

## Metabolism and Nutrition V: Energy and Enzymes

**179 Apparent metabolizable energy responses of male and female broilers from 36 to 47 d of age during a summer grow-out.** 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.

Feed ingredient costs have been a concern to the U.S. broiler industry. Some integrated operations have reduced apparent metabolizable energy (AME<sub>n</sub>) values to decrease live production costs. Our laboratory has previously determined that 36 to 47 d feed conversion and caloric conversion were optimized with broilers fed diets formulated at 3,200 kcal/kg. Finishing broilers may respond to diets formulated to AME<sub>n</sub> higher than 3,200 kcal/kg during a summer grow-out. This research evaluated performance and meat yield of broilers fed diets varying in AME<sub>n</sub>. Ross × 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 and grower diets 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 the 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 point was 25 °C. Broilers fed gradient additions of AME<sub>n</sub> had linear increases (P ≤ 0.03) in BW, BW gain, carcass weight, total breast meat weight, and plasma free fatty acids. Increasing AME<sub>n</sub> decreased (P ≤ 0.02) 36 to 47 d feed conversion and caloric conversion linearly. Optimum AME<sub>n</sub> approximated 3,240 kcal/kg from 36 to 47 d of age based on BW gain, feed conversion, caloric conversion, and total breast meat weight. Linear AME<sub>n</sub> × gender interactions (P ≤ 0.05) were observed for BW, BW gain, feed conversion, caloric conversion, carcass weight, total breast meat weight, and plasma T3. These results indicated that male and female broilers from 36 to 47 d of age subjected to moderate temperatures responded to higher AME<sub>n</sub> than previous research with 36 to 47 d old broilers reared under thermoneutral conditions.

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

**180 Effect of environmental temperature on maintenance energy requirements of broiler breeder pullets.** M. J. Zuidhof<sup>\*</sup>, R. A. Renema, D. Paul, and A. Pishnamazi, *University of Alberta, Edmonton, AB, Canada.*

Feed allocation decisions for feed restricted broiler breeders are complex. Precise feed allocation decisions are important to ensure consistent metabolic rate and BW gains. Fluctuations in environmental temperature (T<sub>e</sub>) complicate feed allocation decisions because T<sub>e</sub> influences the maintenance ME (ME<sub>m</sub>) requirement, which in turn affects the ME available to support growth and development. An experiment was conducted to determine the impact of T<sub>e</sub> on the energy requirements of broiler breeder pullets. Eight hundred broiler breeder pullets were randomly allocated to 32 pens within 8 controlled environmental chambers. Four temperatures (15, 19, 23, and 27°C) were assigned randomly to duplicate chambers for four 2-wk periods from 10 to 18 wk. In each chamber, T<sub>e</sub> was recorded twice per hour, averaged, and adjusted (T<sub>e</sub>-21) so as to predict ME<sub>m</sub> requirements relative to room temperature. ME requirements for maintenance and BW gain were estimated using a mixed model, accounting for correlations between repeated measures within each chamber. Estimates were calculated from 4 BW and ME intake measurements per 2-wk period. The ME requirement for gain was assumed constant. The ME<sub>m</sub> requirement was 117.9 kcal/kg<sup>0.67</sup> - 0.582 kcal/kg<sup>0.67</sup> for every 1°C deviation from 21°C. The ME requirement for gain was 0.928 kcal/g. According to this model, broiler breeder pullets

weighing 1.3 kg would require 147.8, 140.6, or 133.5 kcal/kg<sup>0.67</sup> at 15, 21, and 27°C, respectively. This translates to feed (2,750 kcal ME/kg) intakes of 53.7, 51.1, or 48.5 g/d, respectively. Alternatively, birds fed 55 g/d of this feed at 15, 21, or 27°C would have enough ME available for growth rates of 3.8, 11.5, or 19.2 g/d. Substantial differences in theoretical growth rates at different temperatures on the same amount of feed demonstrate the importance of considering environmental temperature when allocating feed to broiler breeders.

**Key Words:** feed allocation, broiler breeder pullets, feed restriction, energy requirements, environmental temperature

**181 Coccidiosis mediated lesion score effects on calorific cost at 5 age intervals throughout the broiler growth curve to 48 days.**

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A metabolic chamber experiment was conducted utilizing Cobb x Cobb males to evaluate coccidiosis impact and immunity development initially quantified by lesion score. Two groups of birds were reared in cocci free environments with one vaccinated at hatch (Coccivac-B) and the other maintained as naïve to cocci. Birds were selected from the two backgrounds at 5 weekly intervals for chamber placement. The 5 challenge periods consisted of an oral dose of sterile saline or a mixture of 3 *Eimeria* species administered as oocysts to naïve birds at 14, 21, 28, 35, and 42 days. Variables examined six days post challenge included live weight, FE, gross lesion scores (upper small intestine: USI; mid small intestine: MSI; ceca: C), heat production (HP) and body composition. Metabolic costs of cocci challenge included appetite suppression, maintenance energy elevation, excreta calorie elevation and reduced live weight gain, FE and ration net energy (P < .05). Though coccidiosis challenge occurring early in the production cycle had energy cost, birds exposed late (35, 42 days) exhibited higher costs (P < .05). Effective caloric value (ECV) places caloric density equivalents upon nutritional and nonnutritional factors. In this study coccidiosis mediated lesion scores 6 days post oocysts challenge exhibited marked (P < .01) deleterious impact upon ECV. Lesion score 1 and 2 reduced the dietary energy value from an initial 3,200 Kcal/Kg ration by 125 and 596 Kcal for 800 g broilers and by 625 and 2,277 Kcal/Kg for 3000 g birds, respectively. Lesion score cost far exceeded consequences for inadequate lighting program and poor pellet quality. Calorimetry data substantiated the lesion consequence with increased maintenance energy need, heat production and malabsorption. Results demonstrate the importance of time dependency on coccidiosis control.

**Key Words:** broiler, *Eimeria*, coccidiosis, energy, malabsorption

**182 Influence of fiber level in the diet on performance of broilers from 1 to 21 d of age.**

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We studied the effects of type of fiber and level of inclusion in the diet on productive performance of broilers from 1 to 21 d of age. There were 10 experimental treatments; a control diet based on rice, soy protein concentrate, fish meal, and soy oil that contained 3,212 kcal AME<sub>n</sub>/kg, 1.40% total Lys, and 1.61% crude fiber (CF), and 9 extra diets arranged

factorially with 3 fiber sources (OH, oat hulls; SBP, sugar beet pulp, and PH, pea hulls) and 3 levels of fiber inclusion (2.5, 5, and 7.5%). The fiber source was included at expenses (wt/wt) of the basal diet. Therefore, fiber inclusion increased CF content and decreased AME<sub>n</sub> and essential amino acid content of the basal diet. Each treatment was replicated 6 times and the experimental unit was a cage with 12 chicks. The ADG, ADFI, and feed to gain (F:G) were recorded per replicate at 7, 14, and 21 d of age. No interactions among main effects were observed. The inclusion of up to 5% of an additional fiber source improved ADG ( $P < 0.05$ ) and F:G ( $P < 0.05$ ) but no effects were observed for ADFI. A further increase in additional fiber to 7.5%, reduced ADG and impaired F:G ( $P < 0.05$ ) with respect to 2.5 or 5% fiber inclusion but performance of birds fed 7.5% fiber was similar to that of birds fed the control diet. The beneficial effects of fiber inclusion on broiler performance were more pronounced with PH than with OH or SBP ( $P < 0.05$ ) probably because of the higher starch (17.2%) and CP (11.2%) of this ingredient. We conclude that the inclusion of up to 5% fiber, to increase the CF content of the diet from 1.61% of the control diet to 2.42–3.50%, improves performance growth of broilers. However, a further increase of fiber to 7.5% impaired ADG and F:G with respect to the 5% level of inclusion. The beneficial effect of fiber was more pronounced with PH than with OH or SBP. Thus, young broilers have a minimal requirement of dietary fiber (2.42 to 3.50% CF depending on type) for maximal growth.

**Key Words:** oat hulls, sugar beet pulp, pea hulls, broiler performance

**183 Performance, AME and ileal amino acid digestibility of broilers fed corn-soy diets supplemented with a multi-enzyme complex containing xylanase, amylase and protease.** L. F. Romero\*<sup>1</sup>, V. Ravidran<sup>2</sup>, P. L. Utterback<sup>3</sup>, and C. M. Parsons<sup>3</sup>, <sup>1</sup>Danisco Animal Nutrition, Marlborough, United Kingdom, <sup>2</sup>Massey University, Palmerston North, New Zealand, <sup>3</sup>University of Illinois, Urbana.

Four 21-d-performance and four 21-d-cohort digestibility trials were conducted to evaluate growth, feed efficiency, AME, and amino acid digestibility of broilers fed corn-soy diets supplemented with a multi-enzyme complex containing xylanase, amylase and protease (Avizyme 1502®; Danisco Animal Nutrition), as compared to a control diet. Each experiment consisted of two treatments: control and control plus the enzyme complex, with eight replicates per treatment. Amino acid digestibility (excluding tryptophan) was evaluated on an apparent ileal basis, and AME<sub>n</sub> was calculated for each experimental unit. Data were analyzed using the Mixed Procedure of SAS, with experiment as random term. Enzyme supplementation decreased feed per gain of broilers from 1.52 to 1.47 ( $P < 0.01$ ), but had no effect on weight gain. Enzyme supplementation increased AME<sub>n</sub> by 102 kcal/kg (+3.37%;  $P < 0.01$ ) and ileal digestibility of 16 from 17 measured amino acids ( $P < 0.01$ ) by an average of 2.8% versus the control. Of these amino acids, cysteine (+5.3%) and threonine (+4.2%) exhibited the greatest increments in ileal digestibility, whereas lysine exhibited the lowest (+2.0%). Digestibility of methionine tended (+1.0%;  $P = 0.06$ ) to be increased by enzyme supplementation. The lower responses in lysine and methionine digestibility may be related to the fact that diets contained DL-methionine and lysine-HCl. These data suggest that improvements in feed efficiency caused by dietary inclusion of xylanase, amylase and protease are related to increments of energy and amino-acid digestibility. Accounting for differential effects of digestibility of methionine and lysine in diet formulation may be critical to capture performance effects from increased digestibility of other amino acids.

**Key Words:** broiler, enzyme, digestibility, amino acid, feed efficiency

**184 Effect of adding different enzyme activities to high DDGS diets on hen performance.** C. Ramirez<sup>1</sup> and S. R. Fernández\*<sup>2</sup>, <sup>1</sup>GENA Agropecuaria S.A. de C.V., Acatic, Jalisco, México, <sup>2</sup>DSM Nutritional Products México, El Salto, Jalisco, Mexico.

With the objective to evaluate the effect of feeding hens with different enzymes; both phytase & carbohydrase enzymes (designed to degrade non-starch polysaccharides (NSP) molecules), added to a diet with 15% DDGS, 1,344 40-week-old-Hy Line W36 hens were randomly allocated to 4 treatments with 8 replicates of 42 hens each (14 hen cages with 3 hens per cage). The birds were housed in an open hen house with curtains; feed & water were provided ad libitum. The trial lasted 8 weeks. The treatments were as follows: T1, basal sorghum-SBM-15% DDGS diet, added with *Peniophora lycii* phytase (PLP) with -0.1% Ca & Av P & -40 kcal/kg ME; T2, as 1 added with Ronozyme Blend 25, a mixture of B-glucanase, xylanase, & pectinase (RB25) to release 40 kcal/kg ME (80 kcal/kg total); T3, was a sorghum-SBM-15% DDGS diet added with RB25 and a higher amount of (PLP) expected to release 0.13% Ca & Av P as well as 102 kcal/kg ME; T4 was as diet 1 added with a mixture of B-glucanase, xylanase & cellulase (RVB) to release 65 kcal/kg ME (105 kcal/kg total). The data was analyzed as a CRD. When the ANOVA showed a statistically significant response the differences between means were analyzed by the LSD procedure. Egg production (%) T1, 81.4; T2, 83.5; T3, 80.8; & T4, 80.1, feed intake (g/h/d), T1, 100; T2, 101; T3, 101; & T4, 102, egg mass (g/h/d), T1, 51.6; T2, 52.7; T3, 50.9; & T4, 50.8, relative feed egg production cost (%), T1, 100; T2, 98; T3, 100; & T4, 101, & egg shell strength (g/cm<sup>2</sup>), T1, 3,423; T2, 3,679; T3, 3,408; & T4, 3,455, were not statistically ( $P > 0.05$ ) affected by treatment. However, due to the response on egg production, feed conversion was significantly ( $P < 0.004$ ) affected by treatment: T1, 1.944ab; T2, 1.916a; T3, 1.98bc; & T4, 2.019c. Showing the hens fed the Ronozyme Blend 25 treatment a better feed conversion than the ones fed T3 & T4.

**Key Words:** hens, DDGS, NSP enzymes, *Peniophora lycii*, phytase

**185 Performance of broilers fed corn-soybean meal diets containing different enzymes.** D. E. Faria\*, P. W. Rizzolli, H. R. B. Souza, M. I. Sakamoto, C. G. Kikuchi, and G. Hosotani, University of Sao Paulo, Pirassununga, SP, Brazil.

This study was carried out to evaluate the effect of enzymatic complexes on performance of broilers fed corn-soybean meal diets. A total of 2,592 broiler chicks, Cobb-500 strain, were randomly distributed in seven treatments (Diet 1: corn-soybean meal positive control diet without enzymes; Diet 2: negative control diet with a 2% reduction from 1 to 21 days and 2.5% from 22 to 42 days, respectively in dietary energy (AME), amino acids (AA) and crude protein (CP) contents; Diet 3: negative control diet with a 4% reduction from 1 to 21 days and 5% from 22 to 42 days in AME, AA and CP contents; Diet 4: diet 2 plus 400 ppm of complex A (80,000 kNU of  $\alpha$  amylase, and 140,000 FBG of  $\beta$  glucanase); Diet 5: diet 2 plus 500 ppm of complex B (80,000 kNU of  $\alpha$  amylase, 140,000 FBG of  $\beta$  glucanase, and 100,000 FXU of xylanase); Diet 6: diet 3 plus 400 ppm of complex A; Diet 7: diet 3 plus 500 ppm of complex B) with seven replicates, except treatment 1 (six replicates) of 54 birds each. The feeding program adopted had two phases: starter (1 to 21 days) and grower (22 to 42 days). Body weight gain, feed intake, feed conversion and adjusted feed conversion to standard body weight of 2.5 kg for total phase (1 to 42 days) were evaluated. There were no effects of treatments on feed intake. Birds fed diet 5 showed best results for weight gain, feed conversion and adjusted feed conversion. It was concluded that the enzymatic complex B ( $\alpha$  amylase,  $\beta$  glucanase and xylanase) when

added in the diet with a 2% and 2.5% reductions in AME, AA and CP contents for starter and grower phases, respectively, is efficient to restore performance when compared to birds fed positive control diet.

**Key Words:** amylase, glucanase, nutrition, poultry, xylanase

**186 Enzyme complex containing NSP-enzymes and phytase improves the performance of layers fed corn-based diet.** M. Francesch<sup>1</sup>, A. Preynat<sup>\*2</sup>, S. Virden<sup>3</sup>, and P. A. Geraert<sup>2</sup>, <sup>1</sup>IRTA, Constanti, Spain, <sup>2</sup>ADISSEO France S.A.S., rue Marcel Lingot, France, <sup>3</sup>ADISSEO U.S.A. Inc, Alpharetta, GA.

The present experiment was conducted to investigate the benefits of a multi-enzyme complex (Rovabio<sup>®</sup> Max) containing carbohydrases (from *Penicillium funiculosum*) and phytase (bacterial 6-phytase) activities on the performance of layers.

Three basal diets based on corn and soybean meal were tested: one positive control (PC) diet formulated to be adequate in nutrient and two negative control with decrease in available phosphorus (AP, -0.15 pcent point avP) and gradual decrease in energy (AME), (NC1, -50 kcal/kg and NC2, -85 kcal/kg) and protein (NC1, -1.5% CP and NC2, -3.0%CP). NC diets were supplemented or not with Rovabio<sup>®</sup> Max supplying 1,100 visco units of endo- $\beta$ 1,4-xylanase, 100 AGL units of endo-1,3 $\beta$ -glucanase, and 500 Phytase Units of 6-phytase per kg of feed.

675 Hy-Line laying hens were distributed into 5 experimental treatments, 9 replicates, 15 birds per cage. Laying performances were determined from 20 to 43 weeks of age by subsequent 4-wk period. Egg quality parameters were also determined for each 4-wk period.

Supplementation of the NC reformulated diets with the multi-enzyme complex significantly improved feed intake, laying rate, feed conversion and egg weight. Egg quality, as measured by Haugh units and eggshell strength was not different between NC+ Rovabio<sup>®</sup> Max vs PC diets. These results support that the dietary supplementation with a multi-enzyme complex containing NSP-enzymes and phytase is efficient in reducing the phosphorus (-0.15 pcent point avP), energy (up to -85 kcal. kg) and protein (up to -3.0 % CP) specifications of a corn-based diets without laying performance losses.

**Key Words:** NSP-enzymes, phytase, layers, formulation matrix, egg quality

**187 Enzyme complex containing NSP-enzymes and phytase improves the growth performance and bone mineralization of broilers fed corn-based diet.** M. Francesch<sup>1</sup>, A. Preynat<sup>\*2</sup>, S. Virden<sup>3</sup>, and P.A. Geraert<sup>2</sup>, <sup>1</sup>IRTA, Constanti, Spain, <sup>2</sup>ADISSEO France S.A.S., rue Marcel Lingot, France, <sup>3</sup>ADISSEO U.S.A. Inc, Alpharetta, GA.

The present experiment was conducted to investigate the benefits of a multi-enzyme complex (Rovabio<sup>®</sup> Max) containing carbohydrases (from *Penicillium funiculosum*) and phytase (bacterial 6-phytase) activities on the performance of broilers.

Five basal diets based on corn and soybean meal were tested: one positive control (PC) diet formulated to be adequate in nutrient and four negative control (NC1 to NC4) diets with gradual decrease in energy (AME), crude protein (CP), available phosphorus (AP) and total calcium (Ca): NC1 : -85 kcal/kg, -3.0 % CP, -0.15 pcent point avP, -0.12 pcent point Ca ; NC2: -85 kcal/kg, -6.0 % CP, -0.15 pcent point avP, -0.12 pcent point Ca ; NC3: -105 kcal/kg, -6.0 % CP, -0.15 pcent point avP,

-0.12 pcent point Ca ; NC4 : -85 kcal/kg, -3.0 % CP, -0.18 pcent point avP, -0.14 pcent point Ca. NC diets were supplemented or not with Rovabio<sup>®</sup> Max supplying 1,100 visco units of endo- $\beta$ 1,4-xylanase, 100 AGL units of endo-1,3(4)- $\beta$ -glucanase, and 500 Phytase Units of 6-phytase per kg of feed.

2268 day-old Ross male broilers were distributed into 9 treatments, 6 replicates, 42 birds per pen. Growth performances were determined at 21 and 38 days. Tibia mineralisation was also determined at 21-d.

Supplementation of the NC reformulated diets with the multi-enzyme complex improved feed intake, weight gain and feed conversion. 38-d bodyweight and feed conversion were comparable between NC1, NC2 and NC4 + Rovabio<sup>®</sup> Max to those observed in the PC group. Moreover, the bone mineralisation was fully compensated by Rovabio<sup>®</sup> Max supplementation. These results support that the dietary supplementation with a multi-enzyme complex containing NSP-enzymes and phytase is efficient in reducing the phosphorus (up to -0.18 pcent point avP), energy (up to -85 kcal/kg) and protein (up to -3%) specifications of a corn-based diets without performance losses.

**Key Words:** NSP-enzymes, phytase, broilers, formulation matrix, growth

**188 Exogenous phytase alters the expression of nutrient transporters and markers of inflammation in the gastrointestinal tracts of broiler chickens.** S. A. Adedokun<sup>\*</sup>, O. A. Olukosi, O. Adeola, and K. M. Ajuwon, *Purdue University, West Lafayette, IN.*

The role of phytase in releasing phytate-bound phosphorus is well documented. Additionally, supplementation of phytase to poultry diet has been reported to improve ileal digestibility of nutrients. However, there is a dearth of information on the effect of phytase on the expression of active P and Ca transporters and intestinal inflammation. In this study, the role of phytase supplementation on the expression of intestinal P and Ca transporters and markers of inflammation was investigated using 3 diets containing 0, 500, or 1,000 FTU phytase/kg diet fed for 6 d to 42 d-old broiler chickens that were raised on deep litter until d 42. The birds were fed diets that met or exceeded their nutrient requirement from d 0-42 post-hatch. The basal diet (0 FTU phytase/kg diet) to which phytase (500 or 1,000 FTU/kg diet) was added was marginally deficient in available P. Expression level of intestinal P and Ca transporters and inflammatory markers (IL-6 beta and TLR4) were determined semi-quantitatively using the RT-PCR. Results from this study showed that intestinal P transporter was upregulated ( $P < 0.05$ ) while Ca transporter showed a tendency ( $P = 0.069$ ) to be upregulated with increasing level of phytase. Phytase addition resulted in decreased ( $P < 0.05$ ) level of inflammatory marker (IL-6 and TLR4) in the GIT. Because all the diets contained the same level of all nutrients, we conclude that phytase in the diet of broiler chickens results in improved active P absorption and may also play a role in gut health and immunity.

**Key Words:** broiler, inflammation, intestinal transporter, phytase

**189 Performance benefits beyond phosphorus replacement of broilers supplemented with microbial phytase doses between 12 and 292 times current commercial recommendations.** M. E. Persia<sup>\*</sup>, C. Mihaliak, and W. W. Robey, *Syngenta Biotechnology Inc, Research Triangle Park, NC.*

A 42-day experiment was conducted to determine the effect of feeding high doses of phytase from both an *E. coli* source (EP) and a fungal

source (FP). Both phytases were added to basal negative control (NC) diets resulting in a commercial dose (500 FTU/kg) and higher doses of phytase (12, 26, 58, 130 and 292 times the commercial rate). Starter (S), grower (G) and finisher (F) rations for the positive control (PC) and NC diets were formulated to be identical (within phase) in nutrients with the exception of total and nonphytate P (nPP). The nPP levels of the PC and NC diets were 0.50, 0.40 and 0.40% and 0.30, 0.25 and 0.20% for the S, G and F rations, respectively. Performance (body weight:BW and mortality corrected feed conversion ratio: FCRc) were measured. Supplementation of the NC diets with commercial rates of both phytases resulted in performance numerically higher than but statically similar to the PC, validating current inclusion rates based on nutrient replacement. In contrast to commercial doses, supplementation of the NC diets with 12 to 292 times the commercial dose resulted in significant improvements in BW and FCRc in comparison to the PC fed birds. Supplementation of NC diets with the EP resulted in a 4.3 to 6.2% increase in BW with a subsequent improvement in FCRc of 1.5 to 3.0% over the broilers fed the PC diets. Supplementation of NC diets with the FP resulted in a 3.4 to 6.6% increase in BW with a subsequent improvement in FCRc of 0.9 to 2.1% over the broilers fed the PC diets. There were significant and consistent performance improvements over the PC fed broilers when high doses (above 12 times the commercial dose) of either phytase source were included in NC rations. Not only is this response consistent, it appears to have no deleterious effects on performance in rations at levels as high as 292 times current commercial doses. This increased performance and high level of safety, regardless of phytase source, suggests a tremendous opportunity to utilize these high doses of phytase to generate value beyond simple nutrient replacement in broiler rations.

**Key Words:** phytase, broiler, value

**190 Performance, nutrient digestibility and expression of intestinal mucin RNA of 21 day old broiler chickens supplemented with 5000 FTU of phytase.** B. S. Lumpkins\*<sup>1</sup>, B. Humphrey<sup>2</sup>, G. Mathis<sup>1</sup>, and M. E. Persia<sup>3</sup>, <sup>1</sup>*Southern Poultry Research Inc., Athens, GA*, <sup>2</sup>*California Polytechnic State University, San Luis Obispo*, <sup>3</sup>*Syngenta Biotechnology Inc., Research Triangle Park, NC*.

Commercial broiler chickens were fed high concentrations of phytase to determine effects on broiler performance, nutrient digestibility and expression of intestinal mucin RNA. In total three treatments were evaluated. The first was a positive control (PC) diet that contained 21.4% CP, 3090 Kcal of ME, 0.90% Ca and 0.45% nonphytate phosphorus (nPP). A negative control (NC) diet was formulated to contain 21.4% CP, 3090 Kcal of ME, 0.90% Ca and 0.30% nPP. Treatments two and three consisted of the NC diet fed either alone or supplemented with 5000 FTU/kg of an *E. coli* phytase. All diets contained 0.25% Chromic oxide for use as an indigestible marker. Each of these three experimental diets was fed to 8 replicate pens of 6 Cobb x Cobb chicks from 1 to 21 days of age. Broiler chicks were housed in modified battery cages in an environmentally controlled room. Body weight gain and feed conversion ratio (FCR) were calculated for the 21 day period and birds were sacrificed on day 21 for ileal ingesta collection (samples were pooled by replicate group) and mucosal scrapping from one bird per replicate pen. Mucosal scrapings were snap frozen in liquid nitrogen for storage before total RNA isolation, reverse transcription and quantitative real-time PCR for mucin mRNA abundance. Feeding the NC diet (without phytase supplementation) resulted in a 7.3% reduction in body weight gain and a 9.7% worsening of calculated FCR, validating the deficiency of the NC diet in comparison to the PC fed birds. Supplementation of the

NC diet with 5000 FTU of phytase/kg diet not only returned the performance of the birds to that of the PC fed birds, it increased body weight gain by an additional 7.8% without altering FCR. Currently phytase is utilized at lower concentrations to replace inorganic phosphorus, but it appears that at higher concentrations phytase might be ameliorating more of the anti-nutritive effects of dietary phytate and allowing the birds to reach more of their genetic potential in comparison to birds fed a positive control diet.

**Key Words:** phytase, performance, broiler, nutrient digestibility, mucin RNA

**191 Evaluation of a heat stable xylanase enzyme under typical feed industry manufacturing parameters.** C. R. Stark\*<sup>1</sup> and C. Wyatt<sup>2</sup>, <sup>1</sup>*North Carolina State University, Raleigh*, <sup>2</sup>*AB Vista, Chapel Hill, NC*.

Recently, intrinsic thermo-tolerant feed enzymes that appear to withstand temperatures of up to 93°C have been developed. Heat tolerant enzymes can be added in the mixer, which improves the accuracy of the enzyme addition and eliminates the need for a post-pellet liquid system. The objectives of these experiments were to evaluate the mixing characteristics and thermo-tolerance of a xylanase (*Trichoderma reesei*; Econase® XT) product using typical feed processing parameters. A corn-soybean meal diet containing 3% poultry fat added in the mixer was used in the mixer uniformity and enzyme stability experiments. Experiment 1 evaluated the uniformity of xylanase in mixed feed at premix inclusion rates of 80, 100, and 150 g/ton after 3 min in a double ribbon mixer. Experiment 2 investigated enzyme recovery in feed after the pelleting process. The experimental treatments were conditioning temperatures of 85, 88, 91, and 93°C. The feed was conditioned for approximately 30 sec at each temperature and then passed through a 4.4 mm x 35 mm pellet mill die. There were 3 replicates per treatment. Samples of the meal and pellets were collected prior to conditioning and after cooling, respectively. Enzyme recovery was calculated. Results of the mixing study indicated that there was a uniform distribution of the premix as measured by xylanase activity in the finished feed. The coefficient of variation (CV) was 2.7%, 5.4%, and 6.2%, respectively, for the 80, 100, and 150 g/ton diets. Xylanase activity was 20,491 BXU/kg in the mash and 18,676, 19,395, 18,558, and 18,755 BXU/kg in the pellets at 85, 88, 91, and 93°C, respectively. Recovery rates ranged from 91 to 95%, with no significant difference between treatment temperatures. The results from this experiment indicate that the intrinsic thermo-tolerant non-coated xylanase enzyme can be uniformly distributed in feed and retain 90% of its activity after conditioning (93°C for 30 sec) and pelleting.

**Key Words:** mixing, pelleting, xylanase, enzyme, thermo-stability

**192 Effect of feeding *Peniophora lycii* phytase combined with carbohydrase enzyme activities on hen performance.** B. Fuente<sup>1</sup>, E. Avila<sup>1</sup>, E. Rosales<sup>2</sup>, S. Charraga<sup>2</sup>, and S. R. Fernández\*<sup>2</sup>, <sup>1</sup>*Universidad Nacional Autónoma de México, Mexico City, Mexico*, <sup>2</sup>*DSM Nutritional Products México, El Salto, Jalisco, Mexico*.

In order to evaluate the effect of different nutrient matrix values for the combination of *Peniophora lycii* phytase (PLP) and a mixture of B-glucanase, xylanase, & pectinase enzymes (Ronozyme Blend 25 (RB 25)), 480, 36-week-old-Bovans white hens were randomly allocated to 4 treatments with 4 replicates of 30 hens each (10 hen cages with

3 hens per cage). The birds were housed in an open hen house with curtains; feed & water were provided ad libitum. Treatment 1 consisted of a sorghum-SBM diet formulated to fulfill at 100% the Bovans white nutritional requirements, then treatments 2 to 3 were added with 111 ppm of PLP with the following nutrient equivalent values (01% Ca & Av. P, 40 kcal/kg ME, 148 ppm Lys, 102 ppm Met, & 148 ppm Thr) also, 300 ppm of RB25, were added to these 3 treatments, however, a different RB25 feed formulation matrix was applied to each diet, T2 RB25 nutrient equivalent values (NEV) were 35 kcal/kg ME; Lys, 252 ppm; Met, 123 ppm; Thr, 159 ppm; & Arg, 291 ppm (50% ME 100% AA). T3 RB25 NEV were 70 kcal/kg ME & AA values the same as T2 (100% ME 100% AA), T4 NEV were: 70 kcal/kg & 50% of AA values

assigned to T2(100% ME 50% AA). The trial lasted 9 weeks; the data was analyzed as a CRD. When the ANOVA showed a statistically significant response the differences between means were analyzed by the LSD procedure. Egg production (%) T1, 89.1; T2, 89.1; T3, 87.3; & T4, 90.2, feed intake, feed conversion T1, 1.893; T2, 1.909; T3, 1.892; & T4, 1.869, & egg mass, were not statistically ( $P > 0.05$ ) affected by treatment. However, relative feed egg production cost (%), T1, 100b; T2, 91b; T3, 86a; & T4, 86a was lower for treatments 3 & 4 compared to T1 & T2 ( $P < 0.001$ ). Under the experimental conditions of the present trial the combination of *Peniophora lycii* phytase and Ronozyme Blend 25 allowed to keep the hen's productive performance along with a more competitive relative egg production cost.

**Key Words:** hens, carbohydrase enzymes, *Peniophora lycii*, phytase

## Pathology

**193 Chemotherapy of coccidiosis in gamebirds.** L. R. McDougald\* and R. W. Gerhold, *University of Georgia, Athens.*

Anticoccidial drugs commonly available for other poultry were tested against recent field isolates of *Eimeria* in Chinese ringneck pheasants, the chukar partridges, and bobwhite quail. Recent field isolates of coccidia from each of the bird species were used for challenge of 2-3 week old birds in battery cages. Each treatment was replicated in 3 cages, with 10 birds/cage. The anticoccidial drugs were obtained from the manufacturer as premixes, and were mixed into game bird starter mash. The experimental design included an unmedicated, uninfected control and an unmedicated, infected control. In four battery tests with pheasants, 3 with chukars and 2 with quail we evaluated zoalene (125 or 150 ppm), diclazuril (1 or 2 ppm), decoquinate (33 ppm), salinomycin (66 ppm), lasalocid (125 ppm), robenidine (33 ppm), Rofenaid (125/75 ppm for sulfadimethoxine and ormetoprim) and semduramicin (25 ppm). Also, in bobwhite quail, we tested amprolium (250 ppm). The endpoints for efficacy were 1) weight gain 0-6 days postinoculation, 2) reduction in lesion scores in comparison with infected controls, and 3) fecal scores (diarrhea) in comparison with controls. Drugs with good efficacy in pheasants were rofenaid, robenz, decoquinate and lasalocid. Semduramicin and zoalene had moderate activity. In the chukar, rofenaid, robenidine, decoquinate, diclazuril and lasalocid had good efficacy. In the bobwhite quail, rofenaid and diclazuril (2 ppm) had good activity, while lasalocid, decoquinate and robenidine had moderate activity. Amprolium had no detectible activity in comparison with infected controls. There was no noticeable toxicity with any of the treatments in any bird species. These results showed generally poorer efficacy of some drugs, in comparison with earlier published tests, suggesting the possible emergence of drug resistance after extensive field usage.

**Key Words:** pheasant, chukar, quail, coccidia, anticoccidial

**194 The effects of different *Eimeria* challenge methods on weight gain and lesion formation in broilers.** S. Pohl\*<sup>1</sup>, J. Lee<sup>1</sup>, S. Anderson<sup>1</sup>, S. Fitz-Coy<sup>2</sup>, and D. Caldwell<sup>1</sup>, <sup>1</sup>Texas A&M University, College Station, <sup>2</sup>Intervet/Schering-Plough Animal Health, Summit, NJ.

The objective of this study was to examine the effects of direct or indirect routes of *Eimeria* exposure on body weight gain and intestinal lesion development in broilers. Challenge methods were administered on day of hatch (d0) or d7 post-placement. Broilers were challenged with 5,000 (d0) or 50,000 (d7) sporulated oocysts per bird of a mixed species inocu-

lum of field strain *Eimeria*. In addition to a negative (non-challenged) control group, four challenge methods were evaluated on d0: litter spray, oral gavage, feed administration, and a seeder:contact challenge model where 20% of placed broilers were inoculated. Methods evaluated on d7 were litter spray, oral gavage, and feed administration. Birds challenged on d0 were subjected to necropsy on d9, 16, and 23 while birds challenged at d7 were subjected to necropsy on d16 and 23 to assess gross and microscopic intestinal lesions. Body weights were obtained weekly and at each necropsy. Of broilers challenged on d0, lesions were more pronounced and consistent at necropsy on d9, 16, and 23 in oral and feed challenged groups, with peak lesion development occurring on d16. Body weights were not different among d0 challenged broilers on d9 or 16, but reduced body weight in all d0 challenged broilers was observed at d23. For d7 challenge methods, feed challenge and oral gavage resulted in higher and more consistent intestinal lesions on d16 and 23. Differences in broiler body weight among d7 challenge groups were not observed on d16, but on d23, depression in body weight was observed in feed challenge and oral gavage groups. These data suggest that selected *Eimeria* challenge methods may have a more pronounced effect on body weight gain and lesion development in broilers thereby allowing researchers to select the most appropriate methods for different experimental objectives.

**Key Words:** *Eimeria*, challenge method, broilers, lesion development, coccidiosis

**195 Which *Eimeria* species most affects the production of necrotic enteritis in broiler chickens.** G. F. Mathis\*<sup>1</sup>, C. Hofacre<sup>2</sup>, and J. Fricke<sup>3</sup>, <sup>1</sup>Southern Poultry Research, Inc., Athens, GA, <sup>2</sup>University of Georgia PDRC, Athens, <sup>3</sup>University of Georgia PDRC, Athens.

Coccidiosis damage to the intestinal mucosa often leads to proliferation of *Clostridium perfringens* resulting in Necrotic Enteritis (NE). The objective of this study was to examine the association of various species of *Eimeria* to the production of NE. A battery study using 3 replications of 8 birds per cage was conducted. The treatments were no coccidia (NC), *E. acervulina* (EA), *E. maxima* (EM), *E. tenella* (ET), and *E. praecox* (EP). Birds were coccidia challenged at 14 days of age. Each treatment was divided into *Clostridium perfringens* (CP) challenged on days 4, 5, 6, and 7 post coccidia challenge or no CP. The parameters measured were feed conversion, weight gain, necrotic enteritis (NE) mortality, and coccidiosis (0-4) and NE lesion scores (0-3). A significant