Metabolism and Nutrition: Enzymes

424P A meta-analysis of the effect of Victus Broiler under commercial and experimental conditions. Nelson Ward1, James Kessler2, Doug Teige1, April Levy1, and Aaron Cowieson1, 1DSM Nutritional Products, Ringside, NJ, 2DSM Nutritional Products, Murrieta, CA, 3DSM Nutritional Products, Lindell Beach, BC, Canada, 4DSM Nutritional Products, Ankeny, IA, 5DSM Nutritional Products, Ringoes, NJ, 2DSM Nutritional Products, Poult. Sci. 96(E-Suppl. 1)

Today’s technology allows for a wide selection of enzymes and a more targeted approach in products to improve corn/soybean meal-based broiler diets. Victus Broiler is a relatively new complex of carbohydrates, debranching enzymes, protease, and phytase for each feed phase. This complex targets bird physiology (respective of age) and feed substrates, as well branched nonstarch polysaccharides (NSP) - especially corn arabinoxylan. Here, Victus broiler was compared with established commercial carbohydrase-based products for efficacy and feed savings in 17 individually conducted experiments. Seventeen trials evaluated Victus Broiler throughout North America over a 2-year period with approximately 15,000 Ross and Cobb broilers per treatment (Victus versus alternative) grown in floor pens having at least 10 replicates/treatment. Diets mimicked a 3–4 feed pelleted commercial program. Feeds were corn/SBM-based (exception of one wheat-based) and most included corn DDGS and meat and bone meal. Victus (375 g/MT) utilized a matrix for least-cost formulation for metabolizable energy, amino acids, phosphorus and calcium. In 13 of the 17 trials, established competitive enzymes (a carbohydrase alone or a combination of enzymes) were the ‘Existing Enzyme Program’, while the remaining experiments were composed of feeds with ‘No Dietary Enzymes’. Overall, Victus increased broiler body weight 0.7% over existing enzyme programs and 0.6% over all feeds. Victus improved feed conversion ratio (FCR) 0.6% compared with competitive enzyme programs and 4.8% with no enzyme supplementation (P < 0.05). The FCR in the control and Victus groups was correlated (P < 0.05) and the beneficial effect of Victus on FCR was more pronounced in groups with higher inherent FCR. Mortality was unaffected by treatment. Feed costs calculated at the time of the trial (0–21 d) as only birds fed the NC diet supplemented with MC showed dietary energy and MC was observed for FCR during the starter period (0–35 d). The effect of dietary multi-carbohydrase supplementation on growth performance and nutrient digestibility in broiler chickens was evaluated in a 35-d study. A total of 168 1-d-old Ross 308 broiler chicks were randomly allocated to 1 of 4 dietary treatments arranged in a 2 × 2 factorial arrangements with 6 replications per treatment and 7 birds per cage. Diets were corn-soybean meal based and were formulated on Ross 308 (Aviagen, 2014) specifications. Dietary treatments were as follows: (1) positive control (PC); (2) negative control (NC); (3) PC + multi-carbohydrase (MC; Superzyme-CS; 0.05%); (4) NC + MC. Birds were fed their respective experimental diets ad libitum for the entire study period and management practices were performed according to the Ross 308 broiler management guide (Aviagen, 2014). Growth performance, feed intake and FCR were measured on a weekly basis. One bird per pen (n = 24) was selected and sacrificed for collection of ileal digesta on d 21 and 35, respectively. Higher ADG (56.40 vs. 58.60 g, P < 0.05) was observed for birds fed MC for the overall period (0–35 d) compared with birds fed a diet without MC. An interaction between dietary energy and MC was observed for FCR during the starter period (0–21 d) as only birds fed the NC diet supplemented with MC showed improved (1.38 vs. 1.30, P < 0.05) FCR compared with birds fed the NC diets. Multi-carbohydrase supplementation increased (P < 0.05) DM, CP and energy digestibility compared with birds fed a diet without MC on d 21 by 2, 4 and 3%, respectively. Moreover, birds fed diets with MC

Key Words: Victus, enzyme, broiler, performance, cost


A 42d experiment was conducted to evaluate the effects of supplementation of microbial 6-phytase (Cibenza Phytaverse G10) in combination with a protease (Cibenza DP100) and xylanase (Cibenza Xylaverase) in broiler chicks fed reduced levels of available phosphorus (aP), amino acids (aa), and energy corresponding to matrix values assigned for each of the products using Corn-SBM-Canola meal-Rice bran mixed diets. A total of 2016 Ross-308 male chicks were assigned under randomized complete block design to 9 treatments with 8 pens/treatment and 28 chicks/pen. Treatments consisted of reduced levels of aP, aa/CP and energy from the positive control (PC) diet. Test diets included: T1 (negative control, NC); T2 (T1 + phytase at 500U/kg diet); T3 (T1 + protease at 300,000U/kg diet); T4 (T1 + xylanase at 250U/kg diet); T5 (T1 + phytase + protease); T6 (T1 + phytase + xylanase); T7 (T1 + protease + xylanase); T8 (T1 + phytase + protease + xylanase); T9 (industry levels of aP, aa/CP, and energy) (PC). For T1 the energy was reduced by ~90kcal, CP by ~5%, aLys by ~4%, TSAA by ~5%, and Thr by ~7%, across phases compared with T9. The data were analyzed using 1-way ANOVA and the means were separated using protected δ-test at P ≤ 0.05. End of the trial outcome indicated a significant treatment effect for cumulative FCR (adjusted for mortality and culls) (cFCR) (P < 0.05) but not for cumulative weight gain, feed intake, and mortality (P > 0.05). cFCR for the PC was better (P < 0.05) than all the treatments except T5. cFCR for T2, T4, T6, T7, and T8 were similar and not different from the NC (T1) (P > 0.05). T3 (protease) improved (P < 0.05) cFCR compared with the NC but not different from T5. Supplementing the combination of phytase and protease (T5) resulted in a significant improvement (P < 0.05) in cFCR compared with T1 and similar (P > 0.05) to the PC (T9). In summary, under the experimental conditions tested, the data from d 42 indicates that the combination of phytase and protease leads to improved cFCR which is similar to the PC than the enzymes supplemented separately or in other combinations. Cibenza, Phytaverse, and Xylaverase are trademarks of Novus International, Inc. and are registered in the United States and/or other countries.

Key Words: phytase, protease, xylanase, broiler

426P Multi-carbohydrase supplementation improves growth performance and nutrient digestibility in broiler chickens. Samiru Wickramasuriya*1, Eunjoo Kim1, Hyun Min Cho1, Taeg Kyun Shin1, Rob Patterson2, and Jung Min Heo1, 1Chungnam National University, Daejeon, Korea, 2Canadian Bio-Systems Inc., Calgary, Canada.

The effect of dietary multi-carbohydrase supplementation on growth performance and nutrient digestibility in broiler chickens was evaluated in a 35-d study. A total of 168 1-d-old Ross 308 broiler chicks were randomly allocated to 1 of 4 dietary treatments arranged in a 2 × 2 factorial arrangements with 6 replications per treatment and 7 birds per cage. Diets were corn-soybean meal based and were formulated on Ross 308 (Aviagen, 2014) specifications. Dietary treatments were as follows: (1) positive control (PC); (2) negative control (NC); (3) PC + multi-carbohydrase (MC; Superzyme-CS; 0.05%); (4) NC + MC. Birds were fed their respective experimental diets ad libitum for the entire study period and management practices were performed according to the Ross 308 broiler management guide (Aviagen, 2014). Growth performance, feed intake and FCR were measured on a weekly basis. One bird per pen (n = 24) was selected and sacrificed for collection of ileal digesta on d 21 and 35, respectively. Higher ADG (56.40 vs. 58.60 g, P < 0.05) was observed for birds fed MC for the overall period (0–35 d) compared with birds fed a diet without MC. An interaction between dietary energy and MC was observed for FCR during the starter period (0–21 d) as only birds fed the NC diet supplemented with MC showed improved (1.38 vs. 1.30, P < 0.05) FCR compared with birds fed the NC diets. Multi-carbohydrase supplementation increased (P < 0.05) DM, CP and energy digestibility compared with birds fed a diet without MC on d 21 by 2, 4 and 3%, respectively. Moreover, birds fed diets with MC
increased (81% vs. 82%, P < 0.05) DM digestibility on d 35 compared with its counterpart, regardless of dietary energy level. In addition, birds fed PC diets showed increased (P < 0.05) CP (68% vs. 71%) and energy (76% vs. 79%) digestibility on d 21 along with higher (82% vs. 84%, P < 0.05) energy digestibility on d 35, independent of MC supplementation. This study, therefore, indicated that MC supplementation improved growth performance along with nutrient digestibility in broiler chickens fed corn and soybean-meal diets from hatch to 35 d of age, regardless of dietary energy level.

Key Words: broiler, digestibility, energy, growth performance, multi-carbohydrase

427P The effect of enzyme supplementation on egg quality, omega-3 (n-3) fatty acid deposition, and foregut morphology in hens fed flax. Gita Cherian* and Lindsay Westbrook, Oregon State University, Corvallis, OR.

Flax is a rich source of α-linolenic acid (ALA, 18:3 n-3). Feeding flax to hens can increase n-3 fatty acids (FA) in eggs. However, non-starch polysaccharides (NSP) in flax decrease nutrient digestibility and can have a negative impact on egg n-3 FA incorporation. Addition of carbohydrase enzymes to flax-based diets can decrease the anti-nutritive effects of NSP. An experiment was conducted to investigate the effect of enzyme supplementation on FA composition and foregut morphology in hens fed flax. A total of 72 (51-week old) brown layer hens were assigned to one of the four dietary treatments (6 replicates with 3 hens per replicate): corn-soy based diet containing 0% flax (Control), 10% flax (Flax), Flax +0.05% enzyme (Flax+E1), or Flax+0.1% enzyme (Flax+E2) for a 120-d feeding trial. Omega6zyme (Canadian Biosystems) contains cellulase (2800 U/g), xylanase (1000 U/g), gluconex (400 U/g), and mannanex (400 U/g). Egg, yolks and albumen weights were highest in Flax+E1 (P < 0.05). No difference was found in eggshell weight (P > 0.05). Albumen thickness and Haugh unit was lowest in Flax+E2 (P > 0.05). ALA, docosahexaenoic acid (DHA) and total n-3 FA were highest in Flax+E2 eggs (P < 0.05). Total n-3 FA constituted 97.2, 210.9, 235.2, and 259.3 mg in Control, Flax, Flax+E1 and Flax+E2 eggs, respectively (P < 0.05). Total n-6:n-3 FA ratio was lowest in Flax+E1 and Flax+E2 eggs (P < 0.05). No difference was observed in egg total fat content, lipid oxidation products, egg production or feed consumption due to diet (P > 0.05). Liver total lipids were higher in Flax and Flax+E1 than Control and Flax+E2 (P < 0.05). ALA was highest in liver of hens fed flax (P < 0.05). No difference was found in liver DHA, n-6:n-3 FA ratio, and total n-3 FA due to enzyme supplementation in hens fed diets containing flax (P > 0.05). Villi height and villi width was higher in duodenum and jejunum of birds fed flax-based diets than Control (P < 0.05). Enzyme supplementation led to an increase in villi width in jejunum (P < 0.05) in hens fed Flax+E2 (P < 0.05). No effect of diet was observed in the crypt depth and villi height:crypt depth ratio in the jejunum (P > 0.05). It is concluded that enzyme supplementation enhances egg quality, n-3 FA deposition and forestomach histomorphometric indices in hens fed flax.

Key Words: flax, enzyme, egg, n-3 fatty acids, villi morphology

429P Efficacy of NSPase inclusion in reduced energy diets on broiler growth performance. Hakei Williams1, Mallori Williams1, Nathan Augspurger2, Blynn Brown2, and Jason Lee1, 1Texas A&M University, College Station, TX, 2JBS United, Sheridan, IN.

The objective of the current study was to evaluate the performance of male broilers fed reduced energy diets with the inclusion of a non-starch polysaccharide degrading enzyme (NSPase) reared to 35 d of age during the summer. The experimental design consisted of 3 dietary treatments including a positive control (PC), negative control (NC) with a 88 kcal/kg AME reduction throughout the experiment compared with the PC, and the NC supplemented with NSPase. Each treatment consisted of 25 replicate pens with 20 male broilers placed per replicate (1,500 total broilers placed). The dietary program consisted 3 dietary phases; a starter from d 1 to 13, a grower from d 13 to 25, and a finisher from d 25 to 35. All diets were corn and soybean meal based and included dried distillers grain with solubles (DDGS), meat and bone meal and bakery meal in each phase of production. Broilers were weighed and feed consumption was determined on d 13, 25, and 35 which coincided with dietary changes. Evaluated parameters included body weight (BW), feed consumption (FC), and mortality corrected feed conversion ratio (FCR). The reduction of energy in the NC diet reduced (P < 0.05) BW on d 13 compared with the PC fed broilers. Inclusion of the NSPase increased (P < 0.05) BW when included in the NC diet to levels similar to the PC. Energy reduction negatively influenced FCR throughout the
experiment as the NC fed broilers exhibited an increase \((P < 0.05)\) in FCR during all stages of production compared with the PC fed broilers resulting in an increase \((P = 0.01)\) in cumulative FCR at d 35 of age. Inclusion of the NSPase decreased \((P < 0.05)\) FCR during the starter and finisher phases of production along with cumulatively through 35 d of age. These data demonstrate that NSPase inclusion can be utilized in broilers with a short growth period as evidence by improvements in feed efficiency.

**Key Words:** energy, broiler, enzyme, performance

---

**430P Carbohydrases in poultry diets on ileal digestibility of nutrients.** Jomara Broch*,1, Ricardo Nunes1, Cinthia Eynge1, Wagner Silva1, Idiana Silva1, Marina Susin1, Gabriela Sangalli1, and Paulo Pozza1, *Universidade Estadual do Oeste do Paraná, Paraná, GA, 2Universidade Estadual do Oeste do Paraná - UNIOESTE, Marechal Cândido Rondon, Paraná, Brazil, 3Safeeds, Cascavel, Paraná, Brazil, 4Universidade Estadual de Maringá, Maringá, Brazil.

The addition of enzymes in poultry diets has been an alternative to increase the digestibility of feed nutrients, the carbohydrases (CHO) are an important group of enzymes for this purpose, becoming important the development of researches to evaluate these new CHO mixes. In this study the effect of different levels of new CHO inclusions in broiler diets was evaluated from 36 to 42 d of age. A total of 960 one-day-old chicks were randomly distributed in 6 treatments and 8 replicates. The treatments were: T1 - Positive Control (PC); T2 Negative Control (NC) reduction in 150 kcal·kg·1; T3-NC added 40·ton·1 CHO; T4 - NC added 80·ton·1 CHO; T5NC added 120·ton·1 of CHO; and T6-NC added 160·ton·1 CHO. To evaluate the nutrient digestibility, Celite was used as indicator. Data were subjected to ANOVA and mean values were compared with PC and inclusion levels of CHO were analyzed by polynomial regression \((P < 0.05)\). The dry matter (DM) presented a linear effect \((P < 0.05)\) improving the feed digestibility with CHO inclusion. The digestibility of the crude protein (CP) in the diets with NC and CHO did not differ from the PC diet, however, they showed a quadratic effect \((P < 0.05)\), and the highest protein digestibility occurred with CHO inclusion. For CE only the NC treatment presented similar to PC. The use of CHO in termination feed with energy reduction provided a better use of the CE of the diets, showing higher linear effect \((P < 0.05)\). These results were confirmed by the quadratic effect \((P < 0.05)\) observed in the neutral detergent fiber (NDF) and hemicellulose digestibility coefficients, which presented maximum digestibility with the inclusion of 55.52 and 60.34 g/ton of CHO, respectively. The action of the CHO is directly linked to the digestion of structural carbohydrates (NDF and hemicellulose), resulting in an extra caloric improvement to the birds and consequently better nutrient utilization and superior performance. The inclusion of CHO provided an improvement in the nutrient digestibility of the rations evaluated, however the choice of dosage should be evaluated economically.

**Key Words:** digestibility, carbohydrase, enzyme, protein, energy

---

**431P Effects of pellet temperature and inclusion of a non-starch polysaccharide degrading enzyme on broiler performance and nutrient digestibility.** Hunter Walters*,1, Austin Jasek1, Nathan Augspurger2, and Jason Lee1, *Texas A&M University, College Station, TX, 2JBS United, Sheridan, IN.

The objective of the current experiment was to evaluate the impact of increasing pelleting temperatures and the inclusion of a non-starch polysaccharide degrading enzyme (NSPase) in diets fed to male broilers on growth performance and nutrient digestibility. The experiment was a completely randomized block design with a total of 2,250 male broilers being assigned to 6 diets consisting of 15 replicates per treatment with 25 broilers per replicate. A 3 × 2 factorial design was used with conditioning temperature levels being 80, 85, and 90°C with a 12 s conditioning time with and without the inclusion of NSPase. One basal diet was mixed and divided into dietary treatments depending on NSPase inclusion and pelleting temperature. Broilers were fed a starter (d 1–14), grower (d 15–28), and finisher (d 29–42). Average body weight (BW), mortality adjusted feed conversion ratio (FCR), and feed consumption were determined on d 14, 28, and 42. On d 14 and 42, 5 and 3 birds, respectively, were euthanized and ileal contents collected (pooled within replicate) for determination of ileal digestibility of energy (IDE) and nitrogen (IDN). Data were analyzed via a 3 × 2 factorial ANOVA with main effect means being deemed significantly different at \(P \leq 0.05\). Inclusion of NSPase increased \((P = 0.017)\) final BW by 66 g on d 42 while also reducing \((P = 0.032)\) FCR during the finisher phase \((1.911 \pm 1.962)\). Increasing pelleting temperature resulted in an increase \((P = 0.01)\) in FCR during the grower phase \((1.588 \pm 1.587 \pm 1.622)\). For ileal digestibility, a significant interaction was present between pelleting temperature and enzyme on d 14 for both IDE and IDN as NSPase effect was more pronounced at the lower temperature. On d 42, NSPase inclusion as well as increasing pelleting temperature improved \((P < 0.05)\) IDE and IDN. These data demonstrate the benefit of NSPase inclusion on nutrient digestibility and growth performance without the negative impact of increasing pelleting temperature.

**Key Words:** broiler, NSPase, performance, digestibility, pellet temperature

---

**432P Evaluation of a multicarbohydrase in broilers diets.** Lucio Araújo*,1, Márcio Ceccantini2, Cristiane Araújo1, Fabricia Roque1, Brunna García de Souza Leite1, Yasmin Sartore1, Naiara Fagundes2, and Adriana Toscan2, *University of São Paulo, Pirassununga, São Paulo, Brazil, 2Adisseo Brazil, São Paulo, SP, Brazil.

The aim of this trial was to evaluate the use of a multicarbohydrase enzyme on broilers diets from 1 to 42 d of age. A total of 840 d-old male Cobb broilers were allocated in a completely randomized design in 5 experimental treatments \(T1 - \) positive control diet, \(T2 - \) negative control diet 1: positive control diet with a reduction of 50 kcal AME/kg and 2% digestible AA; \(T3 - \) Negative control diet 2: positive control diet with a reduction of 50 kcal AME/kg and 4% digestible AA; \(T4 - \) Negative control diet 1 + multicarbohydrase; \(T5 - \) Negative control diet 2 + multicarbohydrase), with 14 replicates of 12 birds/replicate. The diets were formulated with corn, soybean meal, and phytase, and supplied ad libitum in 5 periods \((1 \to 7, 8 \to 21, 22 \to 28, 29 \to 35, \text{and} \ 36 \to 42)\). Enzymatic activities and AA levels (by HPLC) in the diets were analyzed. Body weight, body weight gain, feed intake, feed conversion ratio and mortality were evaluated. An economic evaluation of the use of different diets was also carried out. Data were submitted to ANOVA and the means were compared by the Tukey test with significance at 5%. The results showed that the reduction of energy and digestible AA resulted in a decrease on body weight \((P = 0.0116)\) and body weight gain \((P = 0.0120)\). However, feed intake, feed conversion ratio and mortality were not influenced by treatments. Also, the multicarbohydrase enzyme supplementation recovered the broilers performance parameters, reaching the standards performance of positive control, demonstrating that the negative control + multicarbohydrase showed the best economic benefits, reducing average cost with feed to produce 1 Ton of meat by US$ 10.44. In conclusion, the treatment using diet reduced in 50 kcal AME/kg and
2% of digestible AA and multizahydrase included provided equal performance to the Control Positive diet, and the best financial return.

**Key Words:** amino acids, energy, multizahydrase, NSP, xylanase

### 433P Effects of increasing concentrations of corn-expressed non-starch polysaccharide enzyme on broiler performance and ileal nutrient digestibility.

Corey Johnson*1, Austin Jasek1, Jon Broomhead2, Xuemei Li2, and Jason Lee1, 1Texas A&M University, College of Veterinary Medicine and Animal Sciences, College Station, TX, 2AB Vista Feed Ingredients, Marlborough, United Kingdom.

The objective of the current study was to evaluate the effects on increasing corn-expressed non-starch polysaccharide (NSP; mixed function glycosyl hydrolase) enzyme concentrations on male broiler growth performance and ileal nutrient digestibility. A total of 728 broilers were randomly assigned to 7 dietary treatments in a randomized complete block design with each treatment consisting of 12 replicates with 8 Cobb 500 male broilers per replicate. The design included a positive control (PC) representing an industry type starter diet, a reduced energy negative control (NC—less 132 kcal/kg) diet, and 5 additional treatments with increasing NSP enzyme dosing (5, 50, 100, 250, and 500 U glucanase/kg) added to the NC diet. Birds were fed a starter ration for the duration of the study (16d). Average body weight (BW), mortality adjusted feed conversion ratio (FCR), and feed consumption (FC) were determined on 16 d of age. At the conclusion of the experiment, all birds from each replicate pen were necropsied and ileal contents pooled within replicate to determine the ileal digestibility of energy (IDE) and nitrogen coefficient (IDN). All dietary treatments were included in a one-way ANOVA to allow comparison of enzyme inclusion rates to both the PC and NC diets. Additionally, regression analysis was conducted to determine the presence of a linear relationship between enzyme inclusion and evaluated parameters. The inclusion of NSP enzyme at 100 and 250 U glucanase/kg increased (P < 0.01) BW compared with both the PC and NC fed broilers. This elevation in BW was related to an increase (P < 0.01) in FC in these treatments. Reduction of energy in the NC diet decreased (P < 0.01) IDE value of the feed as compared with the PC diet. The addition of NSP enzyme to supply ≥ 100 U glucanase/kg increased (P < 0.01) IDE compared with the NC diet and restored IDE similar (P > 0.05) to the PC diet. Regression analysis confirmed linear increases in ileal digestibility of energy and nitrogen with the addition of NSP enzyme. These data demonstrate that increasing levels of corn-expressed NSP enzyme positively influences nutrient digestibility leading to significant improvements in broiler performance.

**Key Words:** NSP degrading enzyme, NSPase, carbohydrate

### 434P Xylanase supplementation does not affect the cecal short-chain fatty acids concentration of 35-day-old broilers fed corn-based diets.


Exogenous xylanase cleaves arabinoxyylan and may release xylo-oligosaccharides, which can be used as substrate by some gut microflora populations and may result in altered short-chain fatty acids (SCFA) profile in the gut of the chicken. Thus, the effects of dietary xylanase supplementation on performance, cecal pH and cecal SCFA concentrations of 35-d-old broilers were evaluated. A total of 744 d-old male Cobb 500 chicks were randomly assigned in a 2 x 2 factorial design (high or low AMEn x 0 or 100 ppm of endo-1,4-β-xylanase per kg of feed). Each treatment included 6 replicates floor pens with 31 broilers per pen. Diets were based on corn and soybean meal and formulated to contain: High AMEn, 3,025 kcal/kg (1 to 21d) and 3,125 kcal/kg (22 to 35d); or Low AMEn, 2,925 kcal/kg (1 to 21 d) and 3,025 kcal/kg (22 to 35d). At 35 d post-hatch, sampling was carried out on 2 birds per pen and 4 birds per pen for cecal pH and cecal SCFA concentration, respectively. Immediately post euthanasia, a pH electrode was inserted into the cecal lumen for determination of pH by a digital pH meter. Cecal samples from the 4 birds were pooled and analyzed for determination of butyric acid, acetic acid and propionic acid concentrations by gas chromatography. There was no interaction between AMEn level and xylanase supplementation on performance, cecal pH and cecal SCFA concentrations (P > 0.05). Broilers fed diets with high AMEn showed improved bodyweight gain (P < 0.01) and feed conversion ratio (P < 0.01). Cecal pH was reduced by xylanase supplementation (P < 0.05). The cecal butyric acid concentration was higher in broilers fed diets with low AMEn levels. Although not significant, there was a tendency (P = 0.07) to higher concentration of total SCFA in ceca of broilers fed diets with low AMEn levels. In summary, xylanase supplementation in corn-based diets does not affect the growth performance and the cecal SCFA profile, but reduces the pH of cecal digesta of 35-d-old broilers.

**Key Words:** broiler, NSP enzyme, performance, digestible energy

### 435P Effect of xylanase on growth performance and cecal short-chain fatty acid production in broilers fed different levels of fiber.

Amit Singh*1, Ryoosuke Kida1, Mike Bedford2, and Rajesh Jha1, 1University of Hawaii at Manoa, Honolulu, HI, 2AB Vista Feed Ingredients, Marlborough, United Kingdom.

This study investigated the effect of xylanase supplementation at different levels of fiber on growth performance and cecal short-chain fatty acids (SCFA) production in broiler chickens. A total of 180 day-old chicks (Cobb 500) were randomly and equally distributed over 30 pens (6 birds/pen). Six dietary treatments were tested using a completely randomized design in a 3 x 2 factorial arrangement (5 pens/treatment). The treatments included 3 levels (0%, 5% and 10%) of wheat bran (WB) as an additional fiber source, supplemented without or with xylanase (0.01% Econase XT) and fed in 2 phases (starter, d 0–21 and finisher, d 22–35). All diets were corn and soybean meal based containing 500 FTU/kg phytase and were offered in mash form ad libitum with free access to water. Xylanase supplementation significantly (P < 0.05) increased average daily gain in the finisher phase and over the whole trial and increased (P < 0.05) average total gain in broilers (2025 vs 1943 g). Broilers fed the xylanase also had improved (P < 0.01) feed conversion ratio (FCR) in the starter phase. A significant interaction (P < 0.05) was found between WB and xylanase on FCR in finisher phase and in total period. The interaction displays that high fiber diets were more responsive to supplemental xylanase and thus showed higher improvement in FCR compared with 0% WB group. Xylanase significantly increased (P < 0.01) total cecal SCFA (86.6 vs 63.4 µmol/g) with significant increase (P < 0.01) in straight chain SCFA. Besides increasing total SCFA, xylanase also shifted the production of SCFA from acetate to more propionate and butyrate production. Unlike the effect on FCR, xylanase increased total SCFA production independent of diet type, suggesting some differences in hydrolysis of soluble and insoluble non-starch polysaccharides during digestion and cecal fermentation. It is concluded that xylanase can enhance growth performance and health of broilers by improving feed efficiency, and that some but not all of this response is related to increasing cecal SCFA production in broilers.
A 16-week laying hen trial utilizing 784 Hy-Line W-36 white leghorn hens was conducted to determine the efficacy of adding a corn-expressed phytase (CEP) to corn-soybean meal diets. Eight dietary treatments were fed to 7 replicates of 14 hens per treatment. Diet 1 was a highly P-deficient diet calculated to contain 0.12% available P (aP). Diet 2 was as Diet 1 plus 500 FTU/kg of the CEP, Diet 3 was as Diet 1 plus 3000 FTU/kg of CEP, and Diet 4 was as Diet 1 plus 5000 FTU/kg of a commercially available phytase. Diet 5 was a marginally P-deficient diet containing 0.35% aP. Diet 6 was as Diet 5 plus 500 FTU/kg of the CEP, and Diet 7 was as Diet 5 plus 3000 units/kg of CEP. Diet 8 was a positive control diet calculated to contain 0.45% aP. The diets were provided for ad libitum consumption. The hens started on treatment diets at 31 weeks of age and average starting body weight as 1506 g/hen. Hen-day egg production, feed consumption, feed efficiency (g egg/g feed), egg weights, and egg mass were recorded in 2-week periods. Data were statistically analyzed as a complete randomized design. After week 6 of the trial (37 weeks of age), feed consumption was approximately 100g per hen per day. Egg weights and feed efficiency were not significantly affected (P > 0.05) by treatment, except for hens fed Diet 1 having a higher feed efficiency (P < 0.05) compared with all other treatments for the first 2-week period. Hens fed Diet 1, the highly P-deficient negative control diet, had the lowest numerical egg production and egg mass after Week 4. A single degree of freedom contrast between Diet 1 and all other diets showed that egg production was significantly lower (P < 0.05) for Diet 1 during periods ending on wk 10, 12, 14, and 16. Egg mass was also significantly decreased (P < 0.05) for Diet 1 in contrast to all other treatments for periods ending on wk 10, 12, and 16. Egg production was statistically similar (P > 0.05) among birds fed Diets 2–8 for the entire trial. No statistical differences (P > 0.05) in egg production or egg mass were observed between enzyme dose or products. Results from this trial show that the CEP is efficacious for increasing egg production and egg mass when supplemented to a highly P-deficient corn-soybean meal diet for laying hens.

Key Words: phytase, available P, laying hen
Diet-fed birds are composed mainly of foods of plant origin, seeds or seed products contain around 60 to 80% of phosphorus in the form of phytate, which corresponds to the unavailable phosphorus of plants. In such circumstances, the exogenous enzymes may be beneficial, complementing those enzymes that are present in the digestive tract, at an effective level and/or providing the hydrolytic capacity which is totally absent. The main goal of this study was to evaluate the extra-phosphoric effect of superdosing on performance of broilers from 1 to 42 d old. Nine hundred twenty broiler chicks were assigned in a complete randomized design to 5 treatments (T1: positive control (PC) without phytase; T2: negative control (NC) (reduction of 0.12% Ca and 0.14% of P available); T3: NC + 1000 FTY/kg (RONOZYME HiPhos GT 100 ppm); T4: NC + 2000 FTY/kg (RONOZYME HiPhos GT 200 ppm); T5: NC + 3000 FTY/kg RONOZYME HiPhos GT 300 ppm). The variables analyzed were weight gain (WG), feed intake (FI) and feed:gain (FG). The data were submitted to ANOVA to compare means by Tukey (P < 0.05), and subsequent regression analysis excluding T1 (0% phytase). The WG showed a quadratic (P < 0.05) response (WG = 2417.70 + 0.226123*PHYTASE -0.0000551180*PHYTASE²; R² = 0.52), estimating a value of 2650g of WG when using the level of 2051.3 FTY of phytase. The same occurred to FI (FI = 4224.78 + 0.227149*PHYTASE E0,0000556494*PHYTASE² (R² = 0.32), estimating a value of 4445.67g of FI when using the level of 1992.4 FTY, of phytase, and to FG (FG = 1,75649-0.000122340*PHYTASE+0.0000000291141*PHYTASE² (R² = 0.52) estimating a value of 1,627 of FG when using the level of 2101.04 FTY/kg. At 42 d of age, the phytase inclusion increased chicken performance remained similar to PC. The best phytase level from 1 to 42 d of age was around 2000 FTY/kg of diet.

Key Words: exogenous enzyme, nutrition, performance, poultry, phosphor

440P Addition of exogenous protease improves the weight gain of broiler chickens. Everton Krabbe*,1, Ednilse Gopinger*, Diego Surek1, and Valdir Avila1, 1Brazilian Agricultural Research Corporation-Embrapa Swine and Poultry, Concordia, Santa Catarina, Brazil, 2Animal Science, Postdoctoral Fellow at National Council for Scientific and Technological Development (CNPq), Concordia, Brazil.

Commercial enzymes (proteases) present chemical and efficiency characteristics according to their production method, it is important to know their efficiency and interaction with raw material composition used in the diets. The objective of this study was to evaluate the effect of a protease enzyme in broilers diets on performance. A total of 1170 d-old Cobb 500 male chicks were used in floor pens containing new wood shavings as litter. Tubular feeders and nipple drinkers were used. Throughout the experimental period (1–21 d), the birds received ration and water ad libitum. The birds were distributed in a randomized block design according to the initial weight, with 3 treatments and 13 replications, totaling 39 experimental units, each pen being an experimental unit with 30 birds. The protease enzyme was analyzed to contain 1 000 000 CPU / kg. Treatments consisted of T1 - standard diet meeting bird nutritional requirements without enzyme, T2 - similar as T1 with addition of protease enzyme (125 g/ton top dress), and T3 - diet formulated according nutritional adjustment as recommended by protease manufacturer (−25 kcal/kg of ME; −0.05% Threonine, −0.04% lysine, −0.05% methionine, −0.10% crude protein) with addition of the protease enzyme (125 g/ton). All diets were pelleted and crumbled according to bird development phase: pre-starter (1 to 7 d) and starter (8 to 21 d). Average body weight, daily weight gain, feed intake and feed conversion ratio were evaluated from 1 to 21 d of age. The data were submitted to ANOVA using SAS (2008). The means comparisons were performed by the Tukey test at 5% significance level. There was no significant effect of the addition of the protease enzyme on feed intake and feed conversion ratio responses. However, it was observed that birds fed diets containing protease (top dress or following nutritional adjustments) presented higher average body weight and daily weight gain in comparison to birds fed the standard diet without enzyme.

Key Words: enzyme, weight gain, feed conversion, poultry

441P Effect of a protease on performance and intestinal health of broiler chickens fed a standard diet or a low-density diet. Mari-ana Lemos de Mores*,1, Kátia M. Cardinal2, Ines Andretta2, Elizabeth Santin3, Derek Detzler1, Ludovic Lahaye1, and Andrea Machado Leal Ribeiro4,1Jefo Nutrition Inc., Porto Alegre, RS, Brazil, 2Federal University of Rio Grande do Sul, Porto Alegre, Brazil, 3Federal University of Paraná, Curitiba, Brazil.

We evaluated the effect of a protease when supplemented on top of a standard diet with or low-density diet on the performance and intestinal health of broiler chickens. Male Cobb chicks (392; 1–42d) were reared in floor pens and allocated in a completely randomized design in a 2×2 factorial with 7 replicates. There were 2 feed formulations: a standard diet (STD) based on the nutritional recommendations of the Brazilian Tables for Poultry and Swine (Rostagno et al., 2011) and a low-density diet (LDD), with 6% reduction in crude protein and main digestible amino acids. The 2 diets were either supplemented (+P) or not (-P) with a protease (PoultryGrow 250 at 125 g/l). The performance was evaluated by feeding period (1–7, 7–21, 21–35 and 35–42d). At d 28, samples of ileum of one bird/replicate were analyzed by a morphometric index for histological alterations (1 See Inside Scoring System - ISI). There was no interaction between factors and no differences between the treatments were observed in the 1–7d period. In general, for all the other periods, birds fed the LDD-P were lighter and/or had poorer feed conversion ratio FCR when compared with all other treatments (P < 0.05). However, the supplementation with the protease on the LDD was able to affect positively body weight gain (BWG) and FCR (P < 0.5) and to promote a performance similar to the birds fed the STD-P. At 42d, the birds on the STD+P were the heaviest (124g difference to STD-P, FCR = 0.1) and presented the same FCR of the STD-P and LDD+P groups while being 13 points lower (P < 0.001) than the LDD-P group. Regarding the gut health analysis, the birds supplemented with the protease presented the best ISI morphological index (P = 0.06) mainly as a result of the lower number of alterations regarding lamina propria and epithelial thickness and enterocytes proliferation. In conclusion, the protease tested improved performance and intestinal health indicators of broiler chickens when supplemented on top of a standard diet or with a low-density diet.

Key Words: broiler chicken, intestinal heath, histology, performance, protease

442P True content of digestible amino acids from different sources associated with exogenous enzymes for broilers at 7 days of age. Bruno Fortes*,1, Marcos Caçà2, José Henrique Stringhini2, Júlio César Carvalho3, Jerônimo Brito4, and Thony Carvalho5,
The use of animal ingredients in broiler diets based on ideal protein concept, as an alternative to corn and soybean, becomes more efficient, as the highest cost of these diets comes from amino acid supply. In this way, an experiment was proposed to determine the true digestibility coefficients of amino acids of corn gluten meal (60%), soybean protein concentrate, bovine dried plasma and viscera meal. A total of 360 male day-old Cobb 500 chicks were randomly allotted in battery cages in a completely randomized design with 9 treatments and 5 replicates of 8 birds each and adapted to experimental diets for 5 d. The pre-starter diets tested were: a control protein-free diet (DFP) and 8 diets with tested feedstuffs + DFP with and without the addition of enzymatic complex (AXTRA - 2000 U xylanase/kg, 200 U amylase/kg, and 4000 U protease/kg). After this period, all birds of each replicate were slaughtered to collect the ileum contents. No difference (\( P > 0.05 \)) was observed for the true digestibility coefficient of essential and non-essential amino acids at 21 d of age. The true digestibility coefficient of essential amino acids were respectively for diets with or without the enzyme complex inclusion, 91.03% and 93.13% for corn gluten meal 60%; 94.72% and 95.12% for soybean protein concentrate; 94.20% and 94.71% for bovine dried plasma; 80.84% and 82.38% for the viscera meal. The results for the non-essential amino acids showed that the true digestibility coefficients were respectively for diets with or without the enzyme complex inclusion 91.06% and 93.49%; 93.08% and 93.25%; 93.75% and 95.35%; 77.35% and 80.03%, for corn gluten meal 60%; soy protein concentrate; blood plasma and viscera meal. It is possible to conclude that the enzymatic complex AXTRA wasn’t effective in the digestibility of amino acids, regardless of the ingredients.

Key Words: amino acids, broilers, enzymatic complex, protein ingredients, starter phase

444P Effects of dietary protease on productive performance and egg quality in aged laying hens raised under hot climate conditions. Gi Ppeum Han*, Tae-Sung Yang, Do Yoon Koo, Ji Eun Shin, Franco Ptiargue, and Dong Yong Kil, Chung-Ang University, Anseong, Gyeonggi-do, Korea.

This experiment was conducted to investigate the effect of dietary protease on productive performance and egg quality in aged laying hens raised under hot climatic conditions. A total of 240 82-week-old Hy-Line Brown laying hens were used and allotted to 3 treatments with 8 replicates in a completely randomized design. Each replicates consisted of 5 consecutive cages with 2 hens per cage. Three dietary treatments included (1) positive control diet containing 17% CP (PC), (2) negative control diet containing 15% CP (NC), and (3) NC diet supplemented with 0.0125% protease (PT, PT125, Jefo Nutrition Inc., Canada). All hens had free access to the diet for 6 weeks and were provided with a 16L:8D photoperiod. The average temperature and humidity were 26.4 ± 2.6°C and 73.1 ± 4.2% during the experiment. Hen-day egg production, egg weight, and egg mass were recorded daily, whereas feed intake (FI) and feed conversion ratio (FCR) were recorded weekly. At the end of the experiment, 5 eggs per replicate were randomly collected to measure egg quality. All date were analyzed using the PROC Mixed procedure in SAS. The LSMEANS procedure was used to calculate treatment means and the PDIFF option was used to separate the means. Results indicated that hen-day egg production, egg mass, FI, and FCR were not affected by dietary treatments. However, egg weight was greater (\( P < 0.05 \)) for PC treatment (69.8 g) than NC treatment (67.9 g), but PT treatment had intermediate egg weight (68.7 g) with no significant difference as compared with PC and NC treatment groups. Egg quality, including eggshell strength, eggshell thickness, eggshell color, and haugh unit, was not affected by dietary treatments. However, egg yolk color for PC treatment was greater (\( P < 0.05 \)) than NC and PT treatment groups. In conclusion, the diet containing 15% CP decreases egg weight and egg yolk color, but addition of dietary protease partly compensates for egg weight reduction in aged laying hens raised under hot climatic conditions.

Key Words: aged laying hen, dietary protease, egg quality, performance, hot climatic condition

445P Effect of keratinase addition on starter diets containing trypsin inhibitors on the productive performance and intestinal health of broilers. Joice Schmidt, Heloisa Fialkowski Bordignon*, Adrieli Braga de Cristo, Alexandra Silva, Jonas Rodrigo Layter, and
Protease inhibitors are capable of complexing with endogenous proteolytic enzymes, blocking its activity and impairing the digestion of diet proteins. The addition of keratinase may represent a tool with great potential for inactivation of the anti-nutritional factors present in soybean meal. Microbial keratinases have the ability to degrade resistant proteins, which have cysteine disulfide bonds as the protease inhibitors. The aim was to evaluate the effect of keratinase addition on diets containing trypsin inhibitors on the productive performance and intestinal health of broilers from 1 to 21 d of age. One thousand two hundred eighty male chicks were distributed in a design of 2 × 2 factorial scheme (with and without raw soybean replacing deactivated soybean X with and without keratinase). Raw soybean or deactivated soybean inclusion was 2%. The protease was added in the diets at a dose of 250 g/ton. Samples of deactivated and raw soybean and soybean meal were analyzed. The calculated values of trypsin inhibitors and urease, considering the soybean meal mixture (soybean meal + deactivated soybean) were 4.29 mg/g and 0.02 pH units, respectively and for the soybean meal mixture (soybean meal + raw soybean) were 5.39 mg/g and 0.15 pH units, respectively. At 21 d of age, fragments of duodenum, jejunum and ileum were collected for histomorphometry and goblet cell counting. At this age, it was also performed the macroscopic and microscopic evaluation of the ileum through the morphometric index “I See Inside” (ISI) and then compared with the Kruskal–Wallis test. In the first week, the protease supplementation showed higher \( P < 0.05 \) weight gain and the raw soybean addition worst \( P < 0.05 \) feed conversion ratio. Birds that received the diet with raw soybean showed lower \( P < 0.05 \) V:C ratio and higher \( P < 0.05 \) number of crypts per villi. Besides, the association of deactivated soybean and the keratinase resulted in a lower \( P < 0.05 \) absorption area. For intestinal evaluation, the inclusion of raw soybean showed higher inflammation of the ileum. However, the use of keratinase provided a decrease of the ISI scores at 21 d, improving intestinal quality. The enzyme improved the productive performance at 7 d of age and the intestinal integrity in the early stage as well.

**Key Words:** feed conversion ratio, histomorphometry, keratinase, protease inhibitors, soybean meal