It was hypothesized that young broilers can respond to high dietary crude protein (CP) and amino acid (AA) levels provided that formulations retained a consistent balance of all other nutrients across a range of CP and metabolizable energy (ME). A series of twelve corn-soy based diets were formulated to contain four levels of total lysine (1.20%, 1.29% 1.38%, and 1.47%) at each of three dietary levels of ME (3.0 kcal/g, 3.1 kcal/g, and 3.2 kcal/g). The percentage of dietary ME contributed from soy oil was kept constant, dietary CP was set such that lysine was 5.5% of CP (21.8%, 23.5%, 25.2%, and 26.9% CP) and remaining AA levels adjusted to a consistent profile. An inert filler was used to maintain specific nutrient ratios across all CP and ME levels. Two trials were conducted using Cobb 500 broilers. Exp. 1 utilized an environmentally modified broiler facility with 72 floor pens and 16 mixed sex birds per pen. Exp. 2 utilized 72 floor pens with 10 mixed sex birds per pen. Experimental diets were pelleted and crumbled and fed to 21 d of age. BW and mortality by sex and total feed intake per pen were recorded weekly and the feed conversion ratio (FCR) calculated. There were no CP by ME interactions at 21 d for mortality, BW or FCR in either experiment. In Exp. 1 BW did not differ between the 21.8% and 23.5% CP diets but was increased stepwise at 25.2% CP and 26.9% CP. In Exp. 2 BW was increased stepwise from 21.9% CP to 23.5% CP to 25.2% CP with no further increase at 26.9% CP. In both experiments BW was increased by the 3.1 and 3.2 kcal/g ME levels relative to the 3.0 level. FCR to 21 d improved in a stepwise manner with incremental CP and ME to the 25.2% and 3.1 kcal/g levels in both experiments. It can be concluded that 21 d broiler BW and FCR can respond positively to incremental dietary lysine and ME of up to at least 1.38% lysine and 3.1 kcal/g ME provided that a balance of all other nutrients is maintained.

**Key Words**: Broilers, Crude protein, Lysine, Metabolizable energy

### Nutrition - Feed Additives

**Xanthophyll supplementation (lutein and canthaxanthin)** may affect the broiler immune system and body composition within 9 days after test feed introduction. A. Mireles Jr.*, S. Kim, R. Thompson, E. Vasquez, and B. Amundsen, Foster Poultry Farms.

To examine the effect of high xanthophyll feeds on body composition and the immune response, two experiments were involved in this study. The first study was conducted in pens. Control (CONTROL) birds were given corn-soy control feed (1.6 mg lutein, 0.7 mg zeaxanthin, 0 mg/kg canthaxanthin) and test birds received High xanthophyll feed (HIGHX) (4.6 mg lutein, 0.9 mg Zeaxanthin, and 1.1 mg canthaxanthin) from day 33 - 45. There were 24 cockerels/treatment. Nine days after test feed introduction, chicks were injected with 1 gms E. coli lipopolysaccharide (LPS)/kg BW. At 42 days, body temperature was similar (P = 0.393) between groups prior to injection (41.66 vs.41.78 C for CONTROL and HIGHX respectively). Two hours later, HIGHX chicks had lower (P = 0.030) body temperature (42.66 vs. 42.26 C). Day 42 to 45 mortality tended to be lower for HIGHX birds (8.33 vs. 0.00%). 45 Days tibia strength and elasticity of LPS CONTROL birds was lower (P = 0.0327) than non-injected CONTROL birds (37.52 vs. 41.74 kg and 4.26 vs. 4.64 mm). HIGHX birds had similar tibia strength and elasticity as non-LPS CONTROL (40.77 vs. 41.74 kg and 4.54 vs. 4.64 mm). The second study was done in battery cages and consisted of 17 cockerels per treatment fed corn-soy based diets for 29 days. In addition to the control (CONTROL) birds, 2 levels of lutein (HIGHL, 5.2 mg, and HIGHESTL, 8 mg lutein), and 2 levels of canthaxanthin (HIGHX) may affect the broiler immune system and body composition within 9 days after test feed introduction. A. Mireles Jr.*, S. Kim, R. Thompson, E. Vasquez, and B. Amundsen, Foster Poultry Farms.
demonstrated that β-mannanase may be a viable alternative to traditional antibiotics in broiler management.

**Key Words:** β-mannanase, Broilers, Antibiotics, Uniformity

114 Effect of β-Mannanase (Hemicellul7M) on turkey hen performance and flock uniformity at two energy levels differing by 150 kcal/kg ME in the absence of antibiotics. M. E. Jackson*, R. L. James1, H. Y. Hsiao2, and G. F. Mathis2, 2ChemGen Corp, Gaithersburg, MD, 2Southern Poultry Research, Athens, GA. A.

Low concentrations of β-mannan, a polysaccharide found in soybean meal and other plant proteins, have been shown to reduce carbohydrate metabolism and health status in monogastrics. In many experiments with poultry, the enzyme β-mannanase has been shown to improve growth, feed conversion, and flock uniformity and it has been estimated that addition of this enzyme results in a net benefit of approximately 120 kcal/kg ME in the presence of antibiotics. A 42-day pen trial was designed to evaluate the effect of β-mannanase on hen performance with corn-soybean meal based diets at two moderate dietary energy concentrations without antibiotics differing by 150 Kcal/kg. Criteria to judge performance and health status were weight gain, feed conversion, and flock uniformity determined by weighing individual birds. Dietary treatments were: 1. Low, no enzymes, 2. High ME plus β-mannanase at 100 MU/t, the manufacturer’s recommendation, (1x), 3. Low ME, no enzyme, 4. Low ME plus β-mannanase (1.5x). The experiment was conducted in floor pens with 20 Nicholas poults per pen and 8 replications (Treatment 3) and 7 replications (other treatments). Similar positive responses to β-mannanase were observed for feed conversion to 21 days and gain to 42 days in both energy regimes (P<0.05). There were no additional benefits to increasing β-mannanase to 1.5 times the manufacturer’s recommendation. Comparing final body weights, the low ME plus β-mannanase was similar to the high ME minus β-mannanase suggesting a possible value of 150 Kcal/kg for β-mannanase. In the high ME regime, β-mannanase improved flock uniformity (P<.02). The experiment clearly demonstrated that β-mannanase improves hen performance at varying moderate energy levels. The data suggests an energy benefit of β-mannanase of up to 150 kcal/kg when antibiotics are not included and confirms past research demonstrating positive effects on flock uniformity.

**Key Words:** Turkeys, B-Mannanase, ME Level, Uniformity, Antibiotics

115 The effect of Alimet® feed supplement on mold growth in poultry feed. J. Wu and C. Schasteen*, Novus International, Inc, Optimize quality and improving stability of feed is critical in maintaining an edge in today’s competitive environment. The mold inhibition properties of DL-2-hydroxy-4-(methylthio)butanoic acid (ALIMET®) have been previously documented by Pro. Doerr at the University of Maryland ((1995) Poultry Sci., 74(1) p. 23). In the study reported here, methionine deficient basal starter mash feed was subdivided into three groups: basal control, +DL-methionine (DLM) (0.2%) or +Alimet® (0.2%). Initial moisture of the feed was 10.8% with upward adjustments made with the addition of 2, 4 and 6% sterile, distilled water to each treatment. Replicates (4) of each moisture group were mixed with and 600g placed into 1L containers, sealed and maintained at 28°C in a temperature controlled room. Total microbial growth was monitored by measuring carbon dioxide (CO2) formation in sealed vessels using Draeger Detector tubes to sample headspace (twice per week) following vessel sealing. At 6% added moisture (dry matter 83.2%): a) ALIMET® treated feed had no significant visible mold growth up to 7 days while b) basal (methionine deficient) starter mash control showed visible mold at 7 days and c) DLM treated feed showed significant mold growth within 2 days. At 4% added moisture (85.2% dry matter): a) ALIMET® treated feed had no significant mold growth up to 15 days while b) basal starter mash control showed greater mold growth than the Alimet® treatment at 15 days and c) DLM treated feed showed mold growth within 12 days. At 2% added moisture (87.2% dry matter): a) ALIMET® treated feed had no significant mold growth up to 60 days while b) basal starter mash control showed mold growth at 48 days with the DLM treated feed showing visible mold growth within 30 days. Therefore, in situations where increased moisture is a factor, e.g., enclosed feed bins, these data suggest that mold growth will be less when ALIMET® is the supplemental methionine source. The presence of ALIMET® in the feed provides an organic acid benefit which DLM cannot claim.

**Key Words:** Mold inhibition, ALIMET®, Organic acid, DL-Methionine, HMB

116 Effect of 2-Hydroxy-4(methylthio) butanoic acid (HMB) and DL-methionine in wheat and corn based diets on broiler performance. M. Vazquez-Anon*, S. D. Peak1, T. Hampton1, J. Firman2, and C. D. Knight1, 1Novus International, Inc, 2University of Missouri-Columbia.

Three floor pen trials evaluated the efficacy of an 88% solution of HMB (Alimet® feed supplement, Novus International, Inc.) and DL-methionine, dry 99% (DL: Degussa Hulls). Diets were formulated to be deficient in methionine and cystine (M+C) but adequate in all other nutrients. Diets were comprised of wheat, soybean meal (SB), corn and peas in study 1, corn and SB in study 2 and 3. Diets included a starter (5d), grower (17d), and finisher (13d) with ME (Mcal/kg), CP (%) and total M+C (%) levels containing 3.1, 3.15, 3.22: 21.4, 20.2, 17. 0.61, 0.62, 0.52, respectively for study 1 and 2 and 3.05, 3.10, 3.19; 23.0, 22. 19; 0.63, 0.62, 0.54 for study 3. Three supplemental levels of the two sources were added on an equimolar activity basis for each diet. Data from the three studies were analyzed separately as 2 x 3 factorial with a basal treatment. BW data were regressed over additional M intake using linear regression as the best fit to estimate efficacy of the two sources. Across studies, BW and feed conversion were improved with M addition (P<0.05). In Study 1, no differences were found between the two sources resulting in an efficacy of HMB vs DL of 105%±37. In Study 2, a significant source by level interaction (P<0.06) was found. HMB birds were heavier at the highest level of supplementation than DL birds (2.7 vs. 2.6 kg), indicating that each source has a unique dose response curve. The resulting efficacy for HMB relative to DL was 111%±21. In study 3, no statistical differences were found between the sources resulting in an efficacy of HMB vs DL of 117%±78. Across studies the relative efficacy value of HMB vs DL ranged from 105 to 117% indicating no overall differences between sources. However, the interaction of level by source in study 2 and the trend for higher performance for the HMB birds at higher levels of supplementation implies each source has a unique dose response curve to be considered when determining efficacy.

**Key Words:** 2-Hydroxy-4 methylthio butanoic acid, Methionine, Broilers

117 Coccidiostat and/or antibiotic feed supplementation improve broiler performance and significantly affect body composition and the immune system. A. Mireles, Jr.*, S. Kim, E. Vasquez, and R. Thompson, Foster Poultry Farms. A study consisting of 8 replicate pens/treatment was conducted to examine the effect of chemical coccidiostat (Coccid) or coccidiostat + anti- biotic (CocciaAB) feed supplementation on performance, the febrile and humoral response, bone, liver, and breast yields. Birds were raised on commercial-like, sixth brood rice hulls litter for 43 days. Compared to the control group (Control), Coccid or CocciaAB chicks had better (P = 0.003) weight gain (2.35, 2.41 and 2.45 kg respectively). Coccid birds had better feed/gain and antibiotic supplementation further improved (P=0.060) feed/gain (1.82, 1.79 and 1.77). Feed additive supplementation had no effect on mortality (10.15, 9.44 and 9.38%). Body temperature at 35 days was higher (P<0.032) for the Control than for Coccid or CocciaAB birds after (41.85, 41.78 and 41.66 C) and after a subcutaneous injection of 1 gm E. coli lipopolysaccharide (LPS)/kg BW (42.22, 41.82 41.71 C). Liver yields at 38 days were lower (P=0.001 for CocciaAB chicks (3.49, 3.44 and 3.02%) regardless of LPS challenge. Breast yields were similar (15.92, 15.93 and 15.98). LPS injection tended to increase severe tibial dyschondroplasia (0.00 vs 5.68%), decreased (P=0.021) bone elasticity (4.24 vs 3.95 mm), Bursal disease (titer (IBD) (2540 vs 1881) and Newcastle titers (INV) (744 vs 431). Control chicks had lower (P=0.009) tibial strength (29.73, 34.38 and 33.62 kg) and lower (P=.050) tibial elasticity (3.94, 4.26 and 4.10 mm). There were significant (P<0.019) diet x LPS interactions in IBD and INV. Not LPS challenged CocciaAB chicks had higher IBD and INV than Control or Coccid birds.

**Key Words:** Growth Promoters, Coccidiostats, Antibiotics, Acute phase response, Nutritional immunomodulation
118 Effects of dietary ingredients and Eimeria acervulina infection of chick performance, ME$_n$ and amino acid digestibility. M. E. Fersa*, P. L. Utterback, E. L. Young, and C. M. Parsons, University of Illinois.

In each of four two-wk experiments, chicks were inoculated either on D 9 or 11 with 5.0 x 10$^3$ sporulated oocysts (acute infection) or D 9, 12, 15 and 18 with lower levels (5.0 x 10$^2$ to 1.5 x 10$^5$) of sporulated oocysts (chronic infection). In Experiment 1, crossed-bred chicks (New Hampshire x Columbia) were fed either normal or a pharmacologic level of Zn (1500 mg/kg) and were inoculated with various chronic levels of sporulated oocysts. The Zn had no effect and coccidiosis infection resulted in significant decreases in growth performance and ME$_n$, but not amino acid digestibility. In Experiment 2, both fishmeal (15%) and GroBiotic-B70(TM) (GB; 5%) diets completely ameliorated the negative effects of acute and chronic coccidiosis infection on growth performance of crossbred chicks. The acute coccidiosis infection greatly reduced ME$_n$ and amino acid digestibility, and the magnitude of response varied with the timing of excreta collection after inoculation. Both fishmeal and GB diets reduced the large negative effects of coccidiosis infection on ME$_n$ and amino acid digestibility. Experiment 3 evaluated the effects of coccidiosis infection in chicks fed a wheat/barley/pectin diet compared to a corn/soybean meal diet. The wheat/barley/pectin diet depressed chick weight gain but did not interact with coccidiosis infection. Commercial broiler chicks were used in Experiment 4 to evaluate the effects of various levels of GB (2 to 6%) on growth performance of coccidiosis-infected chicks. Diets containing GB did not improve the growth performance of the infected broiler chicks, but they did improve the growth of the non-infected chicks. The results of these experiments indicate that coccidiosis infection (E. acervulina) reduces ME$_n$ and amino acid digestibility in chicks and that the coccidiosis effect is influenced by diet composition, type of infection (acute v. chronic) and timing of excreta collection.

Key Words: Coccidiosis, Chick, Digestibility, Fishmeal, GroBiotic-B70(TM)

119 The effect of feeding yolk antibody to phospholipase A$_2$ (aPLA$_2$) on growth and feed conversion in broiler chicks. M. Yang*1, M. Cook1, and K. Roberson2, 1University of Wisconsin-Madison, 2Michigan State University.

One-day-old commercially obtained broiler chicks were grown for three weeks to test the effects of yolk aPLA$_2$ on growth and feed conversion. Yolk aPLA$_2$ antibody was obtained by freeze-drying egg yolk from layers injected with PLA$_2$. Ground egg yolk powder was added into a chick mash diet that met or exceeded NRC (1994) requirements. A total of 300 broiler chicks were grown in three independent experiments. The doses of aPLA$_2$ in the diet were 0, 0.5 or 1.0 g/kg of diet. Birds were grown in batteries for three weeks with 5 birds per pen, 20 pens per battery. Data analysis showed that feed conversion (weight gain/feed consumption) was significantly (P<0.05) lower for both 0.5 (1.596) and 1.0 (1.584) g/kg of aPLA$_2$ groups compared to control (1.680). Pen weight from birds fed 1.0 g/kg aPLA$_2$ yolk powder (3189 g) was significantly heavier (P<0.05) than those from 0.5 g/kg aPLA$_2$ (2988 g) and control (2982 g). The use of dietary aPLA$_2$ may prove to be an alternative to antibiotics for improving growth and feed efficiency in broiler chicks.

Key Words: Broiler chicks, Yolk antibodies, Phospholipase A$_2$, Feeding trial, Feed conversion

120 Impact of glutamine (GLN) and Oasis® hatching supplement on growth performance and immune responses of broilers vaccinated and challenged with Eimeria maxima, G. Y. Yi1, G. L. Allee1, and J. J. Dibner2, 1University of Missouri-Columbia, 2Novus International, Inc.

A total of 720 hatching broilers were allotted to 12 treatments. Trt 1 and Trt 2 were fasted for 48 h post hatch followed by ad lib access to a common diet and water. Trt 3 and 4 were fasted for 48 h post hatch followed by ad lib access to 1% GLN diet and water. Trt 5 and 6 had ad lib access to a 1% GLN diet and water immediately after hatch for 48 h. Trt 9 and 10 were fed normal Oasis®, whereas Trt 11 and 12 were fed 1% GLN sprayed on Oasis®. The birds in Trt 2, 4, 6, 8, 10, 11, and 12 were vaccinated with 50 viable sporulated oocysts of E. maxima immediately after hatch. The Oasis® given to Trt 11 was sprayed with P. Acnes. All birds were orally challenged with 40,000 viable sporulated oocysts of E. maxima on d 22 post hatch. During the first 2 wk posthatch, birds in Trt 7 had the highest BW, gain, and G:F ratio among treatments (P<0.01). Compared to birds in the non-GLN groups, birds in the GLN groups had higher BW, gain, G:F and livability (P<0.05). Among the Fast, Feed and Oasis® groups, during pre-challenged period, birds in the Feed groups had the highest BW and gain (P<0.01). During post-challenge period, birds in the Fast groups had the lowest BW and livability (P<0.01), and in contrast to the first 2 wks, birds in the non-vaccinated groups had lower BW, gain, and G:F relative to E. maxima challenged groups (P<0.01). On d 14, there were differences in serum interferon-γ (P<0.05). During post-challenge period, compared to the E. maxima vaccinated birds, birds in the non-vaccinated groups had higher lesion scores of mid/small intestine (P<0.01). Those results indicated the beneficial effects of early access to feed or Oasis® and 1% GLN addition in improving the growth performance, livability, and immune function of young birds. Vaccination with E. maxima was effective to alleviate growth depression and intestinal infection associated with E. maxima challenge. (Oasis® hatching supplement is a trademark of Novus International Inc., and is registered in the US and other countries).

Key Words: Glutamine, Oasis®, E. maxima

121 Bone mineral density of laying hens housed in enriched versus conventional cages. M. N. Kopka*, H. W. Cheng2, and P. Y. Hester1, 1Purdue University, Livestock Behavior Research Unit, West Lafayette, IN, 2USDA - ARS, West Lafayette, IN.

Cages enriched with nests, perches, scratch pads, and dust baths may allow birds to display behaviors that they normally cannot express in conventional cages. In addition, these enrichments may increase bird activity and subsequently improve skeletal integrity. The objective of the current study was to determine the effect of cage enrichments on bone mineral density (BMD) of White Leghorns. Hens were housed in three caged environments: 1) conventional cages with 3 hens/cage (645 cm$^2$ of floor space/bird), 2) conventional cages with 6 hens/cage (645 cm$^2$ of floor space/bird), and 3) enriched cages with perches, dust bath, scratch pad, and nest box with 10 birds/cage (610 cm$^2$ of floor space/bird). For BMD, repeated measurements of the left leg (tibia and fibula) and wing (humerus) were taken from 12 birds, unaesthetized birds from each of the cage environments at 30, 40, and 50 wk of age using a Norland pDexa X-ray bone densitometer (Model No. 476D014). Using the mixed model procedure of SAS and body weight as a covariant, an analysis of covariance with repeated measurements (30, 40, and 50 wk of age) was conducted using the cage environment as the whole plot with the type of bone (tibia and humerus) within a bird as a sub-plot. Although the BMD of the tibia was always greater for hens housed in enriched cages as compared to hens of conventional cages at 30, 40, and 50 wk of age, the increase was significant only at 40 wk of age. The humerus showed an increase in BMD at 30 but not at 40 and 50 wk of age (treatment x bone x age interaction, P<0.05). There was no difference in the BMD of the tibia and humerus between the 3 hens/cages vs. the 6 hens/cage of conventional cages at any age. It is concluded that cage enrichments improved skeletal integrity perhaps through increased activity.

Key Words: Bone mineral density, Enriched cages, White leghorns

122 A comparison of bone densitometry in live birds with other bone tests using White Leghorns fed varying levels of dietary calcium. M. A. Schreweis*, J. I. Orban2, M. C. Ledur3, and P. Y. Hester1, 1Purdue University, W. Lafayette, IN, 2Southern University, Shreveport, LA, 3Embrapa Swine and Poultry Research Center, Concordia, SC, Brazil.

Bone densitometry is being investigated in our laboratory as a noninvasive tool to monitor bone integrity of live birds for osteoporosis. The objectives were to 1) assess the ability of bone densitometry in detecting changes in bone integrity of White Leghorns fed varying levels of dietary calcium and 2) to correlate densitometric scans with other bone test methods. Hens were fed hypercalcemic (5.4%), control (3.6%), or hypocalcemic (1.8%) diets from 32 to 58 wk of age. A Norland pDexa

Physiology - General Physiology II

Key Words: Bone mineral density, Enriched cages, White leghorns

Physiology - General Physiology II

Key Words: Bone mineral density, Enriched cages, White leghorns