

tinated and lysed, but Hu<sup>O</sup> were not agglutinated and lysed only after prolonged incubation. Hu<sup>O</sup> lytic titers were typically lower than those for Rb in the same sera. In 91 commercial drakes complete Hu<sup>O</sup> lysis occurred in 14/91 (15%),  $\geq 50\%$  lysis in 51/91 (56%), but 7 (8%) sera were negative. Heating sera reduced lytic capacity for both Hu<sup>O</sup> and Rb but not to the same degree. Nearly all Hu<sup>O</sup> lytic capacity was removed after 10 min exposure to 57°C while the same treatment reduced Rb lytic capacity by only 50%. Chelation of Ca<sup>++</sup> by EGTA interfered with Rb lysis suggesting inhibition of the classic complement pathway (CP) perhaps by interference at the C1 q-r-s levels. EGTA had little inhibitory effect on Hu<sup>O</sup> lysis, supporting an alternate pathway (AP) mechanism. EGTA did not affect Rb agglutination.

The addition of carbohydrates, especially melibiose and galactose, to diluents reduces both agglutination and lysis of Rb but has little effect on Hu<sup>O</sup> lysis. This supports a role for anti-Gal as the antibody providing the substrate for CP lysis of Rb and tends rule out an antibody requirement for Hu<sup>O</sup> lysis. Collectively these 2 systems seem to provide a convenient means for investigating innate and acquired immunity of ducks. Moreover the heterogeneity in lytic capacity for Hu<sup>O</sup> of market age ducks may offer a screening tool for identifying those with a weak immunity.

**Key Words:** ducks, alternate and classic complement pathways, erythrocyte agglutination, lysis, immunity

**64 Importance of in ovo environment on subsequent immune function and health risks.** R. R. Dietert\*, *Cornell University, Ithaca, NY.*

The embryonic environment supporting immune development plays a crucial role in defining posthatch immune function as well as potential health risks of the chick. Because landmark immune maturational events occur in ovo and set the template for host defenses of the chick, management of immune maturation is a critical first step in overall management of poultry health. Much of our knowledge of both immune development and embryonic immunomodulation has occurred through the use of in ovo environmental manipulation and/or intervention. Through these techniques a wide array of intended and unintended immune modifiers have been identified and studied. These include feed and water contaminants such as mycotoxins and heavy metals as well as dietary factors, cytokines and various adjuvants. This presentation will consider the role that in ovo manipulation and intervention has played toward improv-

ing immune function and reducing health risks of the chick. Research supported in part by USDA Regional Grant 1016.

**Key Words:** embryonic development, immune maturation, health risks

**65 The role of photoperiod and melatonin injection on alleviation of inflammation induced by lipopolysaccharide injection in broiler chickens.** A. O. Abbas\*<sup>1</sup>, G. M. K. Mehaisen<sup>1</sup>, G. L. Hendricks<sup>3</sup>, A. E. Gehad<sup>2</sup>, and M. M. Mashaly<sup>1,4</sup>, <sup>1</sup>*Cairo University, Cairo, Egypt*, <sup>2</sup>*National Research Centre, Cairo, Egypt*, <sup>3</sup>*Pennsylvania State University, State College*, <sup>4</sup>*Kuwait Institute for Scientific Research, Safat, Kuwait.*

Two experiments were conducted with male broilers to study the effect of different light schedules and melatonin (mel) injection in enhancing the immune response and reducing the inflammatory response induced by lipopolysaccharide (LPS) injection. In the first experiment, 160 one-day-old broiler chicks were divided into 2 groups: the first group was exposed to continuous light (CL) [23L:1D], whereas the other group was exposed to intermittent light [1L:3D]. At 6 wk of age, within each light treatment, 15 broiler chicks were injected intravenously (i.v.) 3 mg/kg BW LPS, and another 15 broiler chicks were injected with saline. B-lymphocyte proliferation and antibody production were significantly higher in the IL-LPS group. However, body temperature and plasma corticosterone concentration, at 3 and 12-h postinjection, were significantly lower in the IL-LPS group, compared to the CL-LPS group. Furthermore, plasma IL-1-like activity, plasma IL-6 concentration, and H/L ratio were significantly lower in the IL-LPS group compared to the CL-LPS group, at 3, 12, and 24 h postinjection. In the second experiment, 160 one-day-old broiler chicks were reared under continuous light (23L:1D). At 6 wk of age, 45 broiler chickens were divided into 3 groups. The first group was injected i.v. with 40 mg/Kg BW mel, followed by 3 mg/Kg BW mel 1 h later. The second group was injected with saline followed by 3 mg/kg BW LPS 1 h later. The third group received 2 saline injections 1 h apart. T and B lymphocyte proliferation and antibody production were significantly higher in the mel-LPS group (mel-LPS) compared to the saline-LPS group (s-LPS). Plasma corticosterone concentration and body temperature were significantly lower in the mel-LPS group compared to the s-LPS group at 3 h postinjection. Plasma IL-1-like activity was significantly higher in the s-LPS group compared to the other 2 groups at 0, 3, 12, and 24 h postinjection, while plasma IL-6 concentration was significantly lower in the mel-LPS group compared to the s-LPS group at 3 and 12 h postinjection.

**Key Words:** broilers, LPS, light, melatonin, immunity

## Environment and Management I

**66 Low protein, hydroxy- and keto-amino acid analog supplemented diets for broiler chickens: 1. Performance and carcass weight.** A. Adrizal<sup>1</sup>, P. Patterson\*<sup>1</sup>, C. Angel<sup>2</sup>, and A. Markant<sup>3</sup>, <sup>1</sup>*Department of Poultry Science, Penn State University, University Park*, <sup>2</sup>*Department of Animal & Avian Science, University of Maryland, College Park*, <sup>3</sup>*Fresenius Kabi Deutschland, Germany.*

This study evaluated the potential of reduced dietary CP and amino acid analogs to sustain growth and carcass weight (wt) in broilers (0 to 21

d). Six dietary treatments with 3 levels of CP (22.5, 19.5, and 16.5%) and 2 sources of amino acids (AA): synthetic AA (SA) vs. OH- or keto-AA analogs (KA) were assigned to 36 pens (8 chicks/pen) in a 3 × 2 design. DL-Met in all SA diets was replaced by MHA in all KA diets. L-Ile and L-Val in the 16.5 and 19.5% SA diets were replaced by keto-Ile and keto-Val in the 16.5 and 19.5% KA diets. The 16.5% KA diet was made by replacing L-Leu and L-Phe in the 16.5% SA diet with keto-Leu and keto-Phe. All isocaloric diets (3,050 kcal) were given ad libitum. Lowering CP to 16.5% reduced BW at 7, 14, and 21 d (P

$\leq 0.0001$ ) and feed intake (FI) at 8 to 14, 15 to 21, and 0 to 21 d ( $P \leq 0.001$ ). BW gain (BWG) was reduced, and feed-to-gain ratio (FGR) was increased ( $P \leq 0.003$ – $0.0001$ ) at all times. Birds fed 22.5 and 19.5% CP had comparable performance with few differences. No effect of AA or the CP $\times$ AA interaction was observed on FI or BW. Differences in BWG (SA, 122.9 vs. KA, 113.9 g/bird) and FGR (SA, 1.26 vs. KA, 1.32) due to AA were observed at 0 to 7 d. This effect on FGR disappeared thereafter, but presented as a 0- to 21-d cumulative effect (1.45 vs. 1.51;  $P \leq 0.02$ ) and by the CP $\times$ AA interaction ( $P \leq 0.05$ ). There were no differences in carcass wt due to CP, AA, or the CP $\times$ AA interaction at 14 or 21 d. Greater liver wt among the 16.5% CP chicks vs. the 19.5 or 22.5% CP chicks was observed at d 14 and 21 ( $P \leq 0.0001$  and  $P = 0.06$ ), but no effect of AA or CP $\times$ AA was noted. Dietary CP reduced spleen wt on d 21 ( $P \leq 0.0005$ ) with lower wt in the 16.5 and 19.5% groups vs. 22.5% CP (0.090, 0.095, 0.119 g/100 g BW). Breast and legs were not affected by treatments at d 14, except on d 21 by dietary CP ( $P \leq 0.003$  and  $P \leq 0.04$ ). Although breast wt of the 16.5% CP group was less than the 22.5%, the 19.5% CP was similar to the others. At 21 d leg wt of the 16.5% CP birds was equal to 22.5% CP. Only dietary CP affected fat pad wt on d 21 resulting in the heaviest in the 16.5% birds ( $P \leq 0.0004$ ).

**Key Words:** keto acid, chick performance, carcass wt

**67 Low protein, hydroxy- and keto-amino acid analog supplemented diets for broiler chickens: 2. Manure nitrogen.** P. Patterson<sup>\*1</sup>, A. Adrizal<sup>1</sup>, C. Angel<sup>2</sup>, and A. Markant<sup>3</sup>, <sup>1</sup>Department of Poultry Science, Penn State Univ, University Park, <sup>2</sup>Department of Animal & Avian Science, University of Maryland, College Park, <sup>3</sup>Fresenius Kabi Deutschland, Germany.

This study evaluated the potential of reduced dietary CP and amino acid analogs to reduce manure N in broilers (0 to 21 d). Six dietary treatments with 3 levels of CP (22.5, 19.5, and 16.5%) and 2 sources of amino acids (AA): synthetic AA (SA) vs. OH- or keto-AA analogs (KA) were assigned to 36 pens (8 chicks/pen) in a 3  $\times$  2 design. DL-Met in all SA diets was replaced by MHA in all KA diets. L-Ile and L-Val in the 16.5 and 19.5% SA diets were replaced by keto-Ile and keto-Val in the 16.5 and 19.5% KA diets. The 16.5% KA diet was made by replacing L-Leu and L-Phe in the 16.5% SA diet with keto-Leu and keto-Phe. All isocaloric diets (3,050 kcal) were given ad libitum. Dietary CP significantly impacted manure DM and nutrients in a repeatable fashion at 14 and 21 d. Manure DM was increased in a linear fashion (52.9 to 61.8%, d 14; 54.3 to 63.5% d 21) as CP was reduced to 16.5% ( $P \leq 0.05$ ). Manure total-N and organic-N were reduced in a linear fashion (total-N 47.0 to 32.8 g/kg, d 14; 47.6 to 31.9 g/kg, d 21) (organic-N 44.7 to 30.9 g/kg, d 14; 45.5 to 29.9 g/kg, d 21) as CP was reduced to 16.5% ( $P \leq 0.0001$ ). Manure NH<sub>4</sub>-N at 14 d was also reduced ( $P \leq 0.05$ ) by lower diet CP. Dietary AA also significantly impacted manure nutrients with KA repeatedly reducing total-N and NH<sub>4</sub>-N compared to birds fed the SA diets, e.g., total-N was 40.9 vs. 38.3 g/kg for SA vs. KA on d 14 and 41.1 vs. 38.0 g/kg, on d 21 ( $P \leq 0.10$ ). Manure NH<sub>4</sub>-N was reduced from 2.4 to 1.9 g/kg when birds were fed SA vs. KA on d 14 and 21 ( $P \leq 0.01$ ). There were also interactions of CP $\times$ AA observed on d 14 ( $P \leq 0.05$ ) and 21 ( $P = 0.11$ ) for total-N. The trend was for higher dietary CP to elevate manure N, and KA supplemented diets to reduce N levels beyond that of SA diets. Manure NH<sub>4</sub>-N was also impacted by the CP $\times$ AA interaction on d 21 ( $P = 0.06$ ) with the same trend for higher CP to elevate NH<sub>4</sub>-N, and KA diets to reduce NH<sub>4</sub>-N levels beyond the SA diets. Implications are chick liver L-AA oxidase and plasma aminotransferase were impacted

by the CP and AA treatment diets. The application of dietary KA for environmental management of N wastes on poultry feeding operations appears to have technical merit.

**Key Words:** keto acid, manure nitrogen

**68 Impact of new or recycled litter on broiler performance, litter characteristics and nitrogen mass balance.** C. S. Taylor<sup>\*1,2</sup>, J. L. Bray<sup>2,1</sup>, J. B. Carey<sup>1</sup>, T. E. Cherry<sup>2</sup>, and C. D. Coufal<sup>3</sup>, <sup>1</sup>Texas A&M University, College Station, <sup>2</sup>Stephen F. Austin State University, Nacogdoches, TX, <sup>3</sup>Mississippi State University, Mississippi State.

The broiler industry utilizes recycled litter to rear broilers under commercial settings. It is also typical practice to clean-out commercial broiler houses after several flocks. Litter age and broiler age effect litter characteristics, nitrogen emissions, and production. Two flocks were raised on new and recycled rice hulls and one flock was raised on new and recycled pine shavings. The first 2 flocks (1 and 2) were raised to 42 days of age and the last flock (3) was raised to 49 days of age. Body mass, feed consumption and feed conversion was calculated for all flocks. Nitrogen loss was calculated using the mass balance method. Broiler performance was not significantly different in any of the flocks with the exception of feed consumption ( $P = 0.036$ ) for flock 2. Starting litter percent moisture was significantly lower ( $P < 0.0001$ ) for new litter across all flocks. For flock 1 and 2, ending litter percent moisture was not significantly different between treatments. For flock 3 ending litter percent moisture of new litter was significantly higher than that of recycled litter. Caked litter percent moisture for flock 1 was 53.7 and 42.5% ( $P = 0.012$ ) for new and recycled litter, respectively. There was no significant difference in caked litter moisture for flocks 2 and 3. Litter dry matter gain (kg/bird) for new litter was significantly higher than recycled litter for flock 1, but did not differ in flocks 2 and 3. Caked litter production (kg/bird) was significantly higher for recycled litter in flock 1, but did not differ in flocks 2 and 3. Average N loss for flock 1 and 2 was not significantly affected by treatment. Nitrogen loss for flock 3 was significantly higher for recycled litter. Flock 1 N partitioned to caked litter was significantly higher for recycled litter; flocks 2 and 3 did not differ. N partitioned to litter was significantly higher in new litter for flock 3; flocks 1 and 2 did not differ. Based on this experiment, litter characteristics and nitrogen partitioning of new and recycled litter may differ for rice hulls and pine shavings. Broiler performance was not affected by these treatments.

**Key Words:** broiler, litter, nitrogen mass balance

**69 Efficacy of acidic calcium sulfate + (clay or diatomaceous earth) litter formulations against *Salmonella* in broilers.** E. L. Larison<sup>\*1</sup>, M. A. Davis<sup>1</sup>, J. A. Byrd<sup>2</sup>, J. B. Carey<sup>1</sup>, and D. J. Caldwell<sup>1</sup>, <sup>1</sup>Texas A&M University, College Station, <sup>2</sup>USDA/SPARC, College Station, TX.

Research has shown that *Salmonella* can be prevalent in poultry litter, which can be a source of contamination for newly arrived chicks at the poultry house. Since this organism is a pathogen of concern to the poultry industry, 2 types of litter amendments were created and tested to determine effects on broiler growth, litter moisture and efficacy against *Salmonella* colonization. Litter amendments consisted of the combina-

tion of Acidic Calcium Sulfate (ACS) with either diatomaceous earth (DE) or hydrated sodium calcium aluminosilicate (HSCAS). Experimental conditions consisted of 12 pens in 4 isolation rooms with 15 broiler chicks in each pen. Each litter amendment was applied to 3 pens for replicates of experimental groups. After litter amendment application, 150 mL of *Salmonella* solution at concentration  $3.8 \times 10^8$  cfu/mL was applied to the litter. Chicks were placed and growout time was 5.5 weeks. There were 2 control groups of 3 pens each consisting of absolute control (no *Salmonella* or litter amendment) and control (*Salmonella*, no litter amendment). Litter samples were taken weekly from 5 areas in each pen and combined for determination of *Salmonella* counts. At 3 and 6 weeks postplacement, 6 birds from each pen were euthanized by CO<sub>2</sub> asphyxiation. The crop and ceca from these birds were tested for counts and/or presence/absence of *Salmonella*. Application of both litter amendments positively affected feed conversion and at 3 weeks postplacement the DE+ACS treatment did not have any birds positive for *Salmonella*. Efficacy of the litter amendments were varied in other treatments and further research is planned to fully determine efficacy on *Salmonella* and *Campylobacter jejuni* colonization.

**Key Words:** *Salmonella*, litter, broiler

**70 Efficacy study of supplementing Bio-Mos<sup>®</sup> and NatuStat<sup>®</sup> for growth-promoting antibiotics on broiler performance and yield.** J. Bray\*<sup>1,2</sup>, C. Taylor<sup>1,2</sup>, T. Cherry<sup>1</sup>, J. Carey<sup>2</sup>, T. Sefton<sup>3</sup>, and J. Pierce<sup>3</sup>, <sup>1</sup>Stephen F. Austin State University, Nacogdoches, TX, <sup>2</sup>Texas A&M University, College Station, <sup>3</sup>Alltech, Inc, Nicholasville, KY.

Alternatives to antibiotics have come to the forefront of research with the mandatory and voluntary decreased use of growth-promoting antibiotics (GPA) in the poultry industry. The objective of this study was to evaluate the feeding of Bio-Mos<sup>®</sup> and NatuStat<sup>®</sup> in the absence of GPA and to examine their efficiency on broiler performance and carcass yield. A total of 6,000 broiler chickens were randomly placed in 48 floor-pens (10 ft × 10 ft) at a stocking density of 125 birds/pen and raised to 49 d of age. One of 4 dietary treatments was randomly assigned to each pen. The 4 dietary treatments consist of: TX 1 negative control (basal diet + coccidiostat), TX 2 positive control (basal diet + coccidiostat + GPA + Roxarsone), TX 3 (basal diet + coccidiostat + Bio-Mos<sup>®</sup>), and TX 4 (basal diet + coccidiosis vaccine + NatuStat<sup>®</sup>). At 49 d of age, birds were weighed and average body weight and feed conversion was calculated. At study end, a total of 384 birds (4 males and 4 females/pen) were randomly selected and processed to evaluate carcass yield. Data was analyzed using the GLM procedure in the SAS software and significant differences were detected using the Duncan's Multiple Range Test. At the completion of the trial, TX 1 and 2 had a significantly higher average body weight from TX 4 but not TX 3. All treatments had a similar feed conversion at 49 d of age with a maximum differential of 0.03 points and were not statistically different. No significant differences were detected between the treatments for carcass WOG, breast, tenderloin, wing and total white meat yield. However, TX 3 was found to have a significantly higher percentage white breast meat relative to live body weight as compared to TX 2 but not from TX 1 and 4. The results of this study suggest that Bio-Mos<sup>®</sup> and NatuStat<sup>®</sup> can be substituted for a GPA program with out negatively impacting performance and yield.

**Key Words:** mannanoligosaccharides, growth-promoting antibiotics, performance

**71 Comparative commercial study on broiler performance between live oocysts Coccidiosis Vaccine-A and live oocysts Coccidiosis Vaccine-B containing the low penetrating Eimeria tenella.** N. L. Gaikwad\*<sup>1</sup>, J. L. Bray<sup>1</sup>, and T. E. Cherry<sup>1</sup>, <sup>1</sup>Stephen F. Austin State University, Nacogdoches, TX, <sup>2</sup>Texas A&M University, College Station.

The purpose of the study was to compare commercial broiler performance parameters and coccidiosis lesion scores between birds receiving 2 different commercial coccidiosis vaccines. Placement of birds was in pens within 2 solid-wall, tunnel ventilated commercial broiler houses for 48 days. The study was conducted with 400 total birds that were vaccinated with Commercial Vaccine-A (TX A) and Commercial Vaccine-B (TX B) consisting of 200 birds per treatment. In the study, 8 pens (6 ft × 6 ft) were evenly divided between the 2 broiler houses with a stocking density of 50 birds/pen. Birds were lesion scored for coccidiosis using 4 birds per treatment at days 14, 21, 28, 35, and 42. Data was collected at 14, 28, and 48 days of age for analysis of average body weight, feed conversion, adjusted feed conversion and mortality. Data analysis revealed that TX A had a numerically lower feed conversion and adjusted feed conversion, while TX B had a numerically higher average body weight. However, there was no statistical difference with respect to average body weight, feed conversion, and adjusted feed conversion between the treatment groups.

**Key Words:** coccidiosis, lesion scoring, *Eimeria tenella*

**72 Using body temperatures to manage broiler house temperature.** E. O. Oviedo-Rondón, M. J. Wineland\*, J. H. Small, and H. R. Cutchin, North Carolina State University, Raleigh.

Ambient temperature affects broiler performance and gas usage. Propane gas cost has recently increased significantly and adequate management of house temperatures and ventilation are more critical now. Two experiments (exp.) were conducted in commercial farms to estimate the best house temperature profile for broilers of 2 different strains raised to 9 weeks. The standard house target temperature recommendations of the integrator companies (CON) were compared with house temperatures managed according to daily chicken body temperatures (CBT). Two paired houses with a comparable composition of day-old broilers were used. In both experiments, 21,000 chickens were placed in each house with old litter and processed at 68 and 61 days of age, in experiment 1 and 2 during fall and winter conditions, respectively. In exp. 1, radiant pancake brooders were used and in exp. 2 side wall heaters were used. Straight run broilers were used in exp. 1 and only males in exp. 2. Body temperatures of at least 25 chickens per house were taken daily for the first 2 weeks and once a week until 35 days of age. House target temperatures were slowly reduced to avoid flock average body temperatures increasing above 105°F during the first 5 days. After the first week, house target temperatures were adjusted to avoid average body temperatures rising above 107.5°F. Total BW, feed conversion (FC), mortality, propane gas consumption, and flock uniformity were evaluated. Final average flock BWs were 109 and 57 grams better in the CBT compared to CON in the first and second experiment, respectively. The CBT group had a better adjusted FC in the first trial (2.10 CON vs. 2.03 CBT) and an unadjusted FC in the second trial of 2.014 CON vs. 2.019 CBT. Flock uniformities improved for males, but not for females in exp. 1 with CBT, and no improvement in exp. 2. Gas consumption was reduced in 20% in exp. 1 and 10% in exp. 2. The improvements in live performance and propane gas usage obtained with the CBT treatment

indicated that monitoring body temperatures could be used to optimize broiler performance and profitability.

**Key Words:** broiler, brooding temperatures, thermoregulation

**73 Ferric sulfate as a litter amendment for ammonia reduction in broiler houses.** C. W. Ritz\*<sup>1</sup>, L. A. Harper<sup>1</sup>, B. D. Fairchild<sup>1</sup>, and V. Johnson<sup>2</sup>, <sup>1</sup>University of Georgia, Athens, <sup>2</sup>Kemira Water Solutions, Inc., Lakeland, FL.

Litter treatment products are commonly applied within broiler houses to aid in the reduction of ammonia generation during the critical brooding phase. Though effective for short-term ammonia reduction, most products have not proven to be a long-term solution for effective ammonia reduction. The purpose of this study was to evaluate the effectiveness of a new litter amendment containing ferric sulfate. Four commercial 25,000-bird broiler houses were used for the study. Through a series of 5 consecutive flocks, the ferric sulfate product was evaluated for effective application rate, ammonia suppression period, and retention of litter nitrogen. The product was evaluated at varying rates (50, 75, and 100 lbs per 1,000 square feet), different within-house locations, and in comparison with aluminum sulfate. Litter samples for nitrogen species analysis were taken throughout the study. Aerial ammonia concentrations were measured using open-path laser spectrometers and electrochemical sensors. The ferric sulfate amendment was consistently effective in reducing ammonia concentrations in the houses during the first 10 to 15 days after bird placement. The effective rate for optimum ammonia suppression ranged from 75 to 100 lbs per 1,000 square feet. Ammonia concentrations between aluminum sulfate- and ferric sulfate-treated houses were similar during the treatment period. There was no difference in litter nitrogen retention between any treatments. No differences were noted in body weight, mortality, and feed efficiency between the treatments. These results suggest that ferric sulfate is an effective product for broiler litter management.

**Key Words:** suppression, nitrogen, aluminum sulfate

**74 Evaluation of sulfuric acid application at three levels as a litter treatment for broiler chickens.** J. P. Blake\*, J. B. Hess, K. S. Macklin, and C. A. Wilson, Department of Poultry Science, Auburn University, Auburn, AL.

A total of 1,120 commercial broiler chicks (Cobb × Ross) were randomized with 70 birds in each of 16 enclosed chambers (2.44 × 2.44 × 2.44 m). Birds were fed a corn-soybean meal starter (1.5 lb/bird; 22% CP, 3,087 kcal/kg ME), grower (3.0 lb/bird; 20% CP, 3,131 kcal/kg ME), finisher (4.0 lb/bird; 17.5% CP, 3,197 kcal/kg ME) and withdrawal (ca. 3.0 lb/bird; 16.5% CP, 3,219 kcal/kg ME). Treatments comprised an untreated control (CON) and concentrated sulfuric acid (SA) (98% H<sub>2</sub>SO<sub>4</sub>) applied at 20, 40, or 60-lbs/1,000 ft<sup>2</sup> (9.76, 19.52, or 29.28 kg/100 m<sup>2</sup>) of floor space with each treatment assigned to 4 pens. New pine shavings (54.42 kg) were placed in each pen. Feed and water were provided ad libitum with 24 h lights. Birds and feed were weighed on day 21, 42, and 49 and litter and air quality samples were obtained weekly through day 49. Ammonia measurements were conducted using a closed container of specified dimension inverted over the litter bed

and determined using a Drager CMS Analyzer equipped with a remote air sampling pump.

No differences ( $P > 0.05$ ) in growth performance occurred during the 49-d experimental period due to treatment. Initial litter pH for CON and SA at 20, 40, or 60 lb rates was 6.73, 2.35, 2.40, and 2.18, respectively. Litter pH remained significantly ( $P < 0.05$ ) lower for all SA-treated pens through day 28 (5.30 vs. 7.67 for CON), while the highest level of SA maintained a significantly ( $P < 0.05$ ) lower pH compared to CON through day 49 (8.85 vs. 8.08). Changes in pH among all treatments tended to increase over time due to increased excretory contribution. Results indicated that by day 14 detectable ammonia levels appeared and by day 28 significantly ( $P < 0.05$ ) lower ammonia levels (ca. 50% lower) were incurred for all SA treatments. By day 35 only the highest SA treatment level exhibited significantly ( $P < 0.05$ ) lower (ca. 60%) ammonia levels as compared to CON. No reductions in ammonia were attributed to SA treatment after 35 days. Litter moisture increased from a low of 10.63 to 24.9% by day 49 with differences between treatments attributed to the volume of acid applied.

**Key Words:** sulfuric acid, litter treatment, ammonia

**75 Evaluation of a liquid aluminum sulfate litter treatment (A-7<sup>®</sup>) at three application rates for broiler chickens.** J. P. Blake\*, J. B. Hess, K. S. Macklin, C. A. Wilson, R. N. Lehman, and F. Kocakaya, Department of Poultry Science, Auburn University, Auburn, AL.

A total of 1,120 commercial broiler chicks (Cobb × Ross) were randomized with 70 birds in each of 16 environmental chambers (2.44 × 2.44 × 2.44 m). Birds were fed a corn-soybean meal starter (1.5 lb/bird; 22% CP, 3,087 kcal/kg ME), grower (3.0 lb/bird; 20% CP, 3,131 kcal/kg ME), finisher (4.0 lb/bird; 17.5% CP, 3,197 kcal/kg ME) and withdrawal (ca. 3.0 lb/bird; 16.5% CP, 3,219 kcal/kg ME). Treatments comprised an untreated control (CON) and liquid aluminum sulfate (A-7) applied at 20, 40, or 60-gals/1,000 ft<sup>2</sup> (81.4, 162.8, or 244.2 lt/100m<sup>2</sup>) of floor space with each treatment assigned to 4 pens. New pine shavings (54.42 kg) were placed in each pen. Feed and water were provided ad libitum with 24-h lights. Birds and feed were weighed on day 21, 42, and 49 and litter and air quality samples were obtained weekly through day 49. Ammonia measurements were conducted using a closed container of specified dimension inverted over the litter bed and determined using a Drager CMS Analyzer equipped with a remote air sampling pump. No differences ( $P > 0.05$ ) in growth performance occurred by the end of the 49-d experimental period due to treatment. Initial litter pH for CON and A-7 at 20, 40, or 60 gal rates was 4.35, 2.09, 1.97, and 1.90, respectively. Litter pH for all A-7-treated pens was lower ( $P < 0.05$ ) through day 28 as compared to CON (5.83 vs. 7.09). Beyond 28 days, the most pronounced differences occurred for the 60 gal rate on day 35 (5.94 vs. 7.35 for CON), 42 (7.20 vs. 8.40 for CON), and 49 (7.50 vs. 8.40 for CON). Lower ( $P < 0.05$ ) ammonia levels were encountered on day 21 and 28 for all levels of A-7 application, after which the 60 lb level proved most successful in maintaining a lower ( $P < 0.05$ ) ammonia level (ranging from ca. 30–60%) as compared to CON through day 49. Results indicate that reductions in pH led to an associated reduction in detectable ammonia and that A-7 remained very effective on clean shavings through day 49.

**Key Words:** liquid aluminum sulfate, litter treatment, ammonia

**76 Evaluation of acidifying litter treatments for broiler chickens.** J. P. Blake\*, J. B. Hess, K. S. Macklin, and C. A. Wilson, *Department of Poultry Science, Auburn University, Auburn, AL.*

For 2 consecutive experiments, 1,500 mixed-sex broiler chicks (Cobb × Ross) were randomized among 30 floor pens (42 ft<sup>2</sup>/pen) with 50 birds each. Experiment 1 was conducted February–March and Experiment 2 April–May. Birds received a corn-soybean meal starter (1.5 lb/bird; 22% CP, 3,087 kcal/kg ME), grower (3.0 lb/bird; 20% CP, 3,131 kcal/kg ME), and finisher (ca. 5.0 lb/bird; 17.5% CP, 3,197 kcal/kg ME). Treatments were a control (CON); Poultry Litter Treatment (PLT), Poultry Guard (PG) or 50:50 All-Clear:PLT (ACPLT) at 100-lbs/1,000 ft<sup>2</sup> and liquid alum (A-7) at 30 gals/1,000 ft<sup>2</sup> with 6 pens containing used litter per treatment. Feed and water were provided ad libitum with 23 h lights. Birds and feed were weighed on day 21 and 42 with air quality and litter samples obtained weekly for ammonia and pH analysis, respectively. Ammonia measurements involved a closed container of specified dimension (21 × 15.5 × 5 in) inverted over the litter bed and determined using a Dräger CMS Analyzer equipped with a remote sampling pump. No differences ( $P > 0.05$ ) in body weight, feed consumption or feed efficiency occurred in either experiment due to treatment. In Experiment 1, all treatments exhibited a reduced ( $P < 0.05$ ) pH as compared to CON through day 21 with A-7 maintaining the greatest reduction. A similar decrease ( $P < 0.05$ ) in ammonia levels was observed in all treatments compared to CON through day 28. In Experiment 2, all treatments maintained a reduced ( $P < 0.05$ ) pH as compared to CON through day 28 with PLT and A-7 exhibiting the greatest reduction. Any effect of litter treatments in reducing ammonia levels was limited to the first 14 days of brooding where A-7 appeared most effective. All treatments failed to reduce ammonia levels after day 14 when compared to CON. Mean litter moisture on day 42 for Experiment 1 and 2 were 18.50 and 22.63%, respectively, with no difference ( $P > 0.05$ ) due to treatment.

**Key Words:** litter treatment, ammonia, broiler

**77 Litter bacterial levels associated with liquid aluminum sulfate (A7) litter treatment.** K. S. Macklin\*, J. P. Blake, and J. B. Hess, *Auburn University, Auburn, AL.*

Litter treatments are commonly applied to litter to reduce ammonia and bacterial levels. In this experiment the effect of liquid aluminum sulfate litter treatment (A7) on litter bacterial counts, percent moisture and pH were measured. The trial was performed using clean pine shaving litter that was placed into 16 environmental chambers (2.44 × 2.44 × 2.44 m). Chicks were placed at a density of 70 chicks/pen. There were 4 treatments, with each treatment getting 4 pens. The treatments comprised of a control (CON) and A7 being applied at 20, 40 and 60 gals/1,000 ft<sup>2</sup>. Litter was collected weekly from 3 areas within each pen for 7 weeks. Bacteriologically total aerobic, anaerobic, and *C. perfringens* levels (CFU/g) were determined. Additionally, the presence or absence of *Salmonella* was determined. Bacterial counts (CFU/g) and percent moisture data were transformed using log<sub>10</sub> and arcsine transformations, respectively. The data was analyzed using GLM with  $P < 0.05$  and significant means were separated using Tukey's honestly significant difference test.

The results for the experiment showed that all A7-treated pens kept the pH lower than in the CON group for 3 weeks ( $P < 0.05$ ). Overall aerobic and anaerobic numbers were lower in the treated pens ( $P < 0.05$ ). However, there was no significant ( $P > 0.05$ ) reduction in enteric bacteria, *C.*

*perfringens* and the incidence of *Salmonella* at any sampling period. A7 plays a role in reducing overall bacterial numbers by lowering the litter pH, but enteric bacteria and *C. perfringens* were not affected.

**Key Words:** liquid aluminum sulfate, litter, bacteria

**78 The fate of avian influenza and Newcastle disease viruses during composting.** J. Guan\*, M. Chan, C. Grenier, D. C. Wilkie, B. W. Brooks, and J. L. Spencer, *Canadian Food Inspection Agency, Nepean, ON, Canada.*

Composting was used on a large scale for disposal of poultry carcasses and manure during an outbreak of avian influenza (AI) in Canada in 2004 and this study was to investigate the survival of both AI virus (AIV) and Newcastle disease virus (NDV) during the composting process. Viruses were detected by assays in embryonated chicken eggs (ECEs) and their RNA was quantified by real time reverse transcriptase (RRT)-PCR. For the first 2 experiments, specimens were 20 g samples of AIV or NDV-contaminated materials that were contained within nylon mesh bags. These materials were: chicken manure; used chicken litter; ECEs that had been homogenized and mixed into corn silage. For comparative purposes, allantoin fluid from infected ECEs was diluted in phosphate buffered saline and this was contained in sealed vials. The bags and sealed vials were buried in the upper, middle and lower regions of the compost on day 0 and from days 3 to 21 the temperatures ranged from 40 and 60°C. Viruses in bags were killed soon after temperatures reached 40 °C and within an additional 7 days the RNA of the viruses was fully degraded. Viruses survived for about 1 week longer in sealed vials than in bags and the viral RNA persisted to day 21. Outside of the compost at ambient temperatures from 13 to 28°C, viruses in bags were inactivated by day 21 but survived in sealed vials. In all specimens held at ambient temperatures the RNA of viruses persisted to day 21. Supporting results were obtained from 2 other experiments in which virus-contaminated specimens were muscle, liver and whole ECEs. The results give evidence that composting could be an effective means for eliminating AIV or NDV from poultry carcasses and manure. Given the stability of viral RNA at ambient temperatures, the RRT-PCR could be used for studying the spread of AIV and NDV in the environment.

**Key Words:** survival, virus, compost

**79 Growth performance, carcass characteristics and antibody titer responses to Newcastle and Avian Influenza vaccine in broilers reared on different litter materials.** M. Toghyani<sup>1</sup>\*, A. Gheisari<sup>2</sup>, and M. Toghyani<sup>3</sup>, <sup>1</sup>*Department of Animal Science, Islamic Azad University, Isfahan, Iran,* <sup>2</sup>*Department of Animal Science, Isfahan Agricultural Research Center, Isfahan, Iran,* <sup>3</sup>*Young Researcher Club of Islamic Azad University, Isfahan, Iran.*

The objectives of this study were to investigate the effects of wood shaving, rice hulls, recycled paper roll and sand as litter sources on performance, carcass characteristics and antibody titer responses to Newcastle and Avian Influenza vaccine in broiler chicks. One hundred and sixty commercial broilers (Ross 308) were weighed and randomly assigned to 1 of 16 pens. There were 4 replicates for each of the following 4 treatments: 1) wood shaving (control), 2) rice hulls, 3) recycled paper roll and 4) sand. All birds were fed the same feeding program:

starter from 0 to 2 wk, grower from 2 to 4 wk, and finisher from 4 to 6 wk. Feed consumption, body weight and feed conversion were measured at 2, 4 and 6 wk. Carcass yield and weights of abdominal fat, gizzard and ceca were also determined at 6 wk. All birds were intramuscularly immunized with killed vaccine of Newcastle and Avian Influenza (H9 N2) at 8 d and antibody titer responses to Newcastle and Influenza were determined by hemagglutination inhibition (HI) test at 18 and 28 d. Body weight and feed intake of broilers reared on rice hulls decreased compared to other litters ( $P < 0.05$ ). Litter materials had no significant influence on feed conversion, carcass yield, gizzard and ceca weights. Percentage of abdominal fat were significantly lower for birds reared on paper roll than birds reared on rice hulls. Antibody titer against Newcastle and Influenza vaccine at 18 d elevated in broilers reared on sand. In conclusion, broilers reared on sand and paper roll perform as well as those reared on wood shavings.

**Key Words:** litter material, performance, antibody titer

**80 Ultrastructural diversity of eggshell quality in some Egyptian local breeds of chicken.** M. M. Fathi\*<sup>1</sup> and Y. K. Afifi<sup>2</sup>, <sup>1</sup>*Ain Shams University, Cairo, Egypt*, <sup>2</sup>*Animal Production Research Institute, Alexandria, Egypt*.

Ultrastructural variations of eggshell in some Egyptian local breeds (Bandara, Mandara, and Norfa) were evaluated using scanning electron

microscopy (SEM). A total of 120 laying hens representing the different breeds were used in this experiment (40 each). Hens were housed in individual wire cages in an open sided house. At 48 weeks of age, 240 eggs were collected from all breeds (80 each) to measure internal and external egg quality traits. In addition, ultrastructural variations in eggshells were assessed. The current results revealed that eggshell of Norfa breed recorded the highest shell thickness compared to the other breeds. With respect to eggshell strength, it is of interest to note that the eggshells of Mandara and Norfa chickens had a highly significant strength compared to that of Bandara siblings. According to scanning electron microscopy data, the incidence of certain structural variants is more common in eggshells of Bandara breed suggesting poor shell strength. In general, the eggshells of Mandara and Norfa chickens had highly significant better total score for overall ultrastructural traits compared with those of Bandara breed. Alignment appearance was more prevalent in Bandara eggshells compared to the other breeds suggesting lower resistance to breakage. Also, type B abnormalities were obviously prevailing in Bandara breed. On the other hand, early fusion and narrow interstitial spaces of palisade layer indicating increase resistance to fracture were observed in eggshells of Mandara and Norfa chickens. In conclusion, although the shell thickness of Bandara and Mandara breeds was equal, the last one recorded higher shell strength and better ultrastructural measurements of the mammillary layer. Thus, the ultrastructural measurements of the eggshell must be taken into consideration through poultry breeding programs and crossbreeding systems.

**Key Words:** scanning electron microscopy, ultrastructure, eggshell

## Metabolism and Nutrition II: Feed Ingredients

**81 Quality characteristics of distillers dried grains with solubles: Wheat and corn DDGS comparison.** B. A. Slominski\*, A. Rogiewicz, C. M. Nyachoti, and K. M. Wittenberg, *Department of Animal Science, University of Manitoba, Winnipeg, Canada*.

A comprehensive evaluation of the nutritive profiles of wheat-based DDGS in comparison to corn DDGS was undertaken. Two samples of wheat DDGS from the Husky Energy Lloydminster Ethanol Plant in Canada and 4 samples of corn-based DDGS from VeraSun, Aurora, ND, Glacial Lakes Energy, Watertown, SD, Minnesota Energy, Buffalo Lake, MN, and Archer Daniels Midland, Walhalla, ND, USA, were used in the study. On dry matter basis, a high level of protein (40.7%), and minimal levels of simple sugars (0.9%) and starch (1.8%) were found in wheat DDGS. This was not the case for the corn DDGS samples showing, on average, a much higher starch (7.1%) and simple sugar (2.1%) contents, and lower protein (30.5%) content. The total fiber content averaged 33.2% for the 2 wheat DDGS samples and was lower than that of corn DDGS (35.5%). This was followed by even a higher magnitude of difference in the NDF content, which averaged 27.3% for wheat and 32.6% for the corn DDGS samples. Compared to wheat, the corn DDGS samples were found to be much higher in fat (4.5 vs. 10.7%), which along with the high starch content would contribute to the high energy content of this products. The nonphytate P content was found to be much higher in wheat DDGS (0.85 vs. 0.62%) which could be of importance and benefit in monogastric nutrition. A carbohydrate fraction deriving from nonstarch polysaccharides hydrolysis by viscosity-reducing enzymes used in the fermentation process accounted for 4.3% in wheat DDGS and was much higher than that of corn DDGS (1.2%), and distinct in

component sugar profile. The total amino acid content averaged 37.0% in wheat and was much higher than that of corn DDGS (30.4%). This was not necessarily followed by the lysine content which averaged 1.0% and was identical, on average, to that of corn DDGS. Although consistent for wheat DDGS, the lysine content among the corn DDGS samples differed significantly (from 0.79 to 1.12%). Similar levels of methionine were found in wheat (0.80%) and corn (0.77%) DDGS.

**Key Words:** wheat DDGS, corn DDGS, chemical composition

**82 Quality characteristics of wheat distillers dried grains with solubles (DDGS).** A. Rogiewicz\*<sup>1</sup>, B. A. Slominski<sup>1</sup>, C. M. Nyachoti<sup>1</sup>, A. L. Brule-Babel<sup>2</sup>, and K. M. Wittenberg<sup>1</sup>, <sup>1</sup>*Department of Animal Science, University of Manitoba, Winnipeg, Canada*, <sup>2</sup>*Department of Plant Science, University of Manitoba, Winnipeg, Canada*.

The quality characteristics of corn DDGS have been extensively evaluated. Current ethanol production in Western Canada uses wheat as a primary feedstock. However, little is known about the chemical composition and nutritive value of wheat-derived DDGS. Therefore, a comprehensive evaluation of the nutritive profiles of wheat-based DDGS from the new-generation Husky Energy Lloydminster Ethanol Plant in Canada was undertaken. The results revealed good quality characteristics of the DDGS samples ( $n = 2$ ) showing, on dry matter basis, a relatively high level of protein (40.7%), fat (4.5%), a very good proportion of nonphytate to phytate P (0.79 vs. 0.22%), and minimal levels of simple