

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-amylase (20000U/g), beta-glucanase (5800U/g), protease (3800U/g), cellulase (1700U/g), xylanase (4600U/g) and pectinase (55000U/g). Basal diet

## PSA Nutrition: Early Nutrition, Immunology, and G. I. Function

**699 Effect of fasting versus feeding Oasis<sup>®</sup> 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<sup>TM</sup>, 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<sup>TM</sup> for 24 or 48 h after hatching. The fasting and feeding Oasis<sup>TM</sup> 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 MEn 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<sup>TM</sup> 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 ( $ME_n$ ) increased for all the experimental treatments. In addition, the  $ME_n$  of the corn-SBM diet for chicks fed Oasis<sup>TM</sup> 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  $ME_n$  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 feeding Oasis<sup>TM</sup> (compared to fasting) had a beneficial effect on subsequent energy utilization of a corn-SBM diet and that Oasis<sup>TM</sup> may be stimulating early gut development even though early growth (0-48 h) is not affected.

**Key Words:** Oasis<sup>TM</sup>, Age, Chicks

**700 The effect of mannanoligosaccharides, bambarmycins, 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. Ferket, *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 poult were assigned to four dietary treatments: Control, Bio-Mos<sup>®</sup> (MOS), Bambarmycins (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

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 0.23%. 360 1-d-old Avian male broilers were randomly allotted into the 6 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

ammonia, pH, lactate, volatile fatty acids, and dietary  $AME_N$  measurement. Birds fed MOS exhibited no effects on physical parameters while BM resulted in significantly increased duodenal attributes compared to control ( $P \leq 0.05$ ). In contrast, feeding VM resulted in significantly decreased duodenal, ileal, cecal, colon weights and decreased duodenal, jejunal, and ileal muscularis weights compared to control ( $P \leq 0.05$ ). 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 ( $P \leq 0.05$ ). Dietary  $AME_N$  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, Mannan oligosaccharide, 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. Puthongsiriporn\*<sup>1</sup> and S. Scheideler<sup>1</sup>, <sup>1</sup>*University 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 replicate pens 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<sup>®</sup>; 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 ( $P \leq 0.02$ ) 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 ( $P \leq 0.008$ ) in hens fed n:6/n:3 of 8:1 (1.028), or 4:1 (0.991) as compared to the control (0.899). Dietary decrease in n:6/n:3 induced higher ( $P \leq 0.0004$ ) 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

**702 Effect of dietary xanthophylls on carotenoid content of lymphoid tissues of layer chicks.** E.A. Koutsos\*, C.C. Calvert, and K.C. Klasing, *University of California, Davis; Davis, CA.*

Layer chicks were fed diets ranging from 0 to 48 mg/kg total xanthophyll (xan) to determine the effect of dietary xan on tissue xan concentration. Dietary xan consisted of lutein (lut) and zeaxanthin (zea) (Oroglo Dry) and canthaxanthin (cantha) (Carophyll Red) at a ratio of 1.5:1. After 4 weeks, splenic macrophages, plasma, red blood cells (RBCs), liver, thymus and bursa were analyzed for xan content by HPLC. Neither bursa lut nor zea correlated with dietary xan ( $p=0.79$ ,  $p=0.10$ , respectively); cantha was undetectable. Thymus lut and cantha correlated with diet levels: thymus lut (ug/g) =  $0.06+(0.02*\text{diet lut (ppm)})$  ( $r^2=0.93$ ,  $p<0.001$ ); cantha =  $-0.01+(0.06*\text{diet cantha})$  ( $r^2=0.83$ ,  $p<0.001$ ). Thymus zea tended to be correlated with diet zea ( $p=0.08$ ). Plasma xan correlated with diet: plasma lut (ug/ml) =  $0.03+(0.05*\text{diet lut})$ , ( $r^2=0.83$ ,  $p<0.001$ ); zea =  $-0.02+(0.014*\text{diet zea})$ , ( $r^2=0.69$ ,  $p<0.002$ ); cantha =  $0.02+(0.09*\text{diet cantha})$ , ( $r^2=0.88$ ,  $p<0.001$ ). RBC lut and zea were not correlated with diet xan ( $p=0.16$ ,  $p=0.26$ ); cantha was undetectable. Liver lut correlated with diet: lut (ug/g) =  $0.24+(0.026*\text{diet lut})$ ,  $r^2=0.78$ ,  $p<0.001$ , but liver zea and cantha were not correlated with dietary xan ( $p=0.44$ ,  $p=0.56$ ). Total liver xan related to diet xan by a polynomial relationship: liver xan(ug/g) =  $1.56+(0.13*\text{diet xan})-(0.002*\text{diet xan}^2)$  ( $r^2=0.77$ ,  $p<0.003$ ), suggesting that liver xan plateaued at approximately 20 mg xan/kg diet. Splenic macrophages contained very high levels of lut (avg=34.8 ug/g 9.7) and zea (56.7 ug/g 10.4), and there was no correlation with diet lut or zea ( $p=0.40$ ,  $p=0.42$ ). Macrophage cantha was not detected. This suggests that macrophages, unlike other tissues, may sequester xan from egg yolk, and maintain xan levels regardless of diet. Liver, bursa and RBC xan appear to plateau within the tested dietary range. In contrast, plasma and thymus xan appeared to continue to increase in a linear response to diet xan.

**Key Words:** Xanthophyll, Macrophage, Layer

**703 Fluid therapy of poult infected with turkey corona virus (TCV) and *E. coli*.** L. El-Hadri\*, M. A. Qureshi, J. D. Garlich, P. R. Ferket, and J. S. Guy, *NC State University, Raleigh, NC USA.*

Supplementation of drinking water with electrolytes, glucose, betaine may help sustain poult afflicted with enteric disease. This hypothesis was tested in 2 experiments with poult receiving an oral inoculation containing TCV and *E. coli* at 7 d of age. In trial 1, beginning at 2 d post inoculation (DPI) poult were randomly assigned to one of the 4 treatments: unsupplemented control (C), electrolytes (E), electrolytes + 25 g glucose/l (EHG), electrolytes + 13 g glucose/l (ELG). Mortality was recorded daily and weights of whole body, bursa, and thymus were taken at 7 and 14 DPI. Birds treated with E (99 mOsm), EHG (252 mOsm) and ELG (189 mOsm) gained more weight than controls (0 mOsm) ( $P<0.01$ ). Feed conversion was reduced ( $P<0.002$ ) in all the supplemented water treatments. In comparison to the E and C treatments, EHG and ELG resulted in lower mortality rates (63 and 52% vs 37 and 36%,  $P<0.01$ ), and greater thymus weight (0.106 g and 0.11 g vs 0.195 g and 0.186 g,  $P<0.006$ ) at 7 DPI. Trial 2 tested betaine (B) as an osmotic modulator in therapeutic fluids containing high (HG) and low (LG) glucose concentration, using a 2X3 factorial arrangement of 2 levels of betaine (0 and 300 mg/l) and 3 levels of glucose (0, 13, and 25 g/l). A B X G interaction effect indicated B depressed body weight gain in LG groups (BLG, 231g vs LG, 267 g,  $P<0.05$ ), whereas it had no effect on HG birds (BHG, 187 g vs HG, 162 g,  $P>0.05$ ). Bursa and thymus weights were increased by the G treatments only ( $P<0.003$ ). Fluid consumption at 3 and 4 DPI was increased by G but not B. Although all fluid treatments had some benefit relative to the controls, the greatest reduction in mortality rate was observed when G and B were included in the fluid together (6.5% vs 20%,  $P<0.05$ ). Supplementation of drinking water with electrolytes (99 mOsm) plus glucose (low, 189 mOsm, or high, 251 mOsm) improved survival and immune organ weights of TCV and *E. coli* -infected poult.

**Key Words:** Electrolytes, Glucose, Betaine

**704 Effect of dietary betaine on intestinal leukocyte numbers, osmolality, and morphology during an *Eimeria acervulina* challenge.** K. C. Klasing\*<sup>1</sup>, K. L. Adler<sup>1</sup>, C. C. Calvert<sup>1</sup>, and J. C. Remus<sup>2</sup>, <sup>1</sup>*University of California, Davis, CA*, <sup>2</sup>*Finnfeeds, St. Louis, MO.*

In addition to its methyl-donor activities, betaine is used by cells to defend against hyperosmolarity. We examined relationships between betaine, osmolality (OS), and coccidiosis. Broiler chicks were fed corn-soy diets containing either 0.0, 0.05, or 0.10% betaine (8 pens/diet; 7 chicks/pen) and half were challenged at 14 d with  $4.6 \times 10^4$  oocysts (Cocci). Cocci decreased weight gain and feed efficiency, while betaine did not affect either. Intestinal samples from 1 chick/pen were taken on 4 and 7 later. Cocci increased OS of the duodenal and jejunal mucosa. Betaine decreased OS of the duodenum ( $P<0.01$ ), especially in Cocci challenged birds (interaction  $P<0.07$ ). Cocci increased the thickness ( $P=0.04$ ) and number of leukocytes ( $P<0.01$ ) in the duodenal lamina propria. The increase in leukocyte numbers was greatest at high betaine levels (interaction  $P=0.05$ ). The height of duodenal villi was decreased by Cocci ( $P=0.05$ ) and this effect was ameliorated by 0.10% betaine (interaction  $P=0.04$ ). Intra-epithelia leukocyte numbers were increased by Cocci ( $P<0.01$ ) and this increase was greatest with 0.05 and 0.10% betaine (interaction  $P=0.04$ ). Villi width and crypt depth were unaffected by the treatments. In a second experiment, peritoneal macrophages (Macs) or peripheral blood heterophils (Hets) were incubated in media with an osmolality of either 200, 310, 600, or 900 milli-osmol and either 0.0, 0.1, 0.5 or 1.5 mM betaine (4x4 factorial). *Eimeria* were added to cultures after 6 hrs exposure to media. Phagocytosis by Macs was decreased by hypo-OS (200) and hyper-OS (600, 900) media relative to iso-OS media ( $P=0.015$ ). Phagocytosis by Hets was decreased only by 900 milli-osmol. In Macs, but not Hets, phagocytosis was increased by 0.1 mM betaine compared to 0.0 betaine ( $P=0.05$ ). Macs and Hets incubated in hyper-OS media had decreased chemotaxis and NO release. Betaine increased NO release by Hets ( $P=0.039$ ).

**Key Words:** Coccidiosis, Betaine, Villi

**705 Utilization of metabolizable energy in broilers.** J. van Milgen\*<sup>1</sup>, J. Noblet<sup>1</sup>, S. Dubois<sup>1</sup>, B. Carr<sup>2</sup>, and H. Juin<sup>3</sup>, <sup>1</sup>*INRA, St-Gilles, France*, <sup>2</sup>*INRA, Nouzilly, France*, <sup>3</sup>*INRA, Le Magneraud, France.*

Four groups of broilers (ISA 915) were used to study the effect of body weight on the partitioning of metabolizable energy between protein and lipid deposition, and components of heat production. Broilers were group-housed in a cage measuring 105 x 65 x 45 cm equipped with two feeders of 30 cm each. The cage was mounted on force sensors to measure physical activity of the animals. Temperature was maintained at 21C (60-65% relative humidity) and a 22 h/d lighting schedule was adopted. Animals had ad libitum access to feed (20.5% CP, and 12.7 MJ ME/kg feed) and water. Heat production was measured using indirect open-circuit calorimetry whereas protein and lipid deposition was determined through nitrogen and energy balances. Heat production was measured during two successive weeks. Each week consisted of one day of adaptation, five days of collection of excreta and measuring feed intake and heat production when fed, and one day of measuring the fasting heat production (temperature 24C). In the first week, heat production and nitrogen balance were measured in groups of 11-12 broilers (starting at 21 d of age). At the start of the second week, group size was reduced to 8-9 broilers. The average weight of the broilers was 1.00 and 1.61 kg during the first and second week, respectively. Dry matter feed intake per broiler increased from 120 g/d in week 1 to 161 g/d in week 2. Growth rates (prior to fasting) averaged 89 and 100 g/d for weeks 1 and 2, respectively. To express maintenance energy requirements relative to BW (prior to fasting), the model  $Y = a + bW^b$  was used. For the fasting heat production, the value of "b" significantly differed from 0.75 but not from 0.60, resulting in an activity-free fasting heat production of 490 kJ/(kg BW<sup>0.60</sup>)/d. Similarly, ME intake and total heat production were not affected by stage of growth when expressed per (kg BW)<sup>0.60</sup>. On average over the two weeks, broilers consumed 1764 kJ ME/(kg BW)<sup>0.60</sup>/d, 53.4% of which was lost as heat. The retained energy was partitioned between protein (47.4%) and lipid (52.6%). Heat production was partitioned between fasting heat production (52.1%), physical activity (17.0%) and thermic effect of feeding (30.9%). For the latter two components, this represented 9.1 and 16.5% of ME intake, respectively.

**Key Words:** Broilers, Energy Metabolism, Heat Production

**706 Broiler bone metabolism changes significantly during acute stress.** Alfonso Jr Mireles\*, Sun Kim, Russell Thompson, and William R. Amundsen, *Foster Farms, Modesto, CA.*

A preliminary study showed acute stress caused by an *E. coli* lipopolysaccharide (LPS) subcutaneous injection significantly decreased weight, breast yield, and bone tibia bone strength. Because weight gain and tibia strength are known to be directly correlated, this study was conducted to determine whether this observed loss of bone quality is also affected by an acute inflammatory response. There were 5 treatment groups of 17 cockerels each. Birds were subcutaneously injected *E. coli* LPS at 0, 33, 66, 100, or 425 micrograms/100 grams body weight. Weight gains after 3 days were 263, 209, 195, 186, and 127 grams/bird respectively. Similarly, tibia strength scores were 43.1, 38.8, 38.5, 34.0, and 32.2 Kgs. Tibia elasticity scores were 3.91, 3.66, 3.51, 3.43, and 3.35 mm. Three day mortality was 5, 0, 10, 15, and 40% respectively. Linear regression equations were calculated for each treatment group, and actual weight vs. predicted bone strength were plotted by treatment group. Results showed that, at the same weight, tibia strength is directly related to LPS dosage. As the level of stress (LPS) increased, the regression lines shifted downwards and away from the non-stressed group line. Results suggested bone catabolism is an essential part of an acute stress, which can be used as a sensitive index for nutritional immunomodulation.

**Key Words:** Nutritional immunomodulation, Bone strength and metabolism, Acute stress

**707 Growth promoters in broiler feed (coccidiostat + antibiotics) may play a crucial role during acute stress.** Alfonso Jr Mireles\* and Sun Kim, *Foster Farms, Modesto, CA.*

To evaluate the effect of growth promoters in broiler feeds during acute stress conditions, 2 treatments were prepared (Control with 50 gms Salinomycin + 25 gms Bacitracin MD/ton (C) vs. No Feed Additives (NFA)). A field experiment was conducted during summer and lasted 45 days. There were 10 replicate pens of 50 birds per treatment. Twenty males per treatment were sampled at 35 days for tibia and breast quality. At 39 days, 14 birds per treatment were injected 100 micrograms *E. coli* lipopolysaccharide (LPS) subcutaneously per 100 grams body weight and their performance was compared vs. 14 non-injected birds. At 35 days, NFA birds had weaker ( $P < 0.05$ ) tibias (37.3 vs 32.7 Kgs), lower tibia yields (1.1 vs 1.0%) and similar breast yields as C birds. At 45 days, NFA birds had poorer ( $P < 0.05$ ) weight gain (2.4 vs 2.3 Kg), feed/gain (1.72 vs 1.77), and similar mortality as C birds. A LPS challenge decreased ( $P < 0.05$ ) weight (2.23 vs 2.09 Kg), tibia strength (35.8 vs 32.3 Kg), breast yield (14.9 vs 14.3%), and increased mortality (0 vs 12%). C birds, however, handled the stress significantly better ( $P < 0.05$ ) than NFA birds. At 210 minutes post-LPS, body temperature of C birds was lower than that of NFA birds (42.6 vs 43.0 °C). Coccidiostats and/or antibiotics appear to impart a critical protective effect on broilers during acute stress. This stress is detrimental to breast yield and bone strength and quality.

**Key Words:** Acute phase (inflammatory) response and stress, Growth promoters, Nutritional immunomodulation

**708 Impact of galactose on growth performance, toxicity and metabolizable energy when fed to broiler chicks.** M.W. Douglas\* and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

A study was conducted to determine the effect of increasing dietary galactose (GAL) on growth performance, toxicity and metabolizable energy when fed to commercial broiler chicks. One-day old Ross x Hi Y male chicks were randomly assigned to one of six treatments. The treatments were a 22% CP corn-soybean meal-dextrose basal diet with the addition of 0, 2, 4, 6, 10 or 15% GAL at the expense of dextrose. The diets were fed from 0 to 21 days of age. Metabolizable energy of the diets was determined from collection of excreta for Days 18 to 21. The 15% GAL treatment resulted in high mortality (26%) by Day 3 and was terminated. The 10% GAL treatment also resulted in increased mortality, most of which occurred during the 7 to 14 d period. However, the 10% GAL diet had no significant negative effect on growth performance compared to the basal diet (0% GAL). There was no difference in mortality for the 0, 2, 4 and 6% GAL treatments. Addition of GAL at the 2, 4, and 6% level resulted in numerically increased weight gain and feed

efficiency over chicks fed 0% GAL, with the increases being 10% and significant ( $P < 0.05$ ) for the 4% inclusion rate. Feed intake for the 21 d period was not significantly ( $P > 0.05$ ) different for any level of GAL fed (0-10%). Metabolizable energy was greatest for chicks fed 0% GAL (3.149 kcal/g DM). Supplementation of 2, 4, 6 and 10% GAL resulted in decreases in  $ME_N$  of 4, 6, 7 and 11%, respectively (significant linear response,  $r^2 = 0.85$ ). Our results indicate that low levels of GAL may increase growth performance of commercial broiler chicks even though dietary  $ME_N$  may be reduced.

**Key Words:** Chicks, Galactose, Growth Performance

**709 The effect of fasting at different ages on growth and tissue dynamics in the small intestine of the young chick.** David Sklan\*, Assaf Geyra, and Zehava Uni, *Faculty of Agriculture, Hebrew University of Jerusalem, Israel.*

The small intestines of hatching chicks undergo rapid developmental changes in the immediate posthatch period when the birds are making the transition from endogenous nutrient supply from yolk to dependence on exogenous feed. This transition usually only begins 48 h or more after hatch due to logistical considerations. The effects of fasting for 48 h at different times during this critical period on small intestinal development and enterocyte dynamics were examined by morphometric determinations and use of staining for proliferative cell nuclear antigen and 5-bromo-2-deoxyuridine. The effects of fasting were specific to both time of fasting and to the intestinal segment examined. Decreased development was found in the duodenum and jejunum and less apparent in the ileum. Fasting between 0 and 48 h decreased crypt size in the duodenum and jejunum, the number of crypts per villus, crypt proliferation, villus area and the rate of enterocyte migration. Fasting at later times resulted in smaller effects, although the jejunum appeared to be the most sensitive of the intestinal segments. Growth was correlated with the number of cells in the crypts, the number of cells along the villus and the segment surface area.

**Key Words:** Small intestine, Fasting, Chicks

**710 Influence of source of energy of the pre-starter diet on performance and nutrient digestibility of broiler.** M. J. Aranibar, M. I. Gracia, R. Lazaro\*, and G. G. Mateos, *Universidad Politecnica de Madrid, Spain.*

A trial was conducted to investigate the influence of different energy sources in the pre-starter diet on performance and nutrient digestibility of broiler chicks. There were five treatments and five replicates of four chicks per treatment. The experimental diets (0 to 10d) were based on corn and soybean meal and included either 6.8% of a fat source (sunflower oil, fish oil or lard) or 15.0% of a carbohydrate source (starch or sucrose). The nutrient content of these diets was approximately 3,150 kcal AMEn/kg and 1.33% Lys for the fat diets and 2,920 kcal AMEn/kg and 1.23% Lys for the carbohydrate diets. From 10 to 21d all the birds received a common diet containing 3,000 kcal AMEn/kg and 1.33% Lys. Productive performance was measured at 10 and 21d and apparent fecal digestibility of crude protein (CPD) and crude fat (CFD), and the AMEn of the diets were determined at 4, 7, and 10d of age. No differences in performance were observed among treatments at 21d of age. As expected, birds fed the fat diets had similar body weight but better feed conversion ( $P < 0.01$ ) than broilers fed the carbohydrate diets at 10d of age. Apparent CPD and AMEn of the diets increased with age (48.3, 55.4, and 58.4%;  $P < 0.001$ , and 2,637, 2,731, and 2,853 kcal AME/kg;  $P < 0.001$  at 4, 7, and 10d of age, respectively). Unexpectedly, apparent CFD decreased at 7d as compared to 4d (67.7 vs 76.4%;  $P < 0.01$ ) and then increased slightly at 10d of age (70.5%). The differences on CFD between 4 and 7d were more pronounced for fish oil (80.8 vs 58.4%;  $P < 0.001$ ) and lard (77.8 vs 62.3%;  $P < 0.001$ ) than for sunflower oil (84.7 vs 80.3%;  $P > 0.05$ ). We conclude that fat digestibility of chicks was lower at 7 than at 4 or 10d and that type and source of energy used from 0 to 10d does not influence broiler performance at 21d.

**Key Words:** Broilers, Digestibility, Fat

**711 Starch digestion rate in the small intestine of broilers differs among feedstuffs.** R.E. Weurding<sup>\*1</sup>, A. Veldman<sup>1</sup>, W.A.G. Veen<sup>1</sup>, M.W.A. Verstegen<sup>2</sup>, and P.J. Van der Aar<sup>1</sup>, <sup>1</sup>*Institute for Animal Nutrition 'De Schothorst', Lelystad, The Netherlands*, <sup>2</sup>*Wageningen University and Research Center, Wageningen, The Netherlands*.

A digestibility trial with 720 broilers was performed in which starch digestion of twelve diets, varying in starch source, was determined in three different segments of the small intestine as well as total starch digestion. The choice for the starch supplying feedstuffs was made considering known differences in starch accessibility, -structure and -composition. Based on digestibility coefficients and retention times in the different gut segments, in vivo starch digestion rate was calculated. Ileal starch digestion varied from 33% (potato starch) to 99% (tapioca). No starch degradation was observed in the hind gut. Dietary mean retention time in the small intestine varied from 136 min (barley diet) to 182 min (potato diet). Starch digestion rates varied from 0.5 /h (common beans) to 4.3 /h (tapioca). Ranking of feedstuffs according to total starch digestion (in increasing order) was: potato starch, legume seeds, cereal grains, tapioca. An in vitro technique which mimics passage through the gastrointestinal tract (GIT) of humans was adapted to mimic passage through the GIT of broilers. In vitro starch digestion was measured at different incubation times in the same diets as used in the in vivo digestion trial. From the starch digestion coefficients at the different incubation times, starch digestion rate was estimated. Correlations between in vivo and in vitro starch digestion data were calculated. In vitro starch digestion after 2 h incubation correlated well with starch digestion in the posterior jejunum ( $r = 0.94$ ) and in vitro starch digestion after 4 h incubation correlated well with starch digestion in the posterior ileum ( $r = 0.96$ ). In vitro starch digestion rate was lower, but showed a good correlation with in vivo starch digestion rate ( $r = 0.87$ ). It was concluded that starch digestion rate in broilers varies among feedstuffs and can be predicted by the adapted in vitro method.

**713 Use of the OptiBreed Sperm Quality Analyzer<sup>®</sup> for evaluating semen quality of turkey breeders.** S. L. Neuman<sup>\*1</sup>, C. D. McDaniel<sup>2</sup>, J. Radu<sup>3</sup>, L. Frank<sup>3</sup>, and P. Y. Hester<sup>1</sup>, <sup>1</sup>*Purdue University*, <sup>2</sup>*Mississippi State University*, <sup>3</sup>*Alpharma, Inc.*

The OptiBreed Sperm Quality Analyzer<sup>®</sup> (SQA) measures overall sperm quality as a Sperm Quality Index (SQI). The SQI value generated by the SQA is indicative of turkey sperm concentration, motility, and viability (Neuman et al., *Poultry Sci.* 79:suppl.1:49) The objective of the current study was to monitor the quality of semen in a turkey breeder flock throughout its semen production cycle. A commercial secondary breeder flock of BUTA breeder toms was monitored for sperm quality at 4-wk intervals beginning at 32 wk of age. Individual ejaculates were collected from the same 200 male breeders each month for 7 months. The semen was diluted 50-fold in 0.85% saline prior to determining the SQI for each individual bird. The SQI values were measured within 5 to 10 minutes of collecting the ejaculates. Individual semen volume was also determined gravimetrically. A univariate procedure, conducted monthly on individual SQI values and semen volume, indicated that SQI values were not normally distributed with the exception of month 7 in which SQI values were normally distributed (Shapiro-Wilk  $W = 0.9939$ ,  $P = 0.65$  for month 7). Semen volume was normally distributed during months 1, 2, 6, and 7 ( $P > 0.05$ ). The CV for SQI was highest during month 1 at 26%, but decreased during subsequent months and averaged 15%. The CV for monthly semen volume averaged 32%. An ANOVA, conducted on semen traits to evaluate time effects, indicated that mean SQI values were lowest during months 1 and 7 of semen production with peak values occurring during months 2 through 6. Semen volume was at its lowest during the first month of production with subsequent increases during months 2 through 7. Correlation for all months between semen volume and SQI values was low ( $r = 0.17$ ,  $P < 0.0001$ ). In conclusion, the SQA can be used as a tool to monitor semen quality of breeder toms as a flock ages.

**Key Words:** Sperm Quality Analyzer, Sperm Quality Index, Turkey breeder

The practical relevance of starch digestion rate will be studied in growth trials.

**Key Words:** Starch, Broilers, Digestion rate

**712 Effect of colistin and aureomycin on intestinal microorganism and their relationship with the riboflavin metabolism of broilers.** H. Y. Cai<sup>\*1</sup>, L. Wang<sup>1</sup>, and G. H. Liu<sup>1</sup>, <sup>1</sup>*Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, P. R. China*.

To investigate the interrelationship between antibiotics, intestinal microorganisms and riboflavin metabolism in broilers, a total of 280 one day of age AA broilers were randomly allotted to 5 dietary treatments. Experimental diets were formulated to contain of two antibiotics at two different dosages (aureomycin: 50, 100 mg/kg; colistin: 10, 20 mg/kg) and the control without adding antibiotics. At 3 wk of age, four birds were taken at random from each of the treatment groups for the riboflavin (B2) analysis of cecal contents and determination of differential microbial counts. All data was statistically analyzed by Statistica 6.0 software and multiple comparisons conducted by DUNCAN. There was a gradual but significant ( $P < 0.05$ ) reduction in *E. coli* numbers with increasing levels of either colistin or aureomycin. Colistin supplementation at 20 mg/kg significantly ( $P < 0.05$ ) increased bifidobacterium numbers. Similarly, aureomycin supplementation at 50 mg/kg and 10 mg colistin/kg numerically increased bifidobacterium counts ( $P > 0.05$ ). The B2 concentrations in the broilers' cecal contents at 21 days of age were significantly higher ( $P < 0.05$ ) in birds receiving 20 mgcolistin/kg. Aureomycin supplementation at 100 mg/kg numerically increased the cecal level of B2 ( $P > 0.05$ ). The B2 concentrations in the colons of 21 day-old birds fed either 100 mg aureomycin/kg or 20 mg colistin/kg were numerically reduced ( $P > 0.05$ ) indicating a possible improvement of B2 absorption in the hindgut.

**Key Words:** Broilers, Antibiotics, Riboflavin

## PSA Physiology: Reproduction

**714 Effects of Feeding Regimen and Strain on Fertility of Broiler Breeder Hens as Indicated by the Perivitelline Layer Sperm Penetration Assay.** R. A. Renema<sup>\*</sup>, F. E. Robinson, and G. M. Fasenko, *University of Alberta, Edmonton, AB., Canada*.

The fertility of broiler breeder hens can be reduced by overfeeding. Monitoring fertility is a key step in the early diagnosis of reproductive problems. The Perivitelline Layer (PL) Sperm Penetration Assay has been demonstrated to be an alternative, non-incubation method of fertility assessment. In this study, the PL Sperm Penetration Assay was used to assess fertility in broiler breeder hens of four strains either feed restricted (FR) or ad libitum (AL) fed from photostimulation. Four strains of pullets (Shaver Starbro, Cobb 500, Hubbard Hi-Y, Avian 24k) were reared on a common growth curve. Strains were assigned the anonymous labels W, X, Y, or Z. Forty pullets of mean BW from each strain were individually caged at 20 wk of age. Birds were photostimulated at 22 wk and either maintained under RF conditions, or switched to an AL regimen. At 45 wk of age, 15 hens/tmt were artificially inseminated with pooled semen, and eggs collected 2-9 d after insemination. Eggs were assessed for PL sperm hole number at 40X and 100X magnification and data summarized in 3, 3-d periods (2-4 d, 5-7 d, and 8-10 d). There were no strain differences in the number of PV sperm holes determined at 100X magnification. However, at 40X magnification, 146 PV holes were present in Strain W eggs 2-4 d after insemination compared to 72 and 80 in Strain X and Y eggs, respectively. Although PV hole numbers were low in Strain Y eggs during the 2-4 d period, they did not subsequently decline as rapidly as in other strains. There were 43.1% and 34.8% fewer PV sperm holes in AL eggs than in RF eggs during the 2-4 d post-insemination period when examined under 100X and 40X magnification, respectively. Despite differences in PV sperm holes due to feeding level, actual fertility was affected by AL feeding in a strain-dependent manner. However, as breeder strain influenced the PV hole number independently of actual fertility, the value of the PV hole method for strain comparison was reduced.

**Key Words:** Broiler breeder, Fertility, Genetic strain