Broilers in a hot environment decrease their feed intake and growth. Uric acid formation from amino acids in excess of optimal balance generates heat. Presumably, adding limiting essential amino acids (EAA) beyond requirement levels but proportioned for total balance enables an increase in effective protein which could compensate for reduced feed intake while decreasing heat generation. A total of 400 male and 400 female broilers Ross x Avian 24K was reared sex separate to 7 weeks of age in a commercial type commercial type feeding regimen was fed either “as is” or supplemented with limiting EAA to assure at least 110% of the requirements that approximated an ideal pattern. Environmental conditions existing from May-June were sufficiently hot to depress performance but not cause related deaths. Increasing the levels of EAA and balance within existing crude protein and ME did alter live performance throughout experimentation. Measurement of abdominal fat after birds were processed indicated a significant increase with the carcasses of both sexes when the 110% level of EAA was employed. Carcass yield without abdominal fat, incidence of grade defects, and recovery of deboned breast meat were similar between treatments, respective of sex. Improved amount and balance of effective protein together with reduced excretion of N likely increased dietary productive energy with its conversion to depot fat, but no advantage to live performance was perceived.

**Key Words:** Broilers, Carcass Characteristics, Heat Stress, Limiting Essential Amino Acids.

**668 Reduced lysine and threonine levels in a phase-feeding regimen can support maximum growth performance during the grower phase.** J.A. Townsend*, H.R. Pope, and J.L. Emmert, University of Arkansas.

Phase-feeding (PF) has been explored as a means of reducing feed costs without reducing growth performance. Predicted amino acid requirements for PF are generated using linear regression equations derived from estimates of lysine (Lys), sulfur amino acid (SAA) and threonine (Thr) requirements. The objective of this study was to determine if growth performance would be impacted by reduced levels of lysine and threonine in a PF regimen relative to birds fed NRC recommendations. In addition to NRC (Treatment 1) and unmodified PF (Treatment 2) regimens, four modified PF treatments were tested. In two modified PF treatments, Lys was increased (Treatment 3) and Thr (Treatment 5) requirements were reduced by 10%, whereas in the remaining modified PF treatments the slopes of the linear regression equations used to predict Lys (Treatment 4) and Thr (Treatment 6) requirements were increased by 15%. The six dietary treatments were administered from 3-6 weeks of age. The NRC diet was fed throughout the entire experiment, whereas treatments 2, 3, 4, 5, and 6 were tested in a series of 3 diets (21-28, 28-35, and 35-42 d). Despite a reduction in Lys and Thr levels in treatments 4, 5, and 6, no differences (P > 0.05) in weight gain, feed intake and feed efficiency were detected among treatments at 42 d. Relative to treatments 1 and 2, digestible Lys intake was reduced (P < 0.05) by treatment 3 and digestible Thr intake was reduced (P < 0.05) by treatments 5 and 6. Breast yield was not reduced (P > 0.05) in treatments 3, 4, 5 and 6 relative to treatments 1 or 2, however abdominal fat percentage was increased (P < 0.05) by treatment 3. These data indicate that despite a substantial reduction in Lys and Thr levels, growth performance of birds fed these PF regimens was not different than birds fed NRC recommendations. Because dietary lysine, SAA, and Thr levels are decreased under PF systems, substantial dietary cost savings may be available.

**Key Words:** Broiler, Phase-feeding, Amino Acids

**688 Growth and carcass response of male broilers to two commercial sources of supplemental L-lysine.** ME Jackson*,1 A. Lemme*,1 JL Emmert*,1 and HR Pope*,2 Degussa Huls Corporation, Kennesaw GA, 2University of Arkansas, Fayetteville, AR.

Biolyse® 60 is a new form of lysine containing 47.3% L-lysine (46.8% free plus 0.5% protein-bound L-lysine) plus additional energy and nutrients from the biomass, including 0.2% phosphorus, 0.3% Met-Cys, 0.5% Thr, and 0.15% Trp. Biolyse® 60 is produced by microbial fermentation of Corynebacterium glutamicum, and the lysine substitution value is calculated as 60% of the value of L-lysine-HCl. A 49-d floor pen trial with 1890 male Ross X Cobb broilers, 54 floor pens, and 35 birds/pen was conducted to determine responses to 2 forms of supplemental lysine. Starter and grower series of corn/soybean meal/corn gluten meal-based diets were provided from 0-21 and 22-49d. Nine isonitrogenous dietary treatments (x 6 replicates) included a non-supplemented control and 4 levels of added lysine from the 2 sources. Starter and grower basal diets contained 20.72 and 17.56% CP and 0.83 and 0.62% Lys, respectively. L-lysine was added at 0.08, 0.16, 0.24% and (0.42% starter, 0.30% grower) from each source. Birds responded to both lysine sources with 0.49 d gain ranging from 1466 g (no supplementation) to 2811 g (highest supplementations) (P<0.01), feed:gain ratio (FCR) decreasing from 3.10 to 2.10 (P<0.01), and breast yield increasing from 17 to 27% of carcass weight (P<0.01). Experimental data were subjected to non-linear exponential regression analysis. This permits the evaluation of the complete response curve to graded levels of a limiting amino acid. The data fitted well to predicted values with r-square values ranging from 0.90 to 0.99 for the measured criteria. The calculated relative effectiveness of Biolyse® 60 compared to L-lysine-HCl was 110 and 104% for weight gain and breast yield, respectively. Both values were not significantly different from 100%. It is concluded that Biolyse® 60 is at least equal to L-lysine-HCl in eliciting performance responses in broiler chickens.

**Key Words:** Lysine Sources, Broilers, Breast Yield

**687 Evaluation of Amino Acid Dose-Response Data and Implications for Commercial Formulation of Broiler Diets.** D. Hoehler*, S. Mack, and M. Pack, Degussa-Huels Corporation, Kennesaw, GA.

Many of the performance indicators of a modern integrated broiler enterprise, such as feed cost per ton, serve to de-link the operation into discrete business units. This disintegrative management does not necessarily lead to the best overall profit. In the present study, case scenarios are drafted for two different production goals minimum feed cost per kg live weight gain or minimum feed cost per kg breast meat, which comprise the whole production chain. The amino acids lysine and Met+Cys are used as variable factors, because their dietary concentration has a large effect on several efficiency measures of an integrated operation. Actual production data of 9 dose-response experiments for Met+Cys and another 5 with lysine were combined with cost figures for feed and supplemented amino acids. Data covered the grower/finisher period of commercial broiler strains. The relative response in performance between the lowest and highest levels of lysine or Met+Cys was similar, which offered the opportunity to pool all dose-response data after transforming them to a relative scale. Data were then subjected to exponential regression analysis. The best performance as described by the maximum of the regression curve was set at 100%. Subsequently, relative performance data were transformed back to absolute values by setting the desired optimum performance at 100%. Under the given conditions, feed cost per kg live weight gain reached a minimum at dietary concentrations of 0.90% Met+Cys and 1.03% lysine. The response in feed cost per kg breast meat to rising amino acid levels is not only affected by the feed to gain ratio, but also by the increasing breast meat yield as percentage of live weight. This extra benefit shifted the optimum dietary Met+Cys and lysine concentration to 0.98% and 1.16%, respectively. Price changes for raw materials or amino acids only slightly shifted the economic optimum level for the respective amino acid. This approach may well be extended to other nutrients and can serve as a general tool to determine dietary specifications in a meaningful way.

**Key Words:** Broiler, Dose-Response, Economics

**686 Extended supplementation of limiting amino acids to increase effective dietary protein and improve production of heat stressed broilers.** A. J. Zarate*, E. T. Moran, Jr.*, and D. J. Burnham*, 1Poultry Science Department, Auburn University, Auburn, AL 36849, 2Heartland Lyseine Inc. Chicago, IL 60631.

The broiler industry changes feed at intervals that differ from those on which NRC recommendations are based. A study was conducted to examine the response of broilers to diets formulated to contain different levels of Lys and Met when diets were changed at intervals on which NRC recommendations are made (0 to 21 d for starter; 21 to 42 d for...
low-protein diet critically deserve research attention, and we hypothesized that supplemental dietary antibiotics might be useful. 5-week old broilers were fed for 4 weeks on diets containing 16% crude protein (CP) and 80% of the recommended methionine and lysine without or with penicillin, streptomycin, tylosin, and zinc bacitracin added separately, for 20% CP and adequate amino acids. Antibiotic-fed broilers enhanced (P<0.05) their feed intakes; feed conversion correlated with dietary CP and was similar in all broilers fed 16% CP. The body weights, carcass and breast yields of antibiotic-fed broilers were heavier (P<0.05) than those fed unsupplemented diet, compared with those fed 18% CP, but lower than those fed the 20% CP. Adiposomal fat of antibiotic-fed broilers was smaller (P<0.05) than those fed unsupplemented 16 and 20% CP, which were inexplicably similar. Antibiotic-fed broilers had bigger (P<0.05) lymphoid organs: spleen and bursa of fabricious; longer (P<0.05) intestines and smaller (P<0.05) gizzards than broilers fed unsupplemented 16% CP though gizzard weights were generally heavier on all the 16% groups irrespective of the supplements. The implication of the comparable productive indices obtained on low-protein antibiotic-fed broilers suggests improved, economical and environmentally friendly feeding program with feasible adoption in finishing broiler nutrition barring no restrictions to antibiotic use in animal feeds.

Key Words: Supplemental Antibiotics, Sub-optimal Dietary Protein and Amino Acids, Finishing Broilers


A trial was conducted to study the influence of heat processing (HP) of cereals, and enzyme supplementation (ES) on digestibility of nutrients of broilers from 0 to 21 d. There were 8 treatments arranged factorially, with two basal cereals (corn vs barley), two processing treatments (raw vs cooked for 1 h at 103°C and 19% moisture), and two levels of ES (0 vs 500ppm). The enzyme complex contained 20,000 TLXU of xylanases, 9000 EAU of α-amylases, and 19,000 PU of proteases per kg. Each treatment was replicated 5 times (16 Cobb chicks per cage). The apparent fecal digestibility (AFD) of organic matter (OM), crude protein (CP), ether extract (EE), and neutral detergent fiber (NDF) was measured at 4, 8, 15, and 21 d of age. Digestibility of nutrients varied with time for all treatments (P<0.05). Heat processing improved AFD of OM, CP, and NDF until 8d of age (58.6 vs 62.1%, 45.5 vs 47.6%, and 22.6 vs 27.5%, respectively; P<0.05), but not thereafter. However, HP increased AFD of EE throughout the trial (54.8 vs 64.3%; P<0.05). Also, HP increased AFD of NDF in barley but not in corn diets (P<0.01), while the opposite occurred for EE (P<0.01). Birds fed barley had lower digestibility coefficient of OM at 8 and 15d (P<0.05) than broilers fed corn diets, but this was reversed after. On the other hand, EE digestibility was greater for barley than for corn diets throughout the trial (P<0.01). Enzyme supplementation improved AFD of OM, CP, and EE for all diets throughout the trial (61.3 vs 64.0%, 46.7 vs 51.1%, and 58.9 vs 63.7%, respectively; P<0.05) but the effect was greater for barley than for corn diets (P<0.05). Enzyme supplementation improved AFD of EE more for HP than for raw cereal diets (P<0.05). It is concluded that nutrient digestibility of broiler chicks was modified by both HP and ES though the beneficial effects of HP were only noticed during the first week of age, and the effect of ES was greater for barley than for corn diets.

Key Words: Heat Processing, Digestibility, Broilers

693 Age and dietary influences on size and fermentation patterns in the gastrointestinal tract (GIT) of broilers fed wheat and corn diets. E. N. Fischer*, E. H. L. Classen1, and M. Chocć, 1University of Saskatchewan, Saskatoon, SK Canada, 2University of New England, Armidale, NSW, Australia.

An experiment was conducted to identify changes in size and bacterial fermentation patterns in broilers (840) fed diets containing corn (C), wheat (W) or wheat supplemented with endoxylanase (E, Avizyme 1300, 0.1%). Birds were sampled for GIT measures and contents were collected weekly for viscosity and volatile fatty acid (VFA) determination. Jejunal viscosity was highest (p<0.05) for the W treatment (trt) at all ages except 7d. Jejunal viscosity was highest in this diet at all ages. Empty jejunal and ileal weights and ileal length were higher (p<0.05) for W and E trts relative to the C trt at most ages. Jejunal content

Key Words: Heat Processing, Digestibility, Broilers
weight also trended higher for W and E trts at most ages (p≤0.001, 35d). Ileal content weights were highest (p≤0.05, 7d) from birds on the W trt to 21d, after which both W and E trts yielded higher content weights than C (p≤0.05, 35d). Empty caecal weights were highest (p≤0.05, 14, 21, 35d; p≤0.10, 42d) from birds on the E trt, while content weight from the C trt trended highest to 21d only. Ileal VFAs were not affected by trt and levels peaked at 14d and declined thereafter. Caecal VFAs from all trts increased steadily to 28d, then declined. Acetate and butyrate accounted for the greatest proportion of total VFAs and were both highest (p≤0.05) in birds from the W and E trts at 21d, while ileal viscosity peaked. Caecal propionate (p≤0.05) and isovalerate (p≤0.10) levels were higher in W and E trts at all ages except 7d. The higher NSP content of the wheat diets likely caused the increased GIT size of the W and E trts. While the NSP in W and E trts are broken down by the caecal bacteria to acetate and butyrate, the C trt resulted in the production of propionate and isovalerate. The latter finding suggests that undigested starch and protein from corn enter the caeca and are being fermented by bacteria in this location.

**Key Words:** Non-starch polysaccharides, Volatile fatty acids, Bacterial fermentation

694 Live performance, caloric efficiency, carcass characteristics, and cost/gain of broiler chickens fed corn-soy-poultry byproduct diets with or without the enzyme Rovabio Excel®. Custom starter, grower and finisher corn-soy based diets containing a level of 4% poultry by-product meal were used in each trial. The studies were similar except for the diets and the levels of test were conducted and the birds were allowed to choose between the diets. The birds were divided into three groups: W (Wheat), E (Enzyme) and C (Control). The enzyme supplement included xylanase, cellulase, phytase and a broad spectrum of other enzyme activities. Body weight gain and feed conversion ratio averaged 2.14, 2.10, 2.17 kg/bird and 1.68, 1.76, 1.66 for PC, NC and NC+Enzyme, respectively. A significant (P<0.05) improvement in broiler chicken performance with enzyme supplementation was further substantiated by the same magnitude of difference in dry matter (71.2, 68.7, 75.1%, energy (AME) (2956, 2827, 3066 kcal/kg), starch (92.5, 90.3, 95.6%), NSP (4.8, 15.0, 36.1%) and phytate (44.3, 37.5, 65.9%) digestibilities. It is evident from this study that the use of wheat screenings in concert with an effective enzyme supplement will allow for cost effective formulation of poultry diets.

**Key Words:** Wheat screenings, Nutritive value, Broiler chicken, Enzyme

697 Apparent metabolizable energy of drought tolerant barley cultivars as affected by enzyme supplementation. G. W. Barbours*, A. H. Darwish1, M. T. Farran2, N. N. Urayran1, M. M. Beck3, H. H. Machlab1, M. G. Uwayjan4, and V. M. Ashkarian2. 1 Agriculture Research Institute, Tel Amara, Beirut, Lebanon, 2American University of Beirut, Beirut, Lebanon, 3Lebanese University, Beirut, Lebanon, 4University of Nebraska, Lincoln, Nebraska.

A chick assay was conducted to study the effect of enzyme supplementation on AAME and AMEs of three drought tolerant barley cultivars ‘Litan’ (L), ‘Pamir-35’ (P), and ‘Bihane-03’ (R). A reference diet containing 55% glucose was prepared. Corn, L, P and R replaced 50% glucose in the experimental diets with 0 or 0.1% Avizyme 1100®. Each diet was fed to 4-d-old Arbor Acres male broiler chicks in four replicates with four birds per replicate. Total fecal collection was made 48 and 96 h post 7-d adaptation period. Soluble non-starch polysaccharide concentration in L, P, and R were 5.8, 5.2, 4.86, and 1.36%, while total β-glucan content was 3.91, 4.32, 3.56, and 0.04% DM, respectively. The AME and AMEs of corn were 3404 and 3944 kcal/kg DM, respectively. There was no significant interaction between barley cultivar and enzyme level. Also no significant cultivar effect was detected and the overall means across enzyme levels of AME were 3226, 3164, and 3191 kcal/kg DM, while those of AMEs were 3094, 3086, and 3088 kcal/kg DM for L, P, and R, respectively. Enzyme addition, however, increased (P<0.05) AME and AMEs means across barley cultivars by

**Key Words:** Broilers, NSP enzymes, Diet composition
283 and 304 kcal/kg DM, respectively. In conclusion, L, P, and R barley cultivars had similar ME values which were improved through enzyme supplementation.

Key Words: Barley cultivars, Enzyme, Apparent metabolizable energy

698 ME-equivalent value of feed enzymes varies with dietary nutrient concentrations for broilers. KEYING Zhang*, Shaoqun Zuo, Zhiyong Ni, and Daiwen Chen, Institute of Animal Nutrition, Sichuan Agricultural University, Yaan, Sichuan 625014, PR. China.

ME-equivalent value (MEV) of feed enzymes is important for the formulation of diets supplemented with enzymes. Whether MEV of an enzyme product is constant or varies with dietary nutrient concentrations (DNC) is not yet known. In this study, a two-factor D-saturated optimization regression design with six treatments was used to measure MEV of a complex feed enzyme product (CFE) in the diets of various DNC for broilers. CFE consisted of amylase (2400U/g), beta-amylose (20000U/g), beta-glucanase (5800U/g), protease (3800U/g), cellulase (1700U/g), xylanase (4600U/g) and pectinase (55000U/g). Basal diet was formulated with corn, soybean meal and extruded soybean to contain on as-fed basis (DM86.9%) ME 12.55 MJ/kg, CP 20%. Ground rice hull was used to dilute the basal diet to formulate diets with 5.0%, 8.0% and 11.5% lower in ME, CP and amino acid contents than basal diet. The doses of CFE in diets ranged from 0% up to 0.25%. 360 1-day-old Avian male broilers were randomly allotted into three treatments with 4 replicates of 15 birds each, and were fed ad libitum until 42 days old. Then 8 birds per treatment were selected for a 4-d metabolism trial, during which excreta were completely collected for measuring nutrient utilizations. Bodyweight gain and feed efficiency were improved quadratically (P<0.01) as DNC increased, and so did the utilizations of dietary energy, protein and dry matter. Performance and nutrient utilizations responded quadratically (P<0.01) to the doses of CFE, and reached peak when CFE dose was 0.1%. ME-equivalent value (MEV) of CFE was calculated by the difference of measured ME of diets with vs. without CFE supplementation at the same DNC. When CFE was included in diets at 0.1%, its MEV was 173, 343, 451 and 586 MJ/kg respectively for the diets of control, and 5%, 8% and 11.5% lower in DNC compared to control. It is concluded that MEV of feed enzymes varies with dietary nutrient concentrations.

Key Words: ME-Equivalent Value, Feed Enzymes, Broilers

699 Effect of fasting versus feeding Oasis® after hatching on nutrient utilization in chicks. A.B. Batal and C.M. Parsons, University of Illinois, Urbana, IL USA.

Two experiments were conducted to determine the effects of fasting, feeding Oasis™, or feeding a corn-soybean meal (SBM) diet immediately after hatching on growth performance, and energy and amino acid utilization of chicks. In each experiment, six pens of eight chicks were assigned to four treatments which were feeding a corn-SBM diet for 21 d immediately after hatching, fasting for 48 h (no feed or water) after hatching, or feeding Oasis™ for 24 or 48 h after hatching. The fasting and feeding Oasis™ treatments were followed by feeding the corn-SBM diet for 21 d. Excreta were collected at 0-2, 3-4, 7, 14, and 21 d on feed for determination of ME and amino acid digestibility. Fasting chicks for 48 h posthatching significantly depressed weight gains compared to all other treatments at 21 d of age. Although weight gains were not significantly different at 48 h posthatching, chicks fed Oasis™ for 48 h had significantly (P<0.05) higher weight gains at 1, 2, and 3 wk of age than did chicks fasted for 48 h. As days on feed increased from three to 21, energy utilization (MEₑ) increased for all the experimental treatments. In addition, the MEₑ of the corn-SBM diet for chicks fed Oasis™ for 24 and 48 h was significantly (P<0.05) higher than for chicks fasted for 48 h at most ages. There were generally no large differences in MEₑ values among other dietary treatments within ages. Digestibility of most amino acids increased with increasing age for all experimental treatments, and the digestibility values were similar among treatments. Our results indicated that fasting Oasis™ (compared to fasting) had a beneficial effect on subsequent energy utilization of a corn-SBM diet and that Oasis™ may be stimulating early gut development even though early growth (0-48 h) is not affected.

Key Words: Oasis™, Age, Chicks

700 The effect of mannanoligosaccharides, bambernycins, and virginiamycin on the physical and microbial characteristics of the gastrointestinal tract of large white male turkeys. C.W. Parks*, J.L. Grimes, and P.R. Ferkert, NC State University, Raleigh, NC USA.

The objectives of this experiment were to investigate the effects of a growth-promoting oligosaccharide and two traditional antibiotics on the physical and microbial attributes of the gastrointestinal tract of male turkeys. Day old Hybrid Large White male pouls were assigned to four dietary treatments: Control, Bio-Mo® (MOS), Bambernycins (BM), and Virginiamycin (VM). There were eight replicate floor pens per treatment with 20 birds per pen reared from 1 to 140 days of age. All data were analyzed using the GLM procedure of SAS (1994). At 12 wks of age, three birds per pen were randomly sampled to measure the following: intestinal section weights, length, density, and mucosal and muscularis weights. Jejunal and cecal digesta samples were taken for ammonia, pH, lactate, volatile fatty acids, and dietary AMEn measurement. Birds fed MOS exhibited no effects on physical parameters while BM resulted in significantly increased duodenal attributes compared to control (P≤0.05). In contrast, feeding VM resulted in significantly decreased duodenal, ileal, cecal, colon weights and decreased duodenal, jejunal, and ileal muscularis weights compared to control (P≤0.05). In comparison to controls, jejunal propionate and total VFA production was decreased in the MOS and BM treatments, respectively. Feeding VM resulted in a significantly increased jejunal pH level and significantly decreased propionate production as compared to control-fed birds (P≤0.05). Dietary AMEn was not significantly affected by treatment. Results suggest that MOS affects the enteric ecosystem by a different mode than antibiotic (BM and VM) growth promotants.

Key Words: Turkey, Mannanoligosaccharide, Antibiotics

701 Effects of ratios of dietary linoleic to linolenic acid on hen performance, mitogenic response, and antibody production of White Leghorn hens against Newcastle disease vaccine. U. Puthongpisarn* and S. Schiedeler1, 1University of Nebraska-Lincoln.

The objective of this study was to investigate the effects of ratio of dietary linoleic to linolenic acid on hen performance, mitogenic response, and antibody production against Newcastle disease (NDV) vaccination in the second phase of the laying cycle. A corn-soybean meal diet was supplemented with flaxseed to have ratios of dietary linoleic to linolenic acid (n:6/n:3) of 17:1 (control), 8:1, or 4:1. Each diet was randomly assigned to 6 replicates with 5 hens/pen. Hy-Line W-36 hens were fed the diets from 53 to 58 wks of age. At the age of 57 wks, hens were boosted with NDV vaccine (Merial Select®; 25–5,000 Pkg/dose). No differences on feed consumption, body weight, egg production, and egg quality were observed throughout the study. The n:6/n:3 ratio did affect mitogenic response and antibody production of hens only after vaccination. Mitogenic response to concanavalin A (Con A) was significantly greater (P<0.02) in hens fed n:6/n:3 of 8:1 (0.742), or 4:1 (0.728) as compared to the control (0.577). Mitogenic response to Salmonella typhimurium lipopolysaccharide (LPS) was greater (P<0.0088) in hens fed n:6/n:3 of 8:1 (1.026), or 4:1 (0.991) as compared to the control (0.899). Dietary decrease in n:6/n:3 induced higher (P<0.0004) antibody production against NDV vaccine measured by an ELISA test. Mortality rate of hens in each treatment was 0% during the study. These results indicate that a decrease in the ratios of dietary linoleic to linolenic acid (n:6/n:3) enhanced mitogenic response and antibody production against the Newcastle disease vaccine, but not performance of White leghorn hens in the second phase of the laying cycle.

Key Words: Ratios of Linoleic to Linolenic Acid, Mitogenic Response, Newcastle Disease Vaccine