contain a more favorable fatty acid profile to improve the marketability. Skin-on boneless chicken thighs were ground and made up the bulk of frankfurters for 4 treatment formulations. The control was a standard frankfurter. Other treatments included 0.7% olive oil, 0.7% flax oil, or 5% ground flax seed. Each treatment was chopped to 4°C, vacuum tumbled and stuffed into collagen casings. Frankfurters were placed in a computerized smokehouse with each treatment represented at each level of the product truck. Once product endpoint was reached the product was cooled to 4°C, vacuum packed, and stored at 4°C. Six frankfurters per treatment were selected at random once per week for 4 weeks and sheared in duplicate with a Warner-Bratzler blade. The texture profile of these samples was also determined in triplicate. Statistical analysis was performed using proc mixed of SAS. The force required to shear the control sample was greater ($P < 0.05$) than all other treatments which were similar to each other. The work required to shear control and flax seed samples was greater than either of the formulations with oil added ($P < 0.05$). Springiness of the samples was not different between treatments. The hardness, gumminess and chewiness of the 4 treatments interacted with the week that sampling was performed ($P < 0.05$). The olive oil treatment was more cohesive than the flax oil treatment but not different from the other 2 treatments ($P < 0.05$). These results indicate that texture of poultry meat products needs to be considered when formulating with plant-based fat sources.

Key Words: omega-3, texture profile, shear force

TP399 Efficiency of manufacturer recommended microwave time on the recovery Of *Listeria monocytogenes* from inoculated ready-to-eat chicken products. A. Morey*, M. Singh, and S. R. McKee, *Department of Poultry Science, Auburn University*, *Auburn, AL*.

Postprocess contamination by *Listeria monocytogenes* is one of the main reasons for recalls of ready-to-eat (RTE) poultry products. Generally, consumers reconstitute RTE products by following the directions on the package. The information about the efficiency of the reconstitution methods to kill *L. monocytogenes* is lacking. Hence an experiment was conducted to determine the lethality of manufacturer recommended reheating methods on recovery of *L. monocytogenes* inoculated on RTE poultry products.

Three chicken products including breaded and battered chicken patties, fully cooked chicken breast fillets (both frozen) and chicken frankfurters (refrigerated) were used. Samples were inoculated with streptomycin resistant (1,500 μg/mL) *L. monocytogenes* (Brie 1) at a level of 10^8 cfu. All samples were either frozen or refrigerated according to specifications. After 12 h, chicken patties were microwaved for 30, 45 and 60 s; chicken breast fillets for 2, 4 and 6 min; chicken frankfurters for 1, 2 and 3 min. Products were sampled in triplicate and 2 separate trials were conducted. Microwaving the chicken patties retained between 6.4 and 6.8 log cfu/g *L. monocytogenes* in each cooking treatment of 30, 45, and 60 s of microwaving time. Breast samples microwaved for 4 and 6 min completely eliminated *L. monocytogenes* while microwaving for 2 min reduced the bacterial load by 2 log cfu/g. In conclusion, it can be observed that lethality of *L. monocytogenes*, when reconstituting products in the microwave depends on product type, surface and microwaving time. As observed in patties, recommended microwaving of 45 s is not effective in eliminating *L. monocytogenes* when contaminated at high levels.

Key Words: *L. monocytogenes*, ready-to-eat, microwave

TP400 Fatty acids stability in enriched broiler meat during cooking. T. I. Perez*[2], M. Betti[2], M. J. Zuidhof[1], R. Renema[2], and Y. Ren[2], [1]*Agriculture Research Division, Alberta Agriculture and Food*, *Edmonton, AB, Canada*, [2]*Department of Agricultural, Food and Nutritional Science, University of Alberta*, *Edmonton, AB, Canada*.

The health benefits of omega-3 (n-3) polyunsaturated fatty acids (PUFAs) make enrichment of broiler meat an excellent opportunity to add value to the poultry meat sector. Due to high linolenic acid (LNA) content, flaxseed is a good source for enhancing n-3 fatty acids in poultry meat. However, these unsaturated fatty acids may be more susceptible to oxidative damage during cooking. This study explored the oxidative stability of n-3-enriched chicken meat from 128 Ross 308 mixed-sex broilers fed an n-3 PUFA enriched base diet with 1 of 4 antioxidant profiles from 21 d of age: [Control (base diet only), Vitamin E (base (50IU/kg) + 200 IU/kg supplement), Selenium (base (0.5 mg selenium/kg feed) + 0.3 mg/kg selenomethionine supplement using Sel-Plex), and Vitamin E + Selenium (base (0.5 mg selenium/kg of feed) + 200 IU/kg vitamin E and 0.3 mg/kg Sel-Plex)]. After processing, all thigh meat from birds on each treatment was pooled and grounded. Fatty acid composition and thiobarbituric acid reactive substances (TBARS) were analyzed on raw or cooked samples (pan frying without oil, roasting, and boiling). Thigh fat content and n-3 long-chain PUFAs (EPA, DPA, DHA) and LNA content did not differ by dietary treatment or by cooking method. However, the cooking process consistently increased oxidation, with samples from the control diet particularly affected ($P < 0.0001$). The TBARS analysis indicated better stability with the incorporation of vitamin E in the meat ($P < 0.0001$), while dietary selenium provided no additional protection against cholesterol and fatty acid oxidation during cooking. Roasted meat had the highest amount of TBARS compared to the other cooking methods. Total n-3 PUFA enrichment is affected by cooking method and is not affected by antioxidants, while TBARS values are highly dependent on the antioxidant supplementation, with vitamin E providing superior results in cooked meat in the current study.

Key Words: n-3 PUFA, enriched broiler meat, antioxidants

TP401 Stability of omega-3 PUFAs in enriched eggs fortified with antioxidants following storage and cooking. Y. Ren*[1], J. Wu[1], R. A. Renema[1], M. Betti[1], M. J. Zuidhof[2], and T. I. Perez[1], [1]*University of Alberta*, *Edmonton, AB, Canada*, [2]*Alberta Agriculture and Food*, *Edmonton, AB, Canada*.

The omega-3 polyunsaturated fatty acids (n-3 PUFA) in n-3-enriched eggs are susceptible to oxidative damage during storage and cooking, as well as to PUFA triggering breakdown of cholesterol into cholesterol oxidative products (COPs). This study assessed the storage and cooking stability of n-3 PUFA enriched eggs fortified with vitamin E and/or selenomethionine. In this study, 120 laying hens (37 wk of age) were provided 1 of 4 n-3 PUFA diets (18.7% CP; 3,000 kcal/kg, 1.5% LNA) enriched with 17% Linpro (extruded flax product) for 28 d: Control (base diet only), vitamin E (base + 200 IU/kg supplement), selenium (base + 0.3 ppm selenium from Sel-Plex), and vitamin E + selenium (base + 200 IU/kg Vit E + 0.3 ppm selenium from Sel-Plex). After 4 wk, 238 eggs were collected divided into 2 groups (A and B). Yolks from Group A eggs (Fresh) were pooled and sampled fresh or cooked (boiling or frying). Group B eggs (Stored) were kept at 4 C for 4 wk prior to pooling and cooking/sampling. Fatty acid profile, COPs content, and TBARS were measured in quadruplicate. Total yolk fat content was unaffected by feeding treatment or storage. Fried yolk had the highest fat content due to cooking loss of moisture. Omega-3 long chain PUFAs (EPA, DPA, DHA) and LNA content did not differ due to diet. However, following storage, LNA was stable but LC-PUFAs were reduced. Cooking did not affect LNA concentration, but LC-PUFAs were reduced with frying. As a result, the fried samples also had the highest yolk n-6:n-3 ratio, regardless of dietary treatment, a measure that was also significantly increased by storage in all feeding regimens. Both vitamin E and organic selenium stabilized the yolk, reducing the appearance of COPs. Frying triggered increased oxidation overall, with samples from the control diet particularly affected. Egg storage did not increase COP appearance. Cooking methods affect the breakdown of omega-PUFA and there are multiple dietary means to provide antioxidant protection to the n-3-enriched egg.

Key Words: n-3 eggs, cholesterol oxidative products, antioxidants

TP402 Consumer acceptance of interior egg spots before and after introducing the idea that the spots may merely be shell pigment. N. P. Johnston*[1], L. K. Jefferies[1], O. A. Pike[1], and B. Rodriguez[2], [1]*Brigham Young University*, *Provo, UT*, [2]*University of San Andres*, *La Paz, Bolivia*.

Brown-shelled eggs are becoming increasingly more popular in the market place as the vehicle for selling specialty eggs. Unfortunately, many contain dark pigmented spots that are viewed negatively by consumers. Much literature suggests the spots are of blood origin while others contend that many are nothing more than shell pigment. The objectives of this study were twofold: (1) to see consumer acceptance of eggs with single spots based on size and (2) to see if the acceptance was improved if the panelist were advised that those spots were likely nothing more than shell pigment. To test these objectives, 52 panelists, all women (ages 18–65) who routinely purchased and consumed eggs, completed the evaluation. The panelists were asked to rate spots on the interior (yolk or white) of 5 dark-shaded brown eggs. The spots ranged in size from 1.03 to 4.21 mm in diameter. Only a single dark brown spot appeared in each egg interior. The panelist were asked to rate the eggs for (1) visual appearance, (2) use as is (3) remove the spot and use and (4) concern for spot content if not used. The panelists were then advised that the spots may be nothing more than eggshell pigment and ask to rate the eggs again. A 9-point Hedonic scale was used for visual appearance with smaller egg spots liked significantly better (<0.05) than those with larger spots (Hedonic range 6.02–3.96). Significantly more panelists would eat the egg with the smaller (81.8%) than the larger spot (54.6%). Asked if they would eat the egg as is, 71.1% would eat the egg with the small spot but none the egg with the largest spot unless the spot was removed ($P < 0.05$). For those who would not use the egg, 94 to 100% (smallest to largest spot size) were concerned about spot contents. There was a negative relationship between egg acceptance and spot size for every parameter. When panelists were advised that spots may be nothing more than shell pigment, acceptance for the egg was improved numerically for every criterion but seldom significantly ($P < 0.05$) so. The concern for spot content overall dropped most (94.7 to 80.0%).

Key Words: spots, brown eggs, pigment

TP403 The national poultry waste management symposium as a forum for discussion on poultry waste management issues. J. B. Hess*[1], J. P. Blake[1], and R. D. Reynnells[2], [1]*Auburn University*, *Auburn, AL*, [2]*USDA, CSREES*, *Washington, DC*.

The National Poultry Waste Management Symposium (NPWMS) was developed to provide a forum for those involved with the poultry industry to discuss issues and solutions related to the handling of poultry by-products related to poultry production and processing. First held in 1988, the NPWMS provided a mixing pot for representatives from the industry (both company technical representatives and farmers), universities, state and federal agencies to meet and share strategies for handling poultry wastes at a time when regulatory oversight of poultry was escalating. This symposium has been held every 2 years, allowing for the exchange of program successes from all major poultry growing regions of the country. An average of 45 invited speakers per symposium has provided a framework for discussion amongst attendees. Through the years, more than 2000 have attended from most poultry growing regions of the United States and internationally. Although waste management programs have matured within most poultry sectors throughout the 20 years that the NPWMS has been in existence, changes and updates in regulatory issues remain, and the need for a forum to bring together interested parties from all portions of the industry has not diminished substantially.

Key Words: poultry, waste management, poultry waste

TP404 Avian crime scene investigation (CSI). G. P. Birrenkott* and R. S. Bernard, *Clemson University*, *Clemson, SC*.

We are often called upon to present summer workshops for middle and high school students explaining what an animal scientist does. We use a series of hands-on experiences to inform and recruit students about majors in the animal sciences. To engage them in these activities, we have prepared a handbook and used the format of a crime scene investigation. The overall goals of the exercise are to highlight observational skills, math competencies, and knowledge of avian and animal physiology and anatomy. We begin with the demise of Humpty Dumpty, a broken-out blood spot egg. From this we can teach egg candling and

grading techniques and the types of eggs that consumers purchase. The suspects are a range of barnyard animals. Depending on the age of the students, we may next do something as simple as identifying the culprit by their tracks, relative to those of other farm animals. For more advanced students we, conveniently, have blood samples from the suspects. A quick blood smear, stain and microscopic examination demonstrate that the culprit has nucleated RBC. This limits the choices to birds, reptiles and amphibians. This may be followed by a (high) blood glucose determination that seems to further limit our choice to birds. A packed cell volume (PCV) determination of the suspect's blood gives us a clue as to the sex of the culprit. Fortunately, our suspect has also left some feathers at the scene of the crime. The feather morphology and color can confirm the sex and breed/variety of the avian culprit as also determined by the PCV. Depending on the workshop, the culprit may be the Little Red Hen, Henny Penny, or Foghorn Leghorn. The mystery is solved. Feedback from students and teachers has been very positive with several students enrolling in our undergraduate programs after participating in these summer workshops.

Key Words: recruitment, applied physiology, laboratory exercises

TP405 Evaluation of the effectiveness of different levels of nanosilver on bursa of fabricius development and on its histopathological lesions in broiler chicks. M. A. Akrami Moghaddam*, A. N. D Jeddi, and F. Ahmadi, *Azad University of Sanandaj*, *Sanandaj, Kordestan, Iran*.

This study focused on evaluation of nanosilver histopathological effects on bursa of Fabricius of broiler chicks. Two hundred forthy chicks were randomly selected and divided into 4 treatments (0, 4, 8, 12 ppm). During this study, all of treatments had same status and facilities to grow (1–56 days).at the end of trial, chicks which had average weight among other chicks, was selected and slaughtered. By necropsy, bursa of Fabricius was detached and then it was put into 10% formaldehyde for pathological study. First, some 6-micron thick sections were obtained stained with hematoxylin and eosin methods. The result showed macroscopic edema in all of treatments. The first treatment was defined as a negative control in this research. In treatments 1, 2, and 3, there was no sign of hemorrhage or necrosis but low degrees of hyperemia, vacoulation, hyperplasia and fibrosis among the follicles were detected and these signs would significant and severe in each treatment, compared to previous treatments. For example, the signs were more clear in the third treatment in comparison with the first (negative control) and second treatments. Additionally, in the fourth treatment, petechia and necrosis were observed and the effects of hemorrhage among follicles were visible. This study showed that increasing the level of nanosilver gradually, led to reduce amount of B lymphocyte in lymphoid follicles.

Key Words: nanosilver, bursa fabricius, pathology

TP406 Effects of feed borne *Fusarium* mycotoxins on intestinal morphology in broiler breeder pullets in the absence or presence of a mixed coccidial infection. G. N. A. Girgis*, T. K. Smith, and J. R. Barta, *University of Guelph*, *Guelph, ON, Canada*.

The effects of feeding diets containing grains naturally contaminated with *Fusarium* mycotoxins on intestinal morphology were studied in broiler breeder pullets raised to 10 weeks of age in the absence or presence of coccidial challenge. Experimental diets included: (1) control grains (2) naturally contaminated grains (3) naturally contaminated grains + 0.2% polymeric glucomannan mycotoxin adsorbent (GMA). Contaminated diets contained up to 3.8 ppm deoxynivalenol (DON), 0.3 ppm 15-acetyl DON and 0.2 ppm zearalenone. Birds were challenged using a standardized mixture of *Eimeria acervulina*, *E. maxima*, and *E. tenella* at 8 weeks of age. Intestinal tissues were collected from duodenum, jejunum and ileum prior to challenge, at the end of the challenge period (7 days postinoculation, PI) and at the end of the recovery period (14 days PI). Morphometric analyses were performed using a computer-aided light microscope imager and OpenLab® software (Improvision Inc., Lexington, MA). Means were compared by Student′s t-test. Comparisons were considered significant at $P \leq 0.01$. Villus height (VH) of the duodenum of birds fed the contaminated diets was significantly lower than that of the controls. VH of the jejunum and ileum in the same birds was significantly higher compared to controls, suggesting a compensatory mechanism. *Fusarium* mycotoxins retarded recovery from coccidial lesions in the intestine as evidenced by lower villus parameters comparing challenged birds to nonchallenged birds of the same age. It was concluded that diets contaminated with *Fusarium* mycotoxins below levels that negatively affect performance could affect small intestinal morphology in broiler breeder pullets as well as intestinal recovery from coccidial infection. Many of the histological alterations caused by *Fusarium* mycotoxins were reduced by GMA.

Key Words: *Fusarium* mycotoxins, intestine, pullets

TP407 3-*O*-Acetyltransferase confers protection against T-2 toxin in vitro. S. L. Perrin, J. Lin, and J. M. Grizzle*, *University of Tennessee*, *Knoxville*.

Trichothecene mycotoxin, T-2 toxin, is one of the most toxic fungal contaminants of feed grains. The gene product of Tri101, 3-*O*-acetyltransferase is known to reduce the toxicity of t-type trichothecene mycotoxins through transfer of an acetyl group to the 3 carbon, and has been reported to protect bacteria challenged with T-2 toxin. It was hypothesized that the *tri101* gene product may confer similar protective effects to eukaryotic cells. The objective of this study was to determine if purified 3-*O*-acetyltransferase would protect HD-11 chicken macrophage cells challenged with T-2 toxin. HD-11 chicken macrophage cells were grown in RPMI 1640 media, 5% fetal calf serum, and 1% antibiotics at a density of 150,000 cells/1 cm^2 well. Cells were allowed to adhere overnight before treatment with increasing doses T-2 toxin (0.1, 0.5, or 1 ppm), purified 3-*O*-acetyltransferase (1 or 2 nM), and acetyl CoA (5 or 10 μM; an acetyl source for the 3-*O*-acetyltransferase enzyme). Following 14–17 h incubations, cells were manually counted by trypan blue exclusion to determine percent live and dead cells in the population. Neither the purified 3-*O*-acetyltransferase nor acetyl CoA was found to be toxic to HD-11 cells at any level tested ($P \geq 0.05$). Fifty percent of HD-11 cells were killed following incubation with 0.1 ppm, with only 40 percent surviving a 14–17 hour incubation with 1 ppm T-2 toxin. Total protection of HD-11 cells (99% live) was found when cells were incubated with 0.1 ppm T-2 toxin, 5 μM acetyl CoA, and 1 nM 3-*O*-acetyltransferase, as compared to 0.1 T-2 toxin alone (54% live; $P \leq 0.05$). At a higher level T-2 toxin, 0.5 ppm, 82.7% of cells survived challenge when co-incubated with 2 nM 3-*O*-acetyltransferase and 10 μM acetyl CoA, as compared to those incubated with 0.5 ppm T-2 toxin alone (45%; $P \leq 0.05$). At 1 ppm T-2 toxin, protective effects were not observed, and only 52% of HD-11 cells survived challenge when

co-incubated with 1 nM 3-*O*-acetyltransferase and 5 μM acetyl CoA as compared to those treated with 1 ppm T-2 toxin alone (46.6%; $P \geq 0.05$). Results from this study show potential intervention technologies for mycotoxin poisoning in avians.

Key Words: T-2 toxin, 3-*O*-acetyltransferase, HD-11

TP408 Case report: Necropsy findings during a phytase research trial in broilers. V. Durairaj*[1,2], T. O'. Conner-Dennie[1], J. L. Emmert[1], N. C. Rath[2], and F. D. Clark[1], [1]*University of Arkansas*, *Fayetteville*, [2]*PPPSRU/ARS/USDA*, *Fayetteville, AR*.

A research trial was conducted to determine the efficacy of 2 commercial phytase enzymes combined with different levels of calcium and phosphorus in the diet. All chicks in the trial were fed a common corn-soybean meal starter diet with 24% crude protein. Eight experimental diets, 2 positive control diets and 2 negative controls were used. Birds were raised in floor pens up to 42 days.All dead birds were collected and necropsy was done to check for any negative effects from the phytase sources. The cause of death was determined based only on gross pathology observed at necropsy. Mortality was seen in all groups irrespective of treatments with overall mortality for this trial at 7.16%. On necropsy, it was found that majority of birds died due to cardiomyopathy. Based on this trial, we conclude that these 2 phytase enzymes had no negative effects in causing mortality in broilers.

Key Words: phytase enzyme, broilers, necropsy

TP409 Comparison of primary chicken embryo cells for propagation of infectious laryngotracheitis virus (ILTV). J. Y. Lee*, A. Wooming, and B-W. Kong, *University of Arkansas*, *Fayetteville*.

Avian infectious laryngotracheitis (ILT) virus (ILTV), *gallid herpesvirus 1*, causes an acute respiratory disease mainly in chickens and may result in severe production losses caused by excessive mortality, decreased growth rates and decreased egg production. Although various ILT vaccines are currently available to control the disease, ILT outbreaks are still a threat to the poultry industry. To develop a new ILT vaccine based on tissue culture, alternative cellular substrates are being tested to produce high titer ILTV. Currently, primary chicken embryo kidney (CEK) cells are being used for ILTV propagation. Various primary chicken embryo tissue cells were isolated from lung, trachea, liver, heart, muscle, intestine, kidney, and bursal tissue, in addition to embryonic fibroblastic (CEF) cells. These primary cells along with the immortal DF-1 CEF cell line were compared to determine the best permissive host for the in vitro propagation of ILTV. Virus infection was determined by cytopathic effect (CPE) and virus titers were measured by plaque assay using the LMH chicken liver tumor cell line (which is widely used to titrate ILTV). Virus titers were detected only when ILTV was propagated in kidney, liver, and lung cells. ILTV titers produced from liver (5×10^4 pfu/mL) and kidney (4×10^4 pfu/mL) cells were higher than ILTV titers propagated from embryonic lung cells (2×10^3 pfu/mL), while other cells derived from muscle, trachea, bursa, heart, and intestine did not propagate ILTV efficiently. Moreover, both primary CEF cells and the DF-1 CEF cell line produced high levels of CPE, but the ILTV titers from CEF cells were not detectable. Undetectable virus titer in DF-1 CEF cells were verified by PCR and did not detect ILTV virion DNA in the culture media from infected cells. Chicken embryo kidney, liver, and lungs cells, which were positive for ILTV propagation, are currently being investigated for immortalization using stable transfection of various molecular constructs that can regulate the cell cycle.
This work is supported by US Poultry and Egg Association.

Key Words: infectious laryngotracheitis virus (ILTV), chicken embryo cells

TP410 Open-field temporal pattern of ambulation in Japanese quail genetically selected for contrasting adrenocortical responsiveness to brief restraint. J. M. Kembro[1], D. G. Satterlee*[2], J. B. Schmidt[2], M. A. Perillo[1], and R. H. Marin[1], [1]*Universidad Nacional de Córdoba, ICTA and CONICET*, *Argentina*, [2]*Louisiana State University Agricultural Center*, *Baton Rouge*.

Japanese quail selected for a reduced (LS) rather than an exaggerated (HS) adrenocortical response to brief mechanical restraint have been shown to possess lower fearfulness (e.g., comparatively enhanced locomotor activity when placed in an open field) and a nonspecific reduction in stress responsiveness. Detrended fluctuation analysis provides information about the organization and complexity of temporal patterns of behavior. The present study evaluated the temporal pattern of ambulation of LS and HS quail in an open-field that was a novel, and therefore frightening, environment. Time series of 4,200 data points were made for each bird registering the distance ambulated every 0.5 s during a 35-min test period. Consistent with their known reduced fearfulness, the LS quail initiated ambulation significantly sooner ($P < 0.02$) and tended to ambulate more ($P < 0.09$) than did their HS counterparts. Detrended fluctuation analyses showed a monofractal series (a series with similar complexity at different temporal scales) in the birds that initiated their ambulatory activity in less than 600 s (72% of the birds). Among those birds, a lower ($P < 0.03$) autosimilarity coefficient was found in the LS quail than in their HS counterparts (0.76 ± 0.03 and 0.87 ± 0.03, respectively), suggesting a more complex (less regular) ambulatory pattern in the LS quail. However, when the patterns of ambulation were re-examined considering only the active period of the series, that is, after the birds had initiated their ambulation activity, monofractal patterns were observed in 97% of the birds and no differences between the lines were found. Collectively, the results suggest that during the active period of open-field testing, during which fear responses were likely less strong and other motivations were the driving forces of ambulation, LS and HS lines have similar ambulatory organization.

Key Words: detrended fluctuation analysis, fractal pattern, genetic selection

TP411 Effects of alternatives of molting on bird well-being. H. W. Cheng*[1], D. Lay[1], R. Marchant-Forde[1], and E. D. Pajor[2], [1]*USDA-ARS*, *West Lafayette, IN*, [2]*Purdue University*, *West Lafayette, IN*.

Induced molting by feed withdrawal may cause stress in birds and affect their well-being. The objective of this study was to develop a welfare friendly alternative for molting by evaluating the effects of currently available molting alternatives on bird stress responses and well-being. One thousand, two hundred 60-wk-old hens were used in the study. The hens were housed in 2-bird cages, and randomly assigned into 1

of the 5 treatments: control (C); feed withdrawal (FW); low energy diet (LE), low salt (LS); and melengestrol acetate (MGA, at 4 mg/hen/day). The lighting schedule was 8:16 h (light:dark). The birds were on the treatment for 26 days. For the FW treatment, feed was withdrawn from the birds for 9 days, followed by grower diet for 17 days, and then returned to layer ration; and for all other treatments, the relative diet were used up to 26 days. Physical and physiological changes were analyzed at various periods of time during the molting. Compared to the controls, body weight (BW) was significantly reduced in the birds from all treated groups except MGA ($P > 0.05$). BW loss in the FW-treated birds started at 3 days posttreatment ($P < 0.01$), reached a peak at 9 days ($P < 0.001$), and then recovered after feeding with grower diet ($P > 0.05$); while the BW of LE- and LS-treated birds did not reach a significant loss until 9 days posttreatment ($P < 0.01$), and did not fully recover up to 26 days posttreatment in LE-treated birds ($P = 0.07$). The changes of blood glucose concentrations were paralleled to the changes of BW. The FW-treated birds had lower levels of glucose at both 3 and 9 days posttreatment ($P < 0.05$, and 0.01, respectively), which was recovered following feeding with grower diet; while LS-treated birds had a significantly lower glucose concentration at 9 days posttreatment ($P < 0.05$), which did not recover during the period of molting ($P < 0.05$); and LE-treated birds had a tendency for a lower glucose concentration from 9 to 17 days during the molting ($P = 0.052$). These results suggest that MGA could be used as a welfare-friendly alternative for molting. The results also provide evidence that it is valuable to further examine if low energy diet fed birds are still hungry.

Key Words: molting, alternatives, chickens

TP412 Effects of separation of resources on behaviour, physical condition and production of laying hens in furnished cages. T. Tanaka*, T. Shimmura, T. Azuma, Y. Eguchi, and K. Uetake, *Azabu University*, *Sagamihara, Japan*.

In our previous studies, we demonstrated that dominant hens had priority in using the dust bath, resulted in increased competition for the resource. It seemed that the problem was that the resource was placed on one side of the cage ("localized"). Therefore, we designed a medium-sized furnished cage with a dust bath and nest box on both sides of the cage ("separated", MFS). In this study, we evaluated the usefulness of separation of these resources synthetically by the many-sided measurements of the behaviour, physical condition and production. We used 180 White Leghorn layers. At the age of 17 weeks, the birds were randomly introduced into 1 of the 4 cage designs: conventional cages (CC, 5 hens/cage), small (SF, 5 hens/cage) and medium furnished cages (MFL, 10 hens/cage) with a "localized" dust bath and nest box on one side of the cage, and MFS (10 hens/cage). The total spaces of resources per bird were same for all cage designs. Behaviour, physical condition (body weight, feather condition, and claw length) and production (egg production, egg quality, and mortality) were measured in each cage. Moving was more frequent in MFS and MFC than in CC and SF ($P < 0.01$). The proportion of hens performing aggressive pecking and severe feather pecking was higher in MFC than CC and SF ($P < 0.05$). These aggressive interactions occurred frequently in the dust bath area in MFC ($P < 0.001$); however, these tendencies were not found in MFS. The claw length at the rear was longer in CC than in the 3 furnished cages ($P < 0.05$). Egg production and egg mass were lower in MFC than in SF ($P < 0.05$), while the production in MFS was similar to those in CC and SF. MFS hens laid eggs on the cage floor more often than in MFC ($P < 0.01$). In conclusion, MFS remains advantages of furnished cages. Also, MFS have lower aggressive interactions and higher production compared with MFC. These results might indicate the usefulness of MFS, although some inconsistent results and points for improving MFS design were also found.

Key Words: dust bath, feather pecking, furnished cage

TP413 Environmental enrichment and use of passionflower in diets of quails. J. D. T. Silva*, F. H. Hada, R. H. Marques, R. A. Gravena, V. K. Silva, R. D. Malheiros, and V. M. B. Moraes, *State University of São Paulo*, *Jaboticabal, São Paulo, Brazil*.

This study evaluated the effect of passionflower in diet and environmental enrichment (EE) on quail performance and tonic immobility time (TIT). One hundered and ninty 2 quails were distributed in factorial 2 (with and without EE) × 2 (with and without 500 mg *Passiflora alata*/kg diet), with 6 replicates and 8 quails per cage. For the enrichment are used metal chains hanging in the center of the cages. The trial period was 6 cycles of 14 days each and evaluated the daily feed intake (DFI), production, feed conversion (feed intake/dozen and kg of eggs) and TIT. The quails that received passionflower obtained the best values for production, feed intake, and TIT. The quails reared in EE become calmer (lower TIT); however, the FI/kg of eggs was worse. It was concluded that the passionflower and enrichment cages were able to decrease the stress of quails during the laying period, and the use of passionflower improved the egg production.

Table 1. DFI, feed conversion, production, and TIT of quails reared or not reared in enrichment cages, receiving or not receiving passionflower

Item	DFI (g)	Production (%)	FI/kg eggs	TIT (s)
Passiflora alata (mg)				
0	23.42	80.01b	2.75b	18.98b
500	23.84	83.82a	2.66a	13.34a
P-value	0.1226	0.0177	0.0013	0.0090
Enrichment cage				
Without	23.67	82.60	2.67a	20.53b
With	23.58	81.23	2.74b	11.79a
P-value	0.7331	0.3609	0.0086	<0.0001
P. alata × enrichment				
P-value	0.6097	0.2829	0.6027	0.3281
CV (%)	2.75	4.40	2.24	89.54

[a,b]Averages with the same letter in the same column di not differ (Fisher's test).

Key Words: behavior, *Coturnix coturnix japonica*, *Passiflora alata*

TP414 Effect of the density of conspecifics on runway social reinstatement behavior of male Japanese quail genetically selected for contrasting adrenocortical responsiveness to stress. D. A. Guzman[1], D. G. Satterlee*[2], J. B. Schmidt[2], J. M. Kembro[1], and R. H. Marin[1], [1]*Universidad Nacional Córdoba, ICTA, CONICET*, *Argentina*, [2]*Louisiana State University Agricultural Center*, *Baton Rouge*.

Runway tests are considered indicative of underlying sociality in birds and their ability to make social discriminations and establish interactions

among conspecifics placed in goal boxes at one or both ends of a runway. Herein, male social reinstatement behavior in juvenile Japanese quail selected for a reduced (LS, low stress) or exaggerated (HS, high stress) adrenocortical response to brief mechanical restraint was evaluated. During a 8 min test period, individual males were given the choice to reinstate with either 2 (low density, LD) or 8 (high density, HD) unfamiliar conspecifics placed in goal boxes at opposite ends of a double runway (DRW). Then, the same males were individually retested in a single goal box runway (SRW) wherein they were exposed, in separate tests, to either a goal box containing a LD or HD of unfamiliar males. Each of the SRW tests used a test ceiling of 6 min. In the DRW, a higher ($P < 0.01$) number of HS males started their ambulation toward the goal box containing a HD as opposed to LD of males. DRW tested HS males also spent more ($P < 0.01$) time in close proximity (within a 10 cm close zone; CZ) to the HD (218 s) rather than the LD (57 s) of conspecifics. In contrast, LS males did not differ in their initial direction of travel in the DRW and they spent similar amounts of times in the CZs of their stimulus LD (141 s) and HD (124 s) males. Similar to the DRW results, in the SRW, HS males spent more ($P < 0.01$) time in the CZ of HD rather than LD conspecifics while LS quail spent similar amounts of time in the CZs of LD and HD males. Considering that runways are novel (and therefore frightening) environments, the present findings suggest that HS quail may find better shelter (i.e., more comfort) in close proximity to a larger rather than smaller group of conspecifics while LS birds find groups of varying conspecific density equally attractive. The results suggest that LS quail possess favorable social adaptive qualities since they appear to be better suited to cope with situations were the density of conspecifics is variable.

Key Words: runway, sociality, genetic selection

TP415 Effect of lighting programs during the growing phase on bone mineralization of two strains of egg type chickens at end of lay. D. A. Wilson*[1], P. Settar[2], J. Arango[2], N. P. O'Sullivan[2], Y. Y. Li[1], Z. Lin[1], and P. Y. Hester[1], [1]*Purdue University*, *West Lafayette, IN*, [2]*Hy-Line International*, *Dallas Center, IA*.

Osteoporosis, a progressive decrease in the amount of mineralized structural bone, leads to skeletal fragility and susceptibility to bone fracture in egg laying strains of chickens. Our objective was to determine if lighting programs during the pullet growing phase affects skeletal integrity at end of lay due to light effects on age at onset of lay. Two strains of chickens, W98 and Hy-Line brown, were exposed to 1 of 3 varying step-down lighting programs during growth (2 to 17 wk of age) referred to as slow, moderate, and rapid. Beginning at 18 wk of age, all pullets were photo-stimulated with the same step-up lighting regimen. At end of lay (66 wk of age), the left drum stick and wing were retrieved for determination of bone mineral density (BMD), bone mineral content (BMC), and bone size traits using dual-energy X-ray absorptiometry. Data were analyzed using an ANOVA for BW and bone width. An analysis of covariance with BW as the covariate was used for BMD, BMC, bone length, and bone area. Results indicate that lighting programs during the growing period had no affect on BMD, BMC, bone area, and bone width of 66 wk-old hens. Pullets exposed to the rapid lighting program had shorter bone length at 66 wk of age than those on the moderate or slow lighting programs ($P = 0.001$). Based on age of first egg laid, pullets of the rapid lighting program matured earlier than those on the other lighting programs, which most likely caused earlier growth plate closure leading to shorter bones. Hens exposed to a rapid lighting program as pullets weighed less ($P < 0.0001$) at 66 wk of age than those of the moderate or slow lighting programs. In conclusion, exposure to the slow step-down lighting programs during the growing phase delayed sexual maturity but did not result in subsequent improvements in bone mineralization at 66 wk of age.

Key Words: pullet lighting programs, bone mineral density, osteoporosis

TP416 Use of artificial turf in colony cage nest boxes for Single Comb White Leghorn hens in mid-lay. K. Doncaster*[1], A. Schuurmans[2], and B. Rathgeber[1], [1]*Agriculture & Agri-Food Canada*, *Kentville, NS, Canada*, [2]*Nova Scotia Agricultural College*, *Truro, Canada*.

The nest box has been identified as a key component of furnished housing for commercial laying hens. A bare wire floor in the nest box is easy to maintain; however, it has been shown that providing nesting substrate increases use of the nest box. An experiment was performed with laying hens accustomed to nest boxes without substrate to determine the benefit inclusion of nesting material. A total 320 laying hens were housed in 8 colony cages equipped with perches, claw shorteners and nest boxes at 18 weeks of age with 40 birds per cage. At 36 weeks of age, the location of where eggs were collected was recorded to determine nest box use. At 37 weeks of age artificial turf was introduced in 4 of the 8 cages, 2 on each tier. Artificial turf was added to half of the cages and location of oviposition was monitored for week 37, 41 and 42. The incidence of cracked, toe-picked and soft-shelled eggs was recorded as well. Statistical analysis was performed using proc mixed of SAS. Prior to introduction of the artificial turf the use of the nest box was not different between treatment groups with approximately 40% of the eggs being laid there. The week after the turf was introduced the use of the nest box went up to 83% and ended up at 91% by the end of the study with the use remaining at 40% for the cages with no turf added to the boxes. The number of damaged shells was reduced in cages with turf installed inspite of eggs accumulating on the egg belt near the nest box. The majority of the cracked shells were from eggs laid outside the nest box. This study demonstrated the value of nesting substrate in furnished cages for both a reduction in damaged shells and providing a preferred location for laying eggs.

Key Words: furnished cage, artificial turf, egg quality

TP417 Response surface regression analysis to locate optimal minimum age at sexual maturity based on body weights at weeks 8 and 12 for indigenous chicken in Khorasan province of Iran. H. Farhangfar*, M. E. Navidzadeh, and S. M. Hosseini, *Birjand University*, *Birjand, Iran*.

A statistical analysis using response surface regression was carried out to identify optimal minimum age at sexual maturity (ASM) based on body weight at weeks 8 (W8) and 12 (W12) for indigenous chickens in Khorasan province of Iran. The data used in this study consisted of 1,617 body weight and ASM records collected from 1,617 indigenous chicken belonging to the same generation and sex (female) during the year 2006. The mean of W8, W12, and ASM were 513 g, 865 g, and 162 days, respectively. The ASM ranged from 138 to 209 days. A response surface regression in which ASM was dependent, and W8 and W12 were independent variables was fitted to the data set. In the

model, linear, quadratic terms of the independent variables as well as interaction between W8 and W12 were included. The model was fitted using RSREG procedure of SAS program. The results obtained in the present research indicated that except the intercept term fitted in the model, all the independent variables (linear, quadratic, and interaction terms) had no statistical significant ($P > 0.05$) effects on ASM variation. This suggested that other possible environmental factors could affect age of sexual maturity in the indigenous chickens. However, the predicted value of the optimal minimum ASM was found to be approximately 161 days (close to the simple average of ASM in the data set) as body weight at W8 and W12 were 504 g and 997 g, respectively.

Key Words: age at sexual maturity, weight, indigenous chicken

TP418 Bayesian estimation of posterior means of heritability for weight at week 8 in Iranian indigenous chickens. H. Farhangfar*[1], R. Lotfi[2], M. E. Navidzadeh[1], R. A. Mirzaei[3], and A. Shoorideh[3], [1]*Birjand University*, *Birjand, Iran*, [2]*Tarbiat Modares University*, *Tehran, Iran*, [3]*Centre of indegenous chicken breeding*, *Mashhad, Iran*.

A total of 6,440 body weight records at week 8 in Iranian indigenous chickens were used to obtain Bayesian estimation of posterior means of heritability. All records were collected in the Centre of Indigenous Chicken Breeding in Mashhad, Khorasan. The average body weight at week 8 was 571.46 g. An animal linear model was applied for genetic analysis. In the model, the fixed environmental effects of sex and hatch (4 hatches) were included. Furthermore, the body weight of chicks at day of hatch (average 35.03 g) was fitted in the model as a covariate. Random additive genetic effect of chicks was also included in the model. The number of sires and dams were 81 and 747, respectively. A Bayesian estimation approach was used to obtain posterior means of additive genetic effect as well as environmental variance components for body weight at week 8. The variance components were estimated using MTGSAM software through carrying out 100,000 Gibbs sampling in which the first 5,000 rounds were assumed as burning in period. The convergence criterion was set to be 0.0001. Estimated additive genetic and environmental variance components were 2,330.91 g2 and 3,564.75 g2, respectively. Posterior means of heritability of weight at week 8 was found to be approximately 0.4 which is in the range of heritability obtained by previous studies. Relative high estimate of heritability found in this study indicates that there is a great genetic potential in the Iranian indigenous chickens to be improved for body weight.

Key Words: Iranian indigenous chickens, Bayesian estimation, heritability

TP419 Sequence characterization of K-gene link region of Nagoya breed. N. Kansaku*[1], M. Kobayashi[1], A. Nakamura[2], and K. Noda[2], [1]*Azabu University*, *Sagamihara, Japan*, [2]*Aichi-ken Agricultural Research Center*, *Aichi, Japan*.

The avian endogenous virus gene (ev21) and dominant sex-linked gene (K) are closely associated on the Z chromosome of late-feathering (LF) chickens. The LF phenotype is widely used for sex identification when chicks hatch. To identify the sex of chicks, early-feathering (EF, k+/k+) males are mated with LF females (K/W). To produce the K/W, K/K males are necessary. However, both K/K and K/k show LF. Thus, progeny testing or DNA analysis are required. In White Leghorn, identification of genotype was conducted using PCR-RFLP of the K-gene linked region. However, our preliminary study showed that the PCR-RFLP technique was not applicable to the Nagoya breed. Accordingly, this study was conducted to identify differences between White Leghorn and Nagoya breed in the K-gene linked region. Based on the phenotype of feathering and results of back cross, genotype of the hen and rooster of Nagoya breed was preliminary determined. Genomic DNAs extracted from red blood cells of Nagoya breed were used for amplification of the K-gene linked region. After amplification, PCR products were purified and sequenced on both strands using an Applied Biosystem Model 310 sequencer. A total of 1,456 bp of K-gene linked region was sequenced. Comparison between K and k+ in Nagoya, indicated that differences were detected at 10 positions. Transition was detected at position 307, 474, 738, and 1,072. Transversion was detected at position 514, 557, 694 and 794. Deletion or insertion was detected at positions 754–757 and 1,063–1,070. At position 1,072–1,075, k+ of White Leghorn and K and k+ of Nagoya had "GGCC" whereas K of White Leghorn had "AGCC". This transition at 1,072 clearly explains the reason that the PCR-RFLP technique used for White Leghorn was not applicable to Nagoya breeds. Interestingly, K of both White Leghorn and Nagoya contain a Mbo I site at position 291-295, whereas, k+ of both White Leghorn and Nagoya did not contain this Mbo I site. Thus, these results indicate that the original RFLP method developed in the White Leghorn cannot be used in Nagoyas but the Mbo I RFLP can be used in both White Leghorn and Nagoya breeds to differentiate the K and k+ alleles.

Key Words: sex, RFLP, feathering

TP420 Variability in embryonic and postembryonic growth in Japanese quail: Effect of egg weight. B. K. Biswas* and K. L. Arora, *Fort Valley State University*, *GA*.

Two experiments were conducted: Experiment I: Includes 3 groups of eggs differing in weights: Large (L) eggs weighing 10.28 ± 0.18 g (n = 11), Medium (M) eggs weighing 9.38 ± 0.37 g (n = 11) and Small (S) eggs weighing 7.83 ± 0.37 g (n = 12). The eggs originated from the same breeding colony housed at 75°F with 16L:6D photoperiod. The eggs were collected between 3:00 and 5:00 PM and were held in the cooler at 45°F overnight prior to incubating at 99–100°F and 75–78% relative humidity. After 12 days of incubation, the eggs were opened and the embryos separated, excess moisture removed and weighed to the nearest 0.1 g. The same embryos were then dried to a constant weight at 110°F. Mean wet weight of embryos were 3.30 ± 0.44 g, 3.47 ± 0.11 g, and 2.94 ± 0.40 g and dry weights 0.70 ± 0.20 g, 0.77 ± 0.08 g and 0.55 ± 0.12 g in L, M, and S eggs, respectively. The embryos from the M eggs were comparatively heavier and more uniform than L and S eggs. The S eggs consistently had smaller embryos ($P < 0.05$). Experiment II: Two groups of eggs with widely divergent egg weights were used. Group I: Large eggs ranging 9.5 to 11.6 g (n = 20) and Group II: Smaller eggs ranging 7.6 to 8.0 g (n = 20) were hatched. Chicks were weighed to the nearest 0.1 g, numbered, and transferred to the brooder. The chicks were then weighed at 3-day intervals up to 30 days of age. Mean and SD values were used for comparing growth. Chicks from larger eggs were heavier by 4 to 6 g than the chicks from the smaller eggs throughout the treatment. Both experiments indicated that egg weight definitely affected the embryonic and postembryonic chick weights. Since Japanese quail is routinely being used in a variety of research projects and is also considered to be a pilot bird for poultry, the researchers must not ignore the role of egg weight. For minimizing experimental variability, the eggs of medium weight should be utilized.

Key Words: Japanese quail, egg weight, embryonic weight