

plasma P4 was higher ($P<0.04$) in cows given 25 mg pLH (3.5 ± 0.3) or GnRH (3.8 ± 0.3) than those given 8 mg pLH (2.4 ± 0.3); P4 was lower with 12.5 mg pLH (2.6 ± 0.3) than with GnRH ($P<0.02$), and tended ($P<0.07$) to be lower than with 25 mg pLH. In summary, cows given 25 mg pLH or 100 μ g GnRH had greater OR, CL area, and plasma P4 than those treated with 8 mg pLH; 12.5 mg pLH gave intermediate responses. A dose of 8 mg pLH was not consistently effective for synchronizing ovulation in mature cows.

Key Words: Porcine LH, GnRH, Ovulatory Response, CL Development

288 Early postpartum biochemical and management characteristics related to dairy cow removal. C. S. McConnel*, S. M. Hiibel, J. A. Kidd, A. E. Hill, and F. B. Garry, *Colorado State University, Fort Collins.*

A large proportion of dairy cow death is concentrated within the early postpartum period. Detection of discriminating characteristics within this period may be useful for defining cows at risk for premature removal from a herd. This nested case-control study explored the value of analyzing standard biochemistry and management characteristics of early postpartum cows in determining features related to removal (death and culling). Serum was collected from cows at 3 to 5 days postpartum on two intensive, Colorado dairies. Biochemistry panels for 47 cows that were removed from the dairies within 30 days of parturition (cases) were compared with herd cohorts surviving through 100 days in milk (controls), matched by calving date and lactation. Wilcoxon signed-rank test analysis demonstrated that levels of calcium, total protein, albumin, total bilirubin (TB), creatine kinase (CK), aspartate aminotransferase (AST), potassium, and anion gaps differed significantly between cases and controls ($P<0.05$). Associations between dairy cow removal and biochemical (19) and animal management characteristics (4) were evaluated univariately via a Chi-square test. Ten variables with $P<0.15$ were selected for ordinal logistic regression analysis. Stepwise backward and forward selection resulted in four significant variables ($P<0.1$): TB, CK, AST, and drench administration. The odds of removal were 3.3, 2.8, and 5.7 times higher among cows with elevated levels of TB, CK, and AST. The odds of removal were 5.7 times higher among cows that were assessed to need systemic treatment in the form of a drench. Appropriate fresh cow management may be guided through adjunctive biochemical analysis, highlighting areas that require modification in an effort to improve postpartum health, such as transition cow and calving management, post-partum cow-side evaluation, and therapy protocols. Similarly, fresh cow

assessment that recognizes discriminating systemic characteristics (as evidenced by the application of a drench in this study) may provide insight into useful modifications for individual sick cow management.

Key Words: Dairy, Removal, Biochemistry

289 Effect of dietary energy and metabolizable protein in lactating dairy cows. A. G. Rius*, M.L. McGilliard, and M.D. Hanigan, *Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.*

The objective of the study was to test NRC (2001) model predictions of energy and protein requirements for the dairy cow. We hypothesized that energy and protein have additive effects on production as opposed to the independent limiting effects assumed by the NRC. A complete randomized design in a 2x2 factorial arrangement was used with high and low energy (1.55 [HE] or 1.44 [le] Mcal NEL/kg DM) and RUP (6.5 [HP] or 4.5% [lp] RUP). Multiparous Holstein ($n=32$) and Jersey by Holstein cross-bred ($n=8$) cows were randomly assigned to one of the four dietary treatments (HEHP, HElp, leHP, and lelp). A common diet (HEHP) was fed from d 1 through 21 followed by the respective treatment diets from d 22 to 40. Diets were formulated for CP contents of 17.0 or 14.4%, and a constant RDP content of 10.4% using the NRC model. Feed intake, milk yield and body weight were measured daily. Milk composition and BCS was measured on weeks 3 and 7. The Proc Mixed procedure of SAS was used to test the main effects and their interactions. Milk yields were not significantly affected by treatment however, there was a tendency ($P<0.09$) and the LSM were 35.0, 33.5, 31.3 and, 26.8 kg/d for HEHP, HElp, leHP, and lelp respectively (SEM=2.4). Although milk yields were significantly different ($P<0.05$) for the average of HElp and leHP vs lelp (5.6; SEM=2.8), there was no difference ($P<0.41$) between HEHP vs the average of HElp and leHP (2.5; SEM=3). Milk protein yields were significantly affected by treatment ($P<0.05$) with LSM of 1.09, 1.01, 0.92 and, 0.88 kg/d; (SEM=0.06). The DMI was significantly affected by treatment ($P<0.05$) with LSM of 25.2, 25.0, 25.6, and 23.1 kg/d (SEM=0.69) for HEHP, HElp, leHP, and lelp treatments, respectively. Non-fat milk solids yields tended to be lower ($P<0.08$) when dietary energy was limiting with LSM of 3.11, 2.97, 2.68, and 2.42 kg/d (SEM=0.04). The results indicate that lower RUP diets can be fed with high energy diets without compromising milk production whereas the combination of low energy and low RUP significantly depressed milk and milk protein yields.

Key Words: Cow, Energy, Protein

Nonruminant Nutrition: Poultry Nutrition - Gut Health and Early Nutrition

290 Maternal dietary conjugated linoleic acid causes embryonic mortality in the absence of vitelline membrane disruption. V. A. Leone*¹, R. Aydin², D. Stransky¹, and M. E. Cook¹, ¹*University of Wisconsin, Madison,* ²*Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey.*

We have previously shown that conjugated linoleic acid (CLA) fed to the laying hen in a low-fat diet reduced hatchability when eggs were stored at 4°Celsius (C) for 24 hours. Mineral analysis of yolk and albumin of eggs from CLA-fed hens stored at 4°C for 10 weeks showed a significant change in mineral composition of Ca²⁺, Mg²⁺,

Fe³⁺, Na⁺, Cl⁻ and Zn²⁺ compared to eggs from control-fed hens. This suggests cooling CLA-containing eggs causes disruption of the vitelline membrane, altering mineral balance, and reducing hatchability. An experiment was performed to determine if maternal CLA-feeding reduced hatchability in the absence of vitelline membrane disruption. Hens (24) were assigned to diets containing 1% Corn Oil (CO) or 1% CLA-80 (40% c9, t11 and 40% t10, c12 isomers), and were artificially inseminated once weekly beginning one week prior to the onset of experimental feeding. Eggs were collected daily and placed directly in the incubator. Production, fertility, and hatchability were recorded.

Eggs were candled daily, and eggs that candled clear or early dead were further assessed. Day of embryonic mortality was recorded (expressed as embryonic days of survival). Production and fertility were not altered by CLA. Hatchability fell to 0% after 15 days of CLA-feeding, while control stayed at 80%. Over a 3-week assessment period of embryonic survival, average days of embryonic survival from the CLA group diminished to 16.68 days, while the CO group stayed at 20.78 (21 days of survival results in a hatched chick) during the second week of feeding. During the third week, average days of embryonic survival from the CLA treatment was reduced to 6.33 days, while CO was at 19.77 days. This suggests that without the disruption of the vitelline membrane, embryonic days of survival and hatchability were still significantly reduced by maternal feeding of 1% CLA in comparison to control-fed hens. Further studies are needed to assess the causes of embryonic mortality seen in the presence of CLA, without the artifact of vitelline membrane disruption.

Key Words: Conjugated Linoleic Acid, Embryonic Mortality, Vitelline Membrane

291 Gluconeogenesis and carbon utilization in day 20 chicken embryos supplemented *in-ovo* with glucose and amino acids. N. E. Sunny*, J. Adamany, S. L. Owens, and B. J. Bequette, *University of Maryland, College Park.*

Late-term chicken embryos undergo a dramatic metabolic transition from maintaining high rates of gluconeogenesis *in-ovo* from amino acids and triglyceride-glycerol to maintaining high rates of lipogenesis *ex-ovo* from dietary carbohydrates and amino acids. The aim of this study was to quantify gluconeogenesis and glucose carbon utilization in small and large egg embryos (d 20) supplemented *in-ovo* with nutrients. Groups of small (n = 5 to 8; 54 to 58 g) and large (n = 5 to 8; 66 to 70 g) eggs were randomly dosed into the amniotic fluid on d 9 embryonic with either sterile water (200 μ L, C), glucose (100 mg in 200 μ L, G), an amino acid mixture (100 mg in 200 μ L, AA) or a mixture of glucose and amino acids (50 mg of each in 200 μ L, G+AA). Beginning on d 17 embryonic, each egg was given a daily dose of [U-¹³C]glucose (15 mg/d in 75 μ L water) into the amniotic fluid followed by tissue and blood collection on d 20. Blood was analyzed by mass spectrometry for ¹³C-mass isotopomer distribution in glucose, alanine, aspartate and glutamate. Embryonic weights on d 20 were lower (P \leq 0.001) for the small vs. large eggs, and *in-ovo* nutrient treatment did not affect weights in either group (small: C 31.8, G 31.6, AA 31.3, G+AA 32.7 g; large: C 36.8, G 36.8, AA 37.1, G+AA 38.1 g). Despite differences in embryo weights, absolute rates of gluconeogenesis (0.72 \pm 0.184 g/d) and glucose carbon recycling (59 \pm 0.051 %) were similar between small and large eggs, and *in-ovo* nutrient supplementation did not affect these glucose fluxes. However, the contribution of glucose carbon to alanine flux was greater (P = 0.002) for the C (36 \pm 0.042 %) and G (40 \pm 0.045 %) treatment groups compared to the AA (25 \pm 0.040 %) and G+AA (20 \pm 0.034 %) treatment groups. In summary, *in-ovo* supplementation of AA or a mixture of G plus AA reduced glycolysis and the entry of glucose carbon into Krebs cycle metabolic pathways, irrespective of embryonic size.

Key Words: Gluconeogenesis, Embryo, Metabolism

292 Changes in the late term turkey embryo metabolism due to *in ovo* feeding. J. E. de Oliveira*¹, P. R. Ferket¹, C. M. Ashwell¹, Z. Uni³, and C. Heggen-Peay², ¹North Carolina State University, Raleigh, NC, ²PAH-Embrex, Durham, NC, ³Hebrew University of Jerusalem, Rehovot, Israel.

Microarray technology has been shown to be an effective method to evaluate changes in gene expression of carbohydrate and lipid metabolism during embryonic development of turkeys. This research revealed that the embryo switches from lipid metabolism to carbohydrate (CHO) metabolism fueled by gluconeogenesis around day 22 of incubation (E), and that the liver is very active producing and utilizing glycogen almost simultaneously from E24 until hatch. These results were then used to formulate an *in ovo* feeding (IOF) solution hypothesized to promote CHO metabolism of late-term turkey embryos. Viable Nicholas turkey eggs of similar weights (85.2 g \pm 10) were *in ovo* fed a 0.4 ml nutritive solution at E24. Liver samples were collected from 16 eggs each from IOF and control treatment-groups at E25, E26 and E28 (hatch), and RNA was isolated for microarray evaluation. The arrays were spotted with 300 genes selected to represent several aspects of general metabolism. At each day of incubation, the expression of several genes were significantly (p<0.01) different among the treatment groups. The IOF treatment clearly altered the expression of genes related to energy metabolism and growth, which may help to explain positive effects of *in ovo* feeding on hatchability, development, and growth of poults.

Key Words: In Ovo Feeding, Turkey Embryo, Microarrays

293 *In ovo*-fed lactose augments small intestinal surface and body weight of 3 day-old turkey poults. D. V. Bohórquez*, A. A. Santos Jr., and P. R. Ferket, *North Carolina State University, Raleigh.*

Avian neonatal development relies on nutrient digestion and absorption, which is integral to gut function and morphological development. Lactose, an indigestible disaccharide in poultry, and *Spirulina pacifica* may stimulate compensatory morphological development of the gut epithelium in poults. *Spirulina pacifica* is an alga that provides protein (65%), carbohydrates (20%), fat (7%) and minerals (5%). Three hundred Nicholas turkey eggs were weighed and equally distributed among 3 treatments: 1) Non-injected CONTROL, 2) Lactose-hydrate (LAC) (9% of solution) and 3) *Spirulina pacifica* + Maltodextrin (Sp+M) (1.4% and 10% of the solution respectively). Using Inovject® V2303 (Embrex, Inc.), 1.5ml LAC and Sp+M solutions were injected into the amnion of turkey embryos at 22d of incubation (22E). Upon hatching, poults were fed a corn/SBM-based diet that met or exceeded the NRC recommendations up to 3d of age. Body weight (BW) was determined at 1 and 3d of age. At 1d, ileum histomorphometry (10 villi/bird) was assessed (10 poults/treatment). Villus measurements were: height (VH), apical width (VAW), basal width (VBW), crypt depth (CD), muscularis depth (MD) and mucosal height (MH). Villus height-crypt depth ratio (V:C) and apparent villus surface area (VS) were also calculated. BW was improved at 1d by both treatments (Sp+M and LAC) as compared to control (66.0, 65.5 vs 64.3g, P<0.1, respectively), yet only LAC maintained significantly higher BW at 3d (90.8 vs 85.7g, P<0.05). *In ovo* Sp+M feeding did not significantly affect histomorphometrical measurements. In contrast, *in ovo* LAC significantly increased VH (142.0 vs 119.8 μ m, P<0.01), MH (183.3 vs 162.4 μ m, P<0.01), V:C (3.45 vs 2.87 μ m: μ m, P<0.01) and enlarged VS by 18% (4846 vs 3963 μ m², P<0.01) compared to the control at 1d. *In ovo*-fed lactose enhanced intestinal development by decreasing cell

turnover (higher V:C) and expanding intestinal surface area, which may boost nutrient absorption and bird performance.

Key Words: Turkeys, *In ovo*-fed Lactose, Intestinal Development

294 Development of an automated delivery system for *in ovo* feeding of turkey embryos. C. L. Heggen-Peay*¹, M. Garrell¹, V. W. Doelling¹, and P. R. Ferket², ¹PAH-Embrex, Durham, NC, ²North Carolina State University, Raleigh, NC.

The turkey industry experiences up to 5% poult mortality losses due to starve out. Many of these poults have insufficient energy reserves left after hatch to sustain them through the first few days until they initiate feed intake and develop adequate digestive capability. *In ovo* feeding administers a nutritional formulation to embryos prior to hatch to provide substrates and co-factors that stimulate carbohydrate metabolism and intestinal development. To deliver *in ovo* feeding to turkey embryos on a large scale, an automated delivery system was developed. Injection studies were conducted to optimize the system for amnion targeting in embryonated turkey eggs at 22, 23, and 24 days of incubation (E). In each study, approximately 100 viable eggs/treatment were injected with Coomassie blue dye using an automated *in ovo* delivery system, embryos were immediately euthanized, and eggs were necropsied to evaluate site of injection. Eggs from both the Nicholas and Hybrid breeds were assessed. With Nicholas eggs, very good amnion targeting was achieved at both E24 (96.0% using a 20 gauge 1.125" needle) and at E23 (90.5% using a 20 gauge 1.25" needle). Successful amnion targeting in Nicholas eggs was not achieved at E22. In Hybrid eggs, excellent amnion targeting was achieved at E23 (97.8% using a 20 gauge 1.25" needle) and E24 (96.1% using a 20 gauge 1.25" needle). These results support optimization of an automated *in ovo* delivery system for amnion targeting in turkey eggs.

Key Words: Turkey, Amnion, *In ovo*

295 Evaluation of microbiota populations and intestinal development of different genetic lines of chickens. B. S. Lumpkins*, A. B. Batal, and M. D. Lee, University of Georgia, Athens.

The gastrointestinal tract (GIT) provides an environment for a large and diverse population of intestinal microbiota, which is unique among animal species. In the poultry industry, producers use different genetic lines of chickens with varying rates of development based on their production goal, but little is known about how the microbiota community relates to the genetic lines of chickens based on the varying rates of development. Therefore, a 35 d experiment was conducted to observe and evaluate the changes in the microbiota populations and GIT development of Cobb 500, Ross 708, and Athens Canadian Random bred (ACR) chicks. All birds were fed a standard non-medicated corn-soybean meal diet ad libitum from 0 to 35 d of age. Intestinal measurements and bacterial analysis of the jejunum and ileum were conducted at 4, 7, 14, 21 and 35 d of age. The bacterial DNA was isolated from the digesta, and denaturing gradient gel electrophoresis (DGGE) and terminal restriction fragment length polymorphism were used to examine PCR amplified fragments of 16s ribosomal DNA. Cobb chicks performed the best from 0 to 14 d of age; however, the overall performance was similar for Cobb and Ross chicks. The ACR chicks had the worst performance at all periods measured. The overall relative weight of the jejunum and ileum was not different between the

3 genetic lines, but the ACR chicks had longer relative jejunum and ileum lengths compared to the Cobb and Ross chicks from 0 to 35 d. Furthermore, the Cobb chicks had the longest villi height, while the ACR chicks had the shortest villi height in the jejunum and ileum at all measuring periods. Based on DGGE, the Cobb and Ross chicks had similar microbiota communities at similar ages. Regardless of the genetic line of chicks the microbiota populations changed with age. The performance, GIT measurements, and microbiota population of the Cobb and Ross chicks were similar, while the ACR GIT measurements and microbiota community differed. The results indicate that the different genetic lines have varying rates of intestinal development, which impact performance and the microbiota community.

Key Words: Microbiota, Gastrointestinal Tract, Genetic Lines

296 Effects of diet type, enzyme addition and *Clostridium perfringens* challenge on growth performance and gut health of broiler chickens. W. Jia*¹, B. A. Slominski¹, H. L. Bruce², G. Blank¹, and O. Jones³, ¹University of Manitoba, Winnipeg, Canada, ²Maple Leaf Food Agresearch, Burford, Canada, ³Canadian Bio-Systems Inc., Calgary, Canada.

The effects of diet type (corn- vs wheat-based), enzyme addition (none or multi-carbohydrase preparation at 0.2 g/kg diet) and oral challenge with *Clostridium perfringens* (none or 10⁹ CFU/bird on day 13) on growth performance, digesta pH and viscosity, *C. perfringens* intestinal population and gut lesion score (from 0 to 4 where 0 = no gross lesions, 4 = severe extensive necrosis) were studied in a 40-day experiment with broiler chickens. A total of 1216 male Ross-308 chickens was assigned to 8 dietary treatments in a randomized complete block design providing 8 replicate pens per treatment. Diets were formulated to meet protein requirement of NRC but were suboptimal in energy level. When compared with corn, birds fed wheat-based diets had inferior weight gain (55.0 vs 58.4 g/bird/day) and feed efficiency (1.71 vs 1.62 g feed/g gain). Pathogen challenge significantly (P<0.05) impaired growth performance and increased *C. perfringens* population in the gut and intestinal lesion score. Increased digesta *C. perfringens* counts (2.4 vs 1.5 CFU/g) and intestinal lesion score (0.9 vs 0.4; P<0.01) were observed for challenged birds fed wheat-based diets. No difference in digesta pH was found among the treatments. Enzyme addition resulted in increased weight gain (59 vs 56 g/bird/day; P<0.01) in challenged birds fed corn-based diets; whereas in those fed wheat-based diets, enzyme supplementation improved feed efficiency during the grower-finisher phase (1.9 vs 2.0; P<0.01). A significant reduction in digesta viscosity (from 4.1 to 2.7 mPa.s; P<0.01) was observed in birds fed enzyme-supplemented wheat-based diets. In conclusion, enzyme addition had beneficial effect on growth performance and minimized the negative effect of *C. perfringens* challenge.

Key Words: Broiler Chicken, Enzyme, *Clostridium perfringens*

297 The effect of dietary sinapic acid on the gastrointestinal tract microbial fermentation, nutrient utilization and egg quality of laying hens. M. Johnson*, A. A. Olkowski, and H. L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

Plant based simple phenolics, such as sinapic acid, are natural antimicrobial and antioxidant compounds. As such, they have potential to modulate gastrointestinal tract (gut) microorganisms to influence

performance and also influence the quality of food products when fed to food animals. An example of a simple phenolic that might be found in poultry diets is sinapic acid, which is the predominant simple phenolic acid found in canola meal. Sinapic acid has previously been shown to improve nutrient retention and affect gut microbiota in broiler chickens, and also to have bactericidal activity against *Salmonella enterica* subsp. *enterica in vitro*. Therefore it was of interest to investigate the impact of dietary sinapic acid in laying hens. Two experiments were conducted to investigate the impact of dietary sinapic acid on fermentation patterns of laying hen gut microbiota as judged by volatile fatty acid (VFA) level, energy and protein retention, and the deposition of sinapic acid in eggs. In trial one, hens were randomly assigned to groups of ten that were fed diets containing 0, 0.025, 0.050 or 0.075% sinapic acid for a total of 4 weeks. Dietary sinapic acid in trial one did not affect jejunal, ileal or cecal VFA level, energy and protein retention or any production trait. Sinapic acid was not found in eggs. To determine if a higher level of sinapic was required to cause an effect, the second trial used twenty hens to compare the effect of 0 and 0.5% dietary sinapic acid. Sinapic acid inclusion again failed to affect gut VFA levels. However, sinapic acid increased both the retention of energy (AME) and protein in comparison to the un-supplemented diet. Feeding sinapic acid also resulted in low levels being found in the yolk and albumen of eggs. The results indicate that dietary sinapic acid can affect laying hens and the nature of eggs, but more research is required to understand the influence of dietary inclusion level.

Key Words: Hen, Sinapic Acid, Aanol Meal

298 The use of natural antibiotic alternative and growth promoter feed additives and subsequent effects on broiler performance and carcass quality. N. P. Buchanan^{*1}, J. M. Hott¹, S. E. Cutlip¹, A. L. Rack¹, A. Asamer², and J. S. Moritz¹, ¹West Virginia University, Morgantown, ²Delacon International, Steyregg, Austria.

The use of subtherapeutic levels of antibiotics in poultry feed improves performance and morbidity in broilers. However, consumer pressure has resulted in the development of natural feed additives that may also improve broiler performance and morbidity. Past research has shown that phytogetic feed additives containing essential oils, herbs, spices, and organic acids may enhance the production of gastric secretions, stimulate blood circulation, and accelerate cell osmosis of pathogenic bacteria. The objective of the current study was 1) to assess the use of Biostrong 505+ as a natural alternative to subtherapeutic antibiotics in broiler diets, 2) to assess the use of Biostrong 510 as a natural growth promoter and 3) to determine the effect of Biostrong 505+ and 510 on performance and carcass quality of broilers. One thousand three hundred forty four Cobb 500 broiler chicks were obtained from a commercial hatchery at 1 day of age. Three-phase feeding (starter, grower, finisher) was utilized for the 0-18, 19-30, and 31-40 day periods. Starter diets were fed as crumbles. Grower and finisher diets were fed as pellets. Broilers were reared on built-up litter. Experimental diets consisted of two diet formulations (Cobb maximum yield or least cost) arranged in a factorial design with two inclusions of either Biostrong 505+ (0 or 0.025%) or 510 (0 or 0.015%). The maximum yield diet improved live weight gain, feed conversion, carcass weight, and breast yield for broilers in the 505+ group ($P \leq 0.05$). The maximum yield diet improved carcass weight and breast yield for broilers in the 510 group ($P \leq 0.05$). Inclusion of either Biostrong 505+ or 510 improved feed conversion ($P = 0.0109$, $P = 0.0438$). In addition,

the inclusion of Biostrong 505+ improved breast yield ($P = 0.0577$). Biostrong 505+ or 510 may be viable natural alternatives to use of subtherapeutic antibiotics and growth promoters, respectively.

Key Words: Antibiotics, Phytogetic Feed Additive, Broilers

299 Evaluation of different additives in chicks challenged with necrotic enteritis. J. L. Shelton¹, A. R. Garcia¹, S. W. Davis², and D. W. Giesting^{*1}, ¹Cargill Animal Nutrition, Elk River, MN, ²Colorado Quality Research, Wellington, CO.

Two experiments (EXP) were conducted at Colorado Quality Research to determine the effect of additives on growth in chicks challenged with Necrotic Enteritis (NE). Both EXP were conducted using floor pens and chicks were housed from hatching to 42 d. Initial and final body weight (BW) were 42 and 2,625 g for EXP 1 or 40 and 2,619 g for EXP 2. Feed intake and BW were measured weekly and chicks had ad libitum access to feed and water. Chicks were inoculated through the feed with coccidia (*E. acervulina*, *E. maxima*, and *E. tenella*) on d 9 and then with *Clostridium perfringens* on d 14 to d 16. Lesion scores (LS) were measured on d 16. Treatments included an unchallenged negative control (NC, no additives), a challenged NC, and a challenged positive control (virginiamycin, Vm). The additives tested in these EXP were *Bacillus* (B), a plant extract (PE), mannan oligosaccharide (M), a prebiotic added at a high (PREH) or a low (PREL) level. In EXP 1, d 21 BW was higher ($p < 0.05$) for chicks fed Vm or B+PREH and LS was lower ($p < 0.05$) for chicks that were unchallenged or fed Vm, B+PREH, PE+M relative to the NC. Overall, chicks fed Vm, B+PREH, PE+M, or B+PE+M had lower ($p < 0.05$) mortality relative to the NC. In EXP 2, different additive feeding programs were tested. They were: 1) feeding one level of additives for 42 d or 2) feeding one level of additives through the challenge period (d 21) and then a lower level for the remainder of the EXP. Chicks that were unchallenged or fed any of the test diets had reduced ($p < 0.05$) LS relative to those fed the NC. However, addition of Vm had no effect on growth. Overall, birds fed the 4-way combination of B+PE+PREL+M fed using feeding program 2 had increased ($p < 0.05$) gain:feed relative to the NC. Results from these trials indicate that combining additives with different modes of action could improve performance in chicks challenged with NE. Reducing the levels of additives after the starter period could be beneficial to chick performance and reduce additive costs.

Key Words: Chick, Necrotic Enteritis, Additives

300 Dietary *Bacillus subtilis* C-3102 spores influence intestinal (excreta) populations of Lactobacilli, *Clostridium perfringens*, Enterobacteriaceae (coliforms), and Salmonella, and live performance of broiler chickens. M. Kato¹, N. Otomo¹, K. Nishimura², Y. Tadano³, T. Marubashi³, H. Miyazaki³, K. Maruta³, and D. M. Hooge^{*4}, ¹Calpis USA, Inc., Schaumburg, IL, ²Quality Tech. Int'l, Inc., Elgin, IL, ³Calpis Co. Ltd, Tokyo, Japan, ⁴Hooge Consulting Service, Inc., Eagle Mountain, UT.

Intestinal Lactobacilli (Lac) counts and Lactobacilli/total anaerobes (Lac/TA%; 50% or more being optimal) are important in relationship to broiler performance and pathogen loads. CALSPORIN® (Calpis Co. Ltd, Tokyo, Japan) contains *Bacillus subtilis* C-3102 (Bs) aerobic spores which vegetate in digesta and consume oxygen causing proliferation of native colonizing, facultatively anaerobic Lactobacilli

to help improve bird performance and reduce pathogen loads. In Exp. 1 in southern Japan, Bs was added to all broiler feeds (0 or 3×10^5 CFU/g), and excreta collected at 2 ages. At 14 d, in the Bs flock Lac increased ($P < 0.05$) and Salmonella were not detected vs 4.97 Log₁₀ CFU/g excreta in the negative control flock. At 49 d, *Clostridium perfringens* (3.22 vs 2.66 Log₁₀ CFU/g excreta; $P < 0.05$) and Salmonella (4.07 vs 3.31 Log₁₀ CFU/g excreta, $P < 0.01$; 20/20 vs 10/20, $P < 0.05$) were reduced in the Bs flock. Two trials were conducted at a US broiler company to compare Bs fed flocks vs previous antibiotic growth promoter (AGP; for necrotic enteritis prevention) fed flocks. Excreta was collected at 35 d. In Exp. 2, Lac ($P < 0.001$) and Lac/TA% (22.9% vs 52.2%; $P < 0.05$) were higher and Enterobacteriaceae (coliforms) lower ($P < 0.01$) in Bs birds. Livability was higher and farm condemnations lower in 7 Bs flocks vs 4 previous AGP flocks ($P < 0.01$), and calorific conversion was lower in 7 Bs flocks vs 902 simultaneous flocks ($P = 0.014$). In Exp. 3a, Lac ($P < 0.001$) and Lac/TA% (21.2 vs 58.5%; $P < 0.01$) were higher in Bs birds. In Exp. 3b (same control as Exp. 3a), Lac ($P < 0.001$) and Lac/TA% (21.2% vs 54.8 and 59.5%; $P < 0.001$) were higher and *Clostridium perfringens* lower ($P < 0.05$) in Bs birds. The Bs C-3102 flocks had higher intestinal (excreta) Lac or Lac/TA%, lower pathogen counts, and/or improved performance, compared to simultaneous (or previous) negative control or AGP flocks.

Key Words: Bacillus Subtilis C-3102, Lactobacilli, Pathogens

301 Effect of synbiotic feed additive in comparison to antibiotic growth promoter on performance and health status of broilers. M. Mohnl*¹, Y. Acosta Aragón¹, A. Acosta Ojeda², B. Rodríguez Sánchez², and S. Pasteiner¹, ¹BIOMIN GmbH, Herzogenburg, Austria, ²Instituto de Ciencia Animal, San José de las Lajas La Habana, Cuba.

The present trial was conducted to evaluate the efficacy of a synbiotic product in comparison to a commonly used AGP (antibiotic growth

promoter) on broiler performance during a 42 day study. 525 one-day-old male chicks (Cuban hybrid EB 34) were randomly distributed to 3 experimental groups with 7 replicates per group and 25 animals per replicate. Experimental groups included a non-treated control group, a group which received a synbiotic product (Biomin® PoultryStar) via the drinking water on the first three days and for three consecutive days at each feed change and an AGP group which received Avilamycin (40 ppm) via the feed. The animals were fed a standard corn-soy ration in a three diet feeding program (starter (1- 14), grower (15- 28), finisher (29- 42)). Feed and water were provided *ad libitum*. The birds were kept under observation for 42 days and performance parameters like body weight and feed intake were measured weekly. Furthermore daily weight gain and feed conversion ratio (FCR) were calculated. Clinical inspections and necropsies were conducted and mortality was registered daily. After 42 days body weight and FCR of birds which received the synbiotic product or the AGP were significantly higher ($P < 0.05$) and feed intake was lower when compared to control group. Synbiotic group and AGP group increased body weight by 2.04% and 1.99% respectively in comparison to control. Mortality could be reduced in treatment groups in comparison to control (control group: 2.8%, synbiotic group: 0.9%, AGP group: 0.9%). In the present study the synbiotic product had a comparable potential to improve broiler performance as Avilamycin and might therefore be a promising alternative to the use of AGPs in broiler production.

Key Words: Synbiotic, Antibiotic Growth Promoter, Broiler Performance

Nonruminant Nutrition: Poultry Nutrition - Breeder and Laying Hen Nutrition and Broiler Environment

302 The effect of feed restriction programs and growth curves on reproductive performance, stress and metabolism in broiler breeder hens. M. de Beer*¹, J. P. McMurtry², D. M. Brocht², and C. N. Coon³, ¹Aviagen, Huntsville, AL, ²USDA-ARS, Beltsville, MD, ³University of Arkansas, Fayetteville.

An experiment was conducted to compare everyday (ED) and skip-a-day (SK) feeding programs and early slow growth (SLOW) and broilerized (BROIL) treatments. Feed restriction programs were implemented from 4 weeks to 5% production. The SLOW group was fed to reach 75% of standard BW by 12 weeks, and then to reach standard BW by 21 weeks. The BROIL group was fed *ad libitum* till 7 weeks and then severely restricted to reach standard BW by 21 weeks. Parameters measured included BW, uniformity, age at sexual maturity (SM), total and settable egg production, body composition, liver size and composition, *in vitro* lipogenesis (IVL), metabolic hormone levels and heterophil to lymphocyte ratio (H/L). The trial period lasted 45 weeks. Birds fed ED grew more efficiently than SK or SLOW. The BROIL treatment had significantly worse feed utilization than all

other groups. Frame size was consistently greater in BROIL pullets and consistently smaller in SLOW pullets. Birds fed ED reached SM before SK, who in turn reached SM before SLOW or BROIL birds. Egg production was significantly higher in ED than SK, which in turn was higher than either SLOW or BROIL. Liver weight and IVL was elevated in SK and SLOW pullets above ED pullets during rearing. Liver weight and IVL were lower in BROIL pullets than other groups during rearing, but after photostimulation dramatic increases in liver weight and IVL resulted in this trend being inverted by 27 weeks. As an indicator of stress, H/L ratios were elevated above ED pullets in SK, SLOW and BROIL pullets at various times during rearing. Corticosterone and T3 levels were elevated in SK and SLOW birds during rearing. IGF-1 was higher in ED than SK birds during rearing. Feeding regimens and growth curves have a major influence on efficiency, metabolism and reproductive performance in broiler breeders.

Key Words: Broiler Breeder, Growth Curve, Metabolism