

collecting 3 samples along the width from the 2 outside and the middle manure pile provided the least difference as compared to the reference value. Collecting only 3 samples vs. 18 would greatly save costs associated with both sample-collecting labor and laboratory analyses of the

samples. Further research is planned to evaluate the number of samples necessary for larger barns with more manure piles.

**Key Words:** laying hen, manure nutrients, nitrogen

### Nutrition III

**M64 Identification of an inflammatory compound for chicks in soybean meal—II.** D. M. Anderson<sup>\*1</sup>, H. Y. Hsiao<sup>1</sup>, and N. M. Dale<sup>2</sup>, <sup>1</sup>ChemGen Corp., Gaithersburg, MD, <sup>2</sup>University of Georgia, Athens.

Previous studies have shown that  $\beta$ -galactomannan ( $\beta$ -mannan) in soybean meal (SBM) stimulates an innate immune response in chickens. SBM is the principal source of  $\beta$ -mannans in most commercial feeds. Plasma levels of the acute phase protein AGP ( $\beta$ -1 acid glycoprotein) were used to reflect the degree of innate immune response.

Studies were conducted to verify (1) the relationship between  $\beta$ -mannan content in diets and degree of immune response and (2) the dosage effect of  $\beta$ -mannanase enzyme (Hemicell<sup>®</sup>, ChemGen Corp.) on the reduction of immune stress. Mixed sex broiler chicks were reared to 14 days of age in battery brooder units and plasma AGP levels were determined. The test diets contained 19.0% isolated soy protein (ISP), 25.4% soy protein concentrate (SPC) or 34.0% SBM. The mannose content in these diets was also determined. As soy products become more refined, the plasma AGP levels were significantly reduced (i.e., less immune response). A linear relationship was calculated between AGP levels and mannose content in testing diets.

In the same study, three doses of  $\beta$ -mannanase (60, 100, 150 million units per ton feeds) were applied on SPC diets and SBM diets. In SBM diets,  $\beta$ -mannanase addition significantly reduced circulating AGP levels in birds. In the relatively low mannan SPC diets, enzymatic hydrolysis of  $\beta$ -mannan consistently, but not significantly, reduced AGP in chicks. It is concluded that normal broiler diet formulations can stimulate an innate immune response, and that  $\beta$ -mannan in SBM appears to be a causative agent. Plant derived  $\beta$ -mannan can thus be considered to be a PAMP (pathogen associated molecular pattern) analog for poultry, engendering a metabolically expensive over-stimulation of the innate immune system. Feeding  $\beta$ -mannanase can result in the reduction of immune stress in chicks.

**Key Words:**  $\beta$ -mannanase, soybean meal,  $\alpha$ -1 acid glycoprotein,  $\beta$ -galactomannan, chickens

**M65 Effect of diet formulation on a total or digestible amino acid basis and amino acid concentration on broiler performance and carcass yield.** M. de Beer<sup>\*1</sup>, T. J. Applegate<sup>2</sup>, K. A. Walter<sup>1</sup>, and D. Burnham<sup>1</sup>, <sup>1</sup>Aviagen, Inc, Huntsville, AL, <sup>2</sup>Purdue University, West Lafayette, IN.

Two experiments were conducted to determine the effects of diet formulation on a total (TOT) or digestible (DIG) amino acid (AA) basis and AA concentration on broiler performance and carcass yield. The first experiment determined the standardized ileal AA digestibility (SIAAD) and AMEn of a corn DDGS and a poultry product meal (PBM). The standardized Lys digestibility was 62.5 and 45.6% for the DDGS and PBM, respectively; whereas the AMEn was 2792 and 2537 kcal/kg, respectively. A subsequent broiler grow-out experiment was conducted

with diets formulated using determined SIAAD and AMEn values for DDGS and PBM and average values for corn and SBM from previous experiments. The grow-out study was designed as a 2 x 2 x 2 factorial contrasting 0 vs. 10% DDGS, TOT vs. DIG, and 100% vs. 90% of 2007 Aviagen amino acid recommendations for Ross x 708 broiler chicks. Each diet was fed to 9 male and 9 female pens containing 20 birds/pen from 0 to 13, 13 to 26, 26 to 42, and 42 to 56 d of age. During each phase, dietary inclusion of PBM was fixed across diets at 3.5, 4.5, 5.5, and 6.5%, respectively. Formulation on a DIG basis vs. a TOT basis increased BW by 56 and 61 g and reduced FCR by 0.03 at both 42 and 56 d of age. Similarly, formulation to 100 vs. 90% increased 42 and 56 d BW by 53 and 43 g and reduced FCR by 0.04 and 0.03 at 42 and 56 d, respectively. Additionally, formulation on a DIG vs. TOT basis increased total white meat yield by 0.33 and 0.41%-units and lowered abdominal fat by 0.18 and 0.10%-units at 42 and 56 d of age, respectively. Likewise, formulation to 100 vs. 90% increased total white meat yields by 0.60 and 0.72 %-units and lowered abdominal fat by 0.22 and 0.24 %-units at 42 and 56 d of age, respectively. Despite potential increases in diet cost by formulating on a DIG vs. TOT AA basis or with a higher AA concentration, FCR and carcass yield differences improve broiler profitability.

**Key Words:** amino acid, broiler, digestibility

**M66 Effect of amino acid formulation and dietary probiotic supplementation on egg production and characteristics of laying hens.** T. J. Applegate<sup>\*1</sup>, E. Onyango<sup>2</sup>, R. Angel<sup>3</sup>, and W. Powers<sup>4</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>East Tennessee State University, Johnson City, <sup>3</sup>University of Maryland, College Park, <sup>4</sup>Michigan State University, East Lansing.

An experiment was conducted to determine whether probiotic supplementation could alleviate a marginal amino acid deficiency in Hyline 36 laying hens from 33 to 44 wk of age. A 2 by 4 factorial experiment with or without a commercial probiotic (1.4 kg /1000 kg) and 4 levels of amino acids (an amino acid adequate diet fed ad libitum (AAL); or an amino acid adequate (A90), marginal (M90) or deficient (D90) diet fed at 90 g/hen/d. Each dietary regimen was fed to 24 cages containing 2 birds per cage (780 cm<sup>2</sup>/hen). Dietary CP concentration was analyzed to be 17.4, 16.6, and 15.5% for the adequate, marginal, and deficient diets, respectively. Egg characteristics (yolk, albumen, or shell proportions and yolk or albumen solids) were not affected by diet ( $P > 0.05$ ). Probiotic supplementation did not improve nor hinder egg production or egg mass despite consuming 10, 4, 7, 6.5, and 7.5 mg of Lys, Met, TSAA, Thr, and Ile less per hen per d, respectively. Probiotic supplementation reduced feed intake-to-egg mass ratio by 2.4% and 3.4% from 33 to 36 and 41 to 44 wk, respectively. Numbers of eggs laid, egg weight (g/egg) and egg mass (kg/feeding period) were maximized when the AAL and A90 were fed vs the M90 or D90 diets. Total eggs laid and egg mass were greatest when at least 14.4 g CP, 804 mg Lys, 382 mg Met, 601 mg TSAA, 502

mg Thr, and 609 mg Ile were consumed per hen per d from 33 to 44 wk of age. In conclusion, probiotic supplementation was not able to alleviate a marginal amino acid deficiency in laying hens but did improve feed intake-to-egg mass ratios during 8 wk of the 12 wk study.

**Key Words:** amino acid, egg production, laying hen, probiotic

**M67 The digestible lysine requirement of fast-feathering, straight-run, 35 to 49 day old Cobb x Cobb 500 broilers.** R. B. Shirley\*, J. L. Usry, and P. B. Tillman, *Ajinomoto Heartland LLC, Chicago, IL.*

In a completely randomized block study, the digestible Lysine (dLys) requirement of fast-feathering, straight-run, Cobb x Cobb 500 broilers was determined for the withdraw phase (35 to 49 days of age). The experiment was conducted in the South-East USA in late summer; and the broilers were raised on litter that had been used by 4 previous flocks. Day-of-hatch, straight-run broiler chicks were randomly allotted across 96 floor pens (four rooms with 24 pens per room; 3 replicates from each treatment in each room; 12 replicates per treatment; 50 chicks per pen). All chicks were fed a common starter diet (0 to 7 days), grower diet (7 to 21 days) and finisher diet (21 to 35 days); the amino acid levels of each diet were formulated to exceed the current Cobb 500 nutrient guidelines. On day 35, the number of birds/pen was adjusted down to 46, with an approximate even split between males and females per pen (weights across all pens were equalized). The eight dose levels of dLys that were evaluated were: 0.60, 0.68, 0.76, 0.84, 0.92, 1.00, 1.08 and 1.16%; the energy (3,215 kcal/kg) and ideal essential amino acid ratios were maintained across all treatments. The intermediate dose levels of dLys were met by blending the 0.60% and 1.16% dLys diets. Broken-line (BL) dLys requirements were determined for feed consumption (FC), feed conversion (FCR) and total white meat yield (TWMP; the sum of total *Pectoralis major* and *minor* parts). The dLys requirement for FC was 0.88% (BL response = 2,218 g/bird), 0.99% for FCR (BL response = 2.42) and 0.95% for TWMP (BL response = 22.30%); mortality was greatest in the 0.60% dLys treatment ( $p = 0.0274$ ). This study demonstrates that the fast-feathering Cobb x Cobb 500 broiler responds positively to higher dLys in the 35 to 49 day period.

**Key Words:** Cobb 500 broiler, digestible lysine requirement, broiler performance, meat yield, lysine

**M68 Apparent metabolizable energy responses of male and female broilers ranging from 1.9 to 3.0 kg in BW.** W. A. Dozier, III\*<sup>1</sup>, A. Corzo<sup>2</sup>, and H. A. Olanrewaju<sup>1</sup>, <sup>1</sup>USDA-ARS, Mississippi State, MS, <sup>2</sup>Mississippi State University, Mississippi State.

Prices of energy contributing ingredients have soared over the last couple of years. Apparent metabolizable energy (AME<sub>n</sub>) inadequacy will result in poor feed conversion and caloric efficiency. Poor caloric utilization is accentuated with finishing broilers due to the older broiler having the ability to maintain caloric intake by increasing feed intake. This research evaluated performance and meat yield of broilers fed diets varying in AME<sub>n</sub>. Ross x Ross 708 chicks were randomly distributed into 96 floor pens (48 pens of males and females, respectively) at 1 d of age and were fed a common starter diet until 35 d of age. At 36 d of age, all pens were equalized with 15 birds (0.09 m<sup>2</sup>/bird) and fed experimental

diets until 47 d of age. Six dietary treatments ranging in AME<sub>n</sub> from 3,140 to 3,240 kcal/kg in increments of 20 kcal/kg were fed to male and female broilers. During experimentation, ambient temperature set points ranged from 21 to 18 °C with temperature decreasing as birds advanced in age. In general, AME<sub>n</sub> and gender did not interact with the variables measured in experimentation. Broilers fed progressive concentration of AME<sub>n</sub> displayed linear decreases ( $P \leq 0.02$ ) in feed intake, feed conversion, caloric efficiency, and abdominal fat weight and percentage. Optimum AME<sub>n</sub> approximated 3,200 kcal/kg from 36 to 47 d of age based on feed conversion and caloric efficiency. Significant quadratic effect ( $P \leq 0.01$ ) was observed for BW gain. Carcass and total breast meat weights and yields were not significantly affected by AME<sub>n</sub>. Male broilers exhibited advantages ( $P \leq 0.02$ ) in BW gain, feed intake, feed conversion, AME<sub>n</sub> intake, caloric efficiency, carcass weight and yield, abdominal yield, and total breast weight over females. No differences in plasma glucose, triglycerides, and plasma T<sub>3</sub> concentrations were observed for AME<sub>n</sub> or gender. These results indicated that an AME<sub>n</sub> of 3,200 kcal/kg is adequate for male and female broilers approximating from 1.9 to 3.0 kg.

**Key Words:** broiler, calorie, metabolizable energy

**M69 An empirical model to study nutritional effects on broiler growth and development.** L. F. Romero\*<sup>1</sup> and M. J. Zuidhof<sup>2</sup>, <sup>1</sup>Danisco Animal Nutrition, Marlborough, United Kingdom, <sup>2</sup>Alberta Agriculture and Rural Development, Edmonton, AB, Canada.

An empirical platform to measure nutritional effects on broiler growth and breast yield was developed to provide an alternative to fixed-age analyses. This study evaluated the effect of energy and protein intake levels on three exponential relationships: cumulative feed intake (CFI; kg) as function of age (d); eviscerated body weight (EBW; kg) as function of cumulative metabolizable energy intake (MEI); and breast weight (BrW; kg) as function of EBW. Data from 2070 Cobb x Avian 48 broilers placed in 60 floor pens was used. Birds were assigned to 3 metabolizable energy (ME) levels, 5 protein levels balanced for 6 total amino acids relative to lysine, and 10 processing ages from 21 to 56 d. A flexible functional form (trans-log) was used to optimize fit and measure derivatives with respect to energy and protein intake. All dependent variables were significant at  $P < 0.05$ .

The following maximum fit models were selected:

$$\ln(\text{CFI}) = a + \ln(\text{Age}) \cdot [b + c \cdot \ln(\text{Age}) + d \cdot \ln(\text{ME}) + e \cdot \ln(\text{CP}) + f \cdot \text{Sex}]; \\ \text{MSE} = 0.059 \text{ kg}^2;$$

$$\ln(\text{EBW}) = a + \ln(\text{MEI}) \cdot [b + c \cdot \ln(\text{Age}) + d \cdot \ln(\text{MEI}) + e \cdot \ln(\text{CPI}) + f \cdot \text{Sex}]; \\ \text{MSE} = 0.015 \text{ Mcal}^2;$$

$$\ln(\text{BrW}) = a + \ln(\text{EBW}) \cdot [b + c \cdot \ln(\text{MEI}) + d \cdot \ln(\text{CPI}) + e \cdot \text{Sex}]; \\ \text{MSE} = 0.0003 \text{ kg}^2.$$

Where ME (Mcal/kg) was mean energy density of the diet, CP (g/kg) was mean crude protein of the diet, and sex was a dummy variable (1 if male; 0 if female). The percent change of CFI in response to 1% change in ME was  $-0.12 \times \ln(\text{Age})$ , whereas the response to 1% change in CP was  $-0.03 \times \ln(\text{Age})$ . The percent change of EBW in response to 1% change in CPI was  $0.02 \times \ln(\text{MEI})$ . The percent change of BrW in response to 1% change in MEI was  $-0.07 \times \ln(\text{EBW})$ , whereas the

response to 1% change in CPI was  $0.05 \times \ln(\text{EBW})$ . Increased dietary ME exhibited negative effects on rate of feed intake, and the allometric relationship of breast muscle. Increased dietary CP exhibited negative effects on rate of feed intake, and positive effects on energy retention, and on the allometric relationship of breast muscle. This platform allowed dynamically evaluating nutritional effects on variables affecting broiler performance.

**Key Words:** empirical model, broiler chicken, breast meat, metabolizable energy, crude protein

**M70 Effects of feed formulation and level of feed intake on the energy partitioning of finisher broiler chickens.** S. Gomez\*<sup>1,2</sup>, M. L. Angeles<sup>1</sup>, E. Ramirez<sup>1,2</sup>, and V. Mondragon<sup>1</sup>, <sup>1</sup>CENIDFyMA - INIFAP, Ajuchitlan, Queretaro, Mexico, <sup>2</sup>FES-Cuautitlán-UNAM, Ajuchitlan, Queretaro, Mexico.

A balance trial and slaughter experiment were carried out to evaluate the true metabolizable energy (TMEn) and the efficiency of conversion from gross energy (GE) to TMEn and from TMEn to net energy (NE) for protein (p) and fat (f) deposition in broiler chickens from 39 to 49 days of age fed different amounts of diets based on sorghum (S) or corn (C) and with or without the inclusion of dry distillers grains with solubles

(DDGS). Forty eight Ross B308 male broilers allocated in individual pens were assigned to 12 treatments in a complete randomized design with a factorial arrangement of 2 grains (S or C), 2 levels of DDGS (0 and 10%) and 3 feeding levels (90, 120 and 150 g of feed/day). The last two days, total excreta were collected and in an additional group of birds the endogenous excretion of nutrients was determined. At the end, birds were killed to determine the energy retained in protein and fat. Chickens killed at the beginning of the trial were used to correct for the initial composition. There were four birds per treatment and results were subjected to analysis of variance. The nutrient excretion was lower and the nutrient retention, TMEn and the energy conversion from GE to TMEn were greater for C than for S ( $P < 0.05$ ). The TMEn was lower but the energy conversion from TMEn to NE<sub>f</sub> and to NE<sub>p+f</sub> ( $P < 0.05$ ) were greater for DDGS0 than for DDGS10 ( $P < 0.05$ ). As the FL increased, the retention of nutrients, the TMEn, the total protein and fat in the body, the energy retained in protein and fat, the conversion from GE to TMEn and from TMEn to NE<sub>p</sub>, NE<sub>f</sub> and NE<sub>p+f</sub> showed linear increments ( $P < 0.01$ ). Diets based on corn had a greater energetic value than diets based on sorghum; the inclusion of 10% DDGS reduced the energy retained in fat; broiler chickens fed at the highest feeding level showed the greatest efficiency of nutrient retention and conversion from gross energy, to true metabolizable energy and to net energy retained in protein and fat.

**Key Words:** broiler chickens, GE, TMEn, NE

## Physiology

**M71 Comparison of egg hatchability between two breeds of layers.** O. K. Awobajo\*<sup>1</sup>, A. A. Mako<sup>1</sup>, O. I. Abiola-Olagunju<sup>2</sup>, O. A. Ogunwole<sup>2</sup>, R. A. Hamzat<sup>3</sup>, A. O. Igboanu<sup>1</sup>, and R. O. Ettu<sup>1</sup>, <sup>1</sup>Tai Solarin, University of Education, Ijebu Ode, Ogun State, Nigeria, <sup>2</sup>Department of Animal Science, University of Ibadan, Ibadan, Oyo State, Nigeria, <sup>3</sup>Purdue University, West Lafayette, IN.

This study was carried out to compare hatchability between Rhode Island Red and White Leghorn. The hatchability records were collected for one year on each breed selected from the hatchery farms in Ijebu-Ode local Government. The result were subjected to statistical analysis. The result of the analysis (including T-test) revealed no significant differences ( $P < 0.001$ ) between rejected eggs (3.97%) from Rhode Island Red and (3.93%) from White Leghorn breeds. There was no significant difference ( $P < 0.001$ ) between the infertile eggs of Rhode Island Red (29.04%) and White Leghorn (24.82%). Significant differences ( $P < 0.001$ ) occurred in the egg hatchability of Rhode Island Red (64.29%) and White Leghorn breeds (68.61%). The White Leghorn had higher egg hatchability percentage than Rhode Island Red.

**Key Words:** hatchability, layers, breeds, rejected eggs, infertile eggs

**M72 Effect of pre-warming profile on hatchability and chick quality.** I. A. M. Reijrink\*<sup>1</sup>, D. Berghmans<sup>2</sup>, R. Meijerhof<sup>1</sup>, B. Kemp<sup>2</sup>, and H. Van den Brand<sup>2</sup>, <sup>1</sup>HatchTech Incubation Technology, Veenendaal, The Netherlands, <sup>2</sup>Wageningen University, The Netherlands.

Pre-warming of hatching eggs prior to incubation is to prevent condensation and to reduce variation in egg temperatures. The pre-warming

profile might affect embryo viability, as it might affect cell death especially when cell viability is reduced after prolonged storage. The aim of this research was to investigate the effect of storage time and pre-warming profile on hatchability and chick quality. Eggs from a Ross broiler breeder flock with an age of 41 to 50 weeks were used. The experiment was a 2\*3 factorial design: 2 storage times (4 and 14 d), and 3 pre-warming profiles (in 30 minutes, 4 h, or 24 h from 17°C to 37.8°C). All eggs were stored at 17°C. Eggs pre-warmed in 30 min were warmed in a water bath with water of 37.8°C. The other eggs were pre-warmed during 4 and 24 h in air. During incubation egg shell temperature was maintained at 37.8°C in all treatment groups. Infertility and embryonic mortality was determined macroscopically. Chick quality was evaluated 12 h after hatch by measuring chick length and yolk free body mass. No interaction was found between storage time and pre-warming profile for hatchability and chick quality. Although no significant interaction was found, there was a numerical difference in first week embryonic mortality between 24 h of pre-warming and 30 min and 4 h of pre-warming in eggs stored for 14 d (3.4%, 11.1%, and 9.4%, respectively,  $P = 0.34$ ). Storage time and pre-warming profile did not affect hatchability. Pre-warming profile did not affect chick quality. Fourteen days storage resulted in 0.1 cm shorter chick length ( $P = 0.003$ ) and 0.4 g lower yolk free body mass ( $P = 0.006$ ) compared with 4 d storage. In this experiment no effect of pre-warming profile on hatchability or chick quality was found.

**Key Words:** storage time, pre-warming profile, hatchability, chick quality