rations cost up to $14/tonne less than traditional corn based ones mainly because less ingredient is used to meet the birds requirements. This is equivalent to an annual savings of up to $266 million to the Brazilian broiler and broiler-breeder producers. Diets formulated with HOC had a lower crude protein content than with traditional corn, and potentially could reduce annual nitrogen excreted to the environment by 5.3 Mtonnes. HOC provided a better nutrient profile than traditional corn, especially in essential amino acids such as methionine and lysine, which led to meeting amino acid requirements without having to increase the total crude protein content of the diet. The analysis also showed a potential to reduce phosphorus excretion by 842 tonnes/yr if HOC was to replace traditional corn, since the need to supplement rations with inorganic phosphorus sources such as dicalcium phosphate would be much lower. We estimate that 36.6 Mtonnes dicalcium phosphate can be saved annually using HOC in poultry rations in Brazil. The literature suggests replacing traditional corn with HOC does not affect bird metabolism and positive impacts on growth rate have been recorded. Substituting traditional corn with HOC has both economic and environmental benefits for the Brazilian poultry production without compromising efficiency of output.

Key Words: Poultry, High-Oil Corn, Environmental Pollution

664 Electrostatic space charge system for dust reduction and air quality improvement in commercial broiler facilities. C. Ritz*[1], B. Mitchell[2], B. Fairchild[1], M. Czarick[1], and J. Worley[1], [1]*University of Georgia,* [2]*Southeast Poultry Research Laboratory USDA-ARS.*

Reducing airborne dust in enclosed animal housing has been shown to result in corresponding reductions in airborne bacteria, ammonia and odor. Technologies that have been shown to be effective for reducing airborne dust in animal areas include misting with an oil spray, water mists, extra ventilation, and electrostatic space charge systems. Increasing pressure from environmental groups to reduce PM-10 and ammonia emissions from animal housing has led to considerable interest by the poultry and swine industries for practical systems to reduce these air pollutants. An electrostatic space charge system (ESCS) was designed to reduce airborne dust and ammonia emissions from a commercial broiler production house. The ESCS for this application was based on patented technology that was developed to reduce airborne dust and pathogens and has proven effective in poultry hatchers and broiler breeder pen trials. In the present study, dust and ammonia were measured at 10-minute intervals over a three-flock period in both a treatment and control house with built-up litter. Results of the study during the months of November through April indicate the ESCS reduced airborne dust by an average of 55%. Dust levels in the treatment house were consistently lower than in the control house. Ammonia levels in the treatment house averaged 8% lower than in the control house with most of the reduction occurring during the evening hours when ammonia levels were highest. No differences in bird activity were observed between treatment and control houses. Successful application of this technology in broiler houses has the potential for improving bird performance and reducing house emissions and caretaker health hazards.

Key Words: Electrostatic, Dust, Broiler

665 In-house composting of litter and poultry carcasses infected with avian influenza. G. W. Malone*[1], S. S. Cloud[1], R. L. Alphin[1], L. E. Carr[2], and N. L. Tablante[2], [1]*University of Delaware, Newark,* [2]*University of Maryland, College Park.*

In February 2004 two Delaware farms were found to be positive for H7N2 avian influenza. The litter and carcasses were composted inside the houses to minimize potential spread of the virus and to address environmental concerns. Farm A had two 12 by 122 m houses with 12,000 dual-purpose birds ranging from 3 to 26 weeks of age while Farm B had three similar size houses with 74,000 five week old commercial broilers. In each house the carcasses and litter were mixed to form a single windrow 97 m long. These windrows had a 10 cm litter base, 4 m wide, 1.5 m high, and capped with 8 cm of litter or sawdust to cover all carcasses. Windrows were turned inside the house, consolidated and capped with additional sawdust at 14 to 19 days. Although the litter moisture was not ideal for composting, temperatures in these windrows were sustained at 55 C for 10 consecutive days. All houses were heated to 38 C for three consecutive days after forming the windrows and again after turning the piles as an additional measure to inactivate this heat-sensitive virus. Virus isolation samples from the compost and house environment were taken prior to turning and again before compost removal from the house. The compost was removed from the house after one month, stockpiled on the farm, covered and allowed to age for another month. Educational materials were developed and used to train poultry company personnel on in-house composting procedures.

Key Words: Composting, Carcass Disposal, Avian Influenza

666 Spatial Variability of Nutrient Species Within a Poultry House. P. R. Owens*, D. M. Miles, and D. E. Rowe, *Waste Management and Forage Research Unit, USDA-ARS, Mississippi State, MS.*

Large broiler operations must annually collect and analyze litter for nutrient content under the U. S. Environmental Protection Agency's Concentrated Animal Feeding Operation Final Rule. The objective of this study was to determine the variability of nutrient species within a poultry house using geostatistical contour plots. This research was conducted in the summer on a tunnel ventilated poultry house that was 146 m by 12.8 m. Prior to sampling, the litter had twenty-eight flocks of chickens grown on it with decaking between each flock. The house was sampled on a grid at 5 m across the house and 12 m down the house for a total of 36 sampling points. The litter was sampled at day 1 and day 21 to examine litter properties. The pH was determined using 1:5 litter water ratio. The total N was determined by total Kheldahl nitrogen method (TKN). The ammonium, nitrate and phosphate were extracted with DI water and analyzed using flow injection analysis. The litter samples were also dry ashed and total metals were determined using an ICP. For both sampling dates, the samples weren't random and the data did not follow a normal distribution, however, the data indicated a higher average concentration of TKN and ammonium in the cooling cell end of the house and decreased to toward the fan exhaust end of the house. The average nitrate data also yielded higher concentrations at the cool cell end of the house and decreased toward the exhaust end of the house. The data from the geostatisitical contour plots illustrated higher TKN and ammonium in the brood end of the house, which corresponded with the lower pH (8.6 vs. 7.5) also in the brood end of the house. The contour plots of the nitrate data illustrated highest concentration near the sidewall of the brood end of the house, which corresponded to the areas with the highest litter moisture. These trends held true with both day 1 and day 21. The water extractable P data did not indicate definite trends within the house during the day 1 and day 21 sampling times. These geostatisical estimates of the nutrient concentrations indicated an anisotropic distribution of the nutrients along the house and illustrated spatial variability of nutrient species within the poultry house.

Key Words: Broiler, Litter, Nutrients

PSA-Nutrition: Feed Additives

667 Egg antibody to phospholipase A_2 increases carcass yield in male broilers. K. D. Roberson*[1], J. L. Kalbfleisch[1], W. Pan[1], R. A. Charbeneau[1], M. E. Cook[2], and M. Yang[2], [1]*Michigan State University, East Lansing,* [2]*University of Wisconsin-Madison.*

Cockerel chicks (Ross X Ross) were procured from a commercial hatchery and placed at day of age into brooding pens which had fresh litter top-dressed on used litter from a previous trial. Dried chicken egg (whole contents) antibody to phospholipase A_2 was added at 0, 0.1, 0.2 or 0.4% of a corn-soybean meal basal diet fed in three phases. Chicks were brooded for 2 wk with 223 chicks/pen and 4 pens/treatment. After brooding, the birds were separated out into 7 pens/treatment with 125 birds/pen and grown to 43 d of age. Body weight and feed consumption were measured for each pen at 14, 28 and 42 d of age. At 43 d of age, 25 birds/treatment (5 pens of 5/pen) were randomly selected for slaughter and weighed live (averaged 3 kg). Hot carcass weight without giblets was determined and small intestinal samples were collected, washed and weighed individually. There were no significant effects on body weight

or feed conversion. Carcass yield was increased ($p<0.0001$) linearly as level of antibody increased (70.8 to 73.0%). Intestinal weight was increased (($p<0.0063$) linearly as antibody level increased. The results show that feeding an antibody to phospholipase A_2, an enzyme that affects arachidonic acid metabolism, to male broilers can increase hot carcass yield by 3% (2.2 percentage units) when supplemented at 0.4% of the diet from whole egg contents.

Key Words: Broiler, Carcass Yield, Phospholipase A_2

668 Effect of growth promoters (antibiotics + Roxarsone + copper sulfate) on broiler performance during stress: Possible mechanisms of growth promotion. A. Mireles Jr.*[1], D. Sutton[1], E. Koutsos[2], R. Spiller[2], and S. Kim[1], [1]*Foster Poultry Farms,* [2]*California Polytechnic State University, San Luis Obispo.*

The objective of this study was to examine the effects and interactions of growth promoters and litter quality on broiler performance during stress. A 2 (NoGrowth vs. +GrowthP) x 2 (Clean vs. Dirty Litter) factorial design study was conduced in commercial-like pens for 43 d. Birds raised on dirty litter had heavier ($P < 0.05$) weight at 20 d (649 vs 672) and 33 d (1648 vs 1684). +Growthp birds had heavier ($P < 0.05$) weight at 20 d (672 vs 649). Feed/gain was poorer ($P < 0.05$) for birds on growth promoters at 11 d (1.13 vs 1.09). Mortality was similar for all groups (2.21, 2.78, 1.60, 3.19%, respectively). At 11, 17, 34, and 41 d, 12 birds per treatment were injected subcutanously with 1 mg E. coli LPS/Kg BW, and their body temperature measured at 0 and 150 m post-LPS. Birds fed growth promoters developed a similar fever 150 m post-lps throughout all 4 periods (+0.41, +0.39, +0.45, +0.32 C respectively). NoGrowth birds had higher ($P < 0.05$) fever at 11 d and lower at 41 d (+0.64, 0.55, 0.46, 0.22 C, respectively). Gain 2 days post-LPS challenge was higher ($P < 0.05$) for GrowthP birds at 13 d (63 vs 55 gm) and lower ($P < 0.05$) at 19 d (636 vs 687 gm). Intestinal coliform counts at 13 d were lower ($P < 0.05$) in birds on dirty than clean litter (171,425 vs 6809). Bursal disease and I. bronchitis titers were increased ($P < 0.05$) by dirty litter. Growth promoters likely improve performance by modulation of the inflammatory response.

Key Words: Growth Promoters, Litter Quality, Acute Phase Response

669 Growth performance of male broiler chicks fed diets supplemented with two levels of Versazyme® to 26 days of Age. N. H. Odetallah*[1], M. H. Fosnaught[1], and J. C. H. Shih[2], [1]*Bioresource International, Raleigh, NC,* [2]*North Carolina State University, Raleigh.*

Two inclusion levels of Versazyme (VZ), a feed additive enzyme, were supplemented in broiler diets to determine the optimal level for broiler growth performance from 0-26 d. Birds were fed a control basal diet without (C) or with VZ (0.05% or 0.10% wt/wt). Diets were formulated to NRC (1994) with the exception of CP (19%) and Amino Acids (110%) as research indicates VZ has protease activity and is optimized at lower CP levels. VZ was added in the dry form post mixing of original mash feed. A total of 168 Ross x Ross male broiler chicks were allocated to 24 pens of a battery brooder in a Completely Randomized Design with 12 replicate pens/control and 6 replicate pens/treatment (0.05 or 0.10%); the experimental unit was a pen of 7 birds. Body weight (BW), Gain, and Feed intake were determined at 14, 21, and 26 d, and mortality used to calculate adjusted feed conversion ratio (adjFCR). Level of VZ had no effect on mortality. Feeding VZ increased ($p<.01$) BW at 21 d (852b and 915^a vs. 807^c g for 0.05 and 0.10% vs. C, respectively) and 26 d (1143^b and 1213^a g vs. 1092^c g for 0.05 and 0.10% vs. C, respectively) and Gain at d 21 (412^b and 441^a g vs. 385^c g for 0.05%, and 0.10% vs. C, respectively). Feeding VZ increased ($p<.01$) overall Gain (1102^b, and 1173^a vs. 1052^c g/bird for 0.05% and 0.10% vs. C, respectively) and improved ($p<.01$) overall adjFCR (1.47^a and 1.44^a vs. 1.55^b for 0.05% and 0.10% vs. C, respectively). There was no effect of VZ level on Feed Intake except at d 14 when it was increased ($p=.02$) by the 0.10% inclusion level (520^b, 517^b, and 556^a g/bird for control, 0.05%, and 0.10%, respectively). Both levels of VZ improved growth performance of broilers up to d 26 although the 0.10% level demonstrated a higher response ($p<.01$) in BW and Gain over the 0.05% level. Results of the current research suggest that supplementing diets with VZ at either the 0.05% or 0.10% level will improve broiler growth performance up to 26 days of age but optimal performance will be realized at the 0.10% level.

Key Words: Versazyme®, Growth Performance, Broiler Chick

670 Effects of purified β-Mannanase and commercial product, Hemicell® on performance and uniformity in commercial broilers compared with dietary nutrient adjustment. M. E. Jackson*[1], H.-Y. Hsiao[1], D. M. Anderson[1], R. L. James[1], and G. F. Mathis[2], [1]*ChemGen Corp., Gaithersburg, MD* [2]*Southern Poultry Research, Inc., Athens, GA.*

β-Mannans are antinutritional components of soybean meal and other plant protein sources. An enzyme product containing primarily β-mannanase with lower levels of other enzymes including α-galactosidase, xylanase, amylase, and β-glucanase (Hemicell®) has been demonstrated to break down soybean β-galactomannan and improve performance in broiler chickens. An experiment was conducted to determine 1. The extent to which the efficacy of the commercial product (Hemicell®) is due to the presence of β-mannanase, and 2. if the growth performance loss due to adjusting energy downwards by 120 Kcal/Kg ME and amino acids downwards according to matrix recommendations can be recovered by the use of the enzymes. Four dietary treatments consisting of 1. a positive control, 2. a negative control with nutrient reductions, 3. as (2) with the commercial product, and 4. as (2) with purified β-mannanase were provided to 8 replicate pens with 30 male CobbxCobb broilers per pen. All diets were corn-soybean meal based. Individual body weights of all birds were determined on days 17 and 42. Addition of the commercial product to the low nutrient dense diets resulted in live performance improvements comparable to that of increasing the nutrient density (5.6% in gain and 7.7 points in feed conversion, $P<0.05$). Addition of the purified enzyme also yielded significant improvements in live performance over its negative control. There was no statistcally signifcant difference in performance between commercial product and purified enzyme. Body weight uniformity was significantly improved with the commercial product with a 38% reduction in 42-day %CV ($P<0.05$). The data shows that the active ingredient of the commercial enzyme product (Hemicell®) is primarily the β-mannanase component, and that β-mannanase is capable of improving performance comparable to an increase in nutrient density on the order of 120 kcal/kg ME plus an additional amino acid benefit.

Key Words: Broilers, β-Mannanase, Uniformity

671 Efficacy of purifed β-mannanase isolated from Hemicell® in broiler chickens with Coccidiosis and Necrotic enteritis. H.-Y. Hsiao*[1], D. M. Anderson[1], M. E. Jackson[1], F. L. Jin[1], and G. F. Mathis[2], [1]*ChemGen Corp.,* [2]*Southern Poultry Research, Inc.*

Hemicell®, a β-mannanase based feed enzyme, has been shown to significantly improve growth performance, and reduce mortality and lesion scores in broiler chicks simultaneously challenged with *Eimeria sp.* and *Clostridium perfringens.* Since β-mannanase used in these trials is a commercial product with some side activities such as amylase, xylanase, β-glucanase and α-galactosidase, etc. an experiment was designed to determine if the benefits observed are due solely to β-mannanase. β-Mannanase was purified through ion exchange (DEAE-Sephacel) and hydrophobic interaction (Phenyl-Sepharose) chromatography to remove all other enzyme activities. The purified mannanase produced a single band on SDS acrylamide gel electrophoresis demonstrating a high level of purity. A 21-day male broiler chick (CobbxCobb) trial was conducted in battery cages with 10 birds per cage, 4 diets, and 8 replications per treatment. Birds were fed diets with four different treatments: Control without medication, Hemicell® added, pure β-Mannanase added and Medication (BMD and salinomycin) added. All birds were challenged with 50,000 *E. acervulina* and 5,000 *E. maxima* on day 7 and with 108 cfu *C. perfringens* on days 12, 13, and 14, all by oral gavage. Results indicated that pure β-mannanase significantly improved weight gain by 9.4% (700g vs. 640g; $P<0.05$) and feed conversion by 5.4% (1.440 vs. 1.519; $P<0.05$) over its Control. Hemciell® gave a similar performance improvement over the non-medicated control indicating that the β-mannanase is the primary active ingredient in Hemciell®. This result also provides a foundation for a better understanding of the mechanism of action for Hemicell®.

Key Words: Broilers, β-Mannanase, Necrotic Enteritis

672 Effect of Growth Promoters (Antibiotics + Roxarsone + Copper Sulfate) on Broiler Composition during Stress: Possible Mechanisms of Growth Promotion. A. Mireles Jr.*[1], D. Sutton[1], E. Koutsos[2], R. Spiller[2], and S. Kim[1], [1]*Foster Poultry Farms,* [2]*California Polytechnic State University, San Luis Obispo.*

The objective of this study was to examine the effects and interactions of growth promoters and litter quality on body composition during stress. A 2 (Clean vs. Dirty Litter) X 2 (NoGrowth vs. +GrowthP) factorial design study was conducted in commercial-like pens for 43 d. At 11, 17, 34, and 41 d, 12 birds per treatment were injected subcutaneously with 1 mg E. coli LPS/Kg BW. Two days post-LPS, birds were euthanized. Litter x Growthp x Stress interactions were found ($P < 0.05$) for total serum Ca, liver, spleen, tibia, breast relative weight, and tibia Ca and total P. LPS stress increased ($P < 0.05$) total serum Ca at 19, 36, and 43 days (+11, +4, +4 PPM), liver weight at 13, 19, 36, and 43 d (+0.21, +0.62, +0.36, +0.25%), spleen weight (+0.03, +0.03, +0.01, +0.02%), decreased ($P < 0.05$) breast weight at 19 d (-0.37%) but increased breast moisture at 36 d (+0.77%), and decreased tibia strength at 13 and 43 d (-458, -2868 gm) while increasing ($P < 0.05$) tibia Ca (18.67 vs. 19.87%) and P (8.61 vs 9.13%). At 19, 36, and 43 d, +GrowthP birds had constant serum Ca levels 2 d post-LPS challenge. NoGrowth chicks had higher serum Ca 2 days post-LPS at 19, 36, and 43 d. Spleen weight of NoGrowth chicks was heavier 2 d post-LPS at 36 and 43 d (+0.01, +0.01%). Tibia Ca and P, breast weight and moisture of NoGrowth were higher ($P < 0.05$) than in +GrowthP chicks. Growth promoters likely affect body composition by modulation of the acute phase response.

Key Words: Growth Promoters, Litter Quality, Acute Phase Response

673 Effect of mannan oligosaccharides supplementation to laying hen diets. M. I. Gracia*[1], P. Cachaldora[2], L. Tucker[3], F. Baucells[1], and P. Medel[1], [1]*Imasde Agropecuaria, S.L., Spain,* [2]*Coren, S.C.L., Spain,* [3]*Alltech Inc., Ireland.*

A study was conducted to determine the effect of feeding laying hens a diet supplemented or not with a source of mannan oligosaccharides (MOS, Bio-Mos®) on performance and egg quality. A total of 1,200 Isa Brown laying hens (38-66 wks of age) were allocated randomly to the experimental treatments. A completely randomized block design was applied using two barns (block) and two experimental treatments: 1) basal diet (control), 2) basal diet with 1 g/kg of MOS. Each treatment was replicated 40 times (20 per barn) with 15 laying hens constituting the experimental unit. Egg production, average egg weight, feed efficiency, Haugh units, yolk color measured by Roche Color Fan (RCF), and shell thickness were calculated every 4 wks. For the whole study period (38 to 66 wks of age), MOS supplementation significantly improved laying index (85.1 *vs* 86.9 %; $P<0.01$), feed consumption (114.3 *vs* 115.7 g/d; $P<0.01$), and feed conversion (2.09 *vs* 2.06 g feed/g egg; $P<0.05$). Moreover, average egg weight significantly increased from 54 to 58 wks (65.2 *vs* 66.1 g; $P<0.05$) and tended to increase from 58 to 62 wks of age (65.8 *vs* 66.5; $P=0.09$) with supplementation of laying hen diets with MOS, but the positive effect was lost thereafter. Addition of MOS had no effect on the ratio between normal, dirty and broken eggs. Regarding egg quality parameters, the addition of MOS to the diet of laying hens resulted in a deeper yolk color as measured by the RCF (12.5 *vs* 12.8; $P<0.001$), however control hens had higher Haugh units than MOS supplemented hens ($P<0.05$). It was concluded from this experiment that the addition of MOS to laying hen diets results in improved laying performance and deeper yolk color.

Key Words: Mannan Oligosaccharides, Laying Index, Laying Hens

674 CRINA® poultry essential oils and BMD in the diet of broilers exposed to *Clostridium perfringens*. M. Sims*[1], P. Williams[2], M. Frehner[3], and R. Losa[3], [1]*Virginia Diversified Research, Harrisonburg, VA,* [2]*Akzo Nobel Surface Chemistry LLC, Davis, CA,* [3]*CRINA SA, Akzo Nobel Group, Switzerland.*

Two 7 week floor pen trials were designed to determine if the performance of broiler chickens fed CRINA® Poultry Essential Oils was similar to that of broiler chickens fed the growth promotant Bacitracin MD in the presence of a *C. perfringens* (Cp) challenge. In Trial 1 there were 8 groups replicated 8 times: Non-supplemented Uninfected Controls (NUC), Non-supplemented Infected Controls (NIC), Uninfected CRINA 100 ppm (UCR100), Infected CRINA 100 ppm (ICR100), Uninfected BMD 55 ppm (UBMD), Infected BMD 55 ppm (IBMD), Uninfected CRINA 200 ppm (UCR200) and Infected CRINA 200 ppm (ICR200) for a total of 64 pens (64 birds/pen; density = 0.073 m^2 /chick). In Trial 2 there were 3 groups replicated 10 times: NIC, ICR100 and IBMD for a total of 30 pens (60 birds/pen; density = 0.078 m^2 /chick). Broilers of both trials were weighed at 7 weeks of age, challenged with Cp during Week 3 and Cp lesions scored at 7 and 28 days post-challenge in Trial 1 and 7 and 14 days post-challenge in Trial 2. In Trial 1, there were no differences (p#88050.05) between the Week 7 average live weights of the NIC, ICR100, ICR200 and IBMD fed broilers while in Trial 2 the ICR100 broilers had heavier Week 7 live weights (p#88040.05) than both the IBMD and NIC groups (2.39 vs. 2.27 and 2.21 kg, respectively). Both IBMD groups had heavier (p#88040.05) live weights than their NIC counterparts. Week 7 feed conversions and mortality rates of the ICR100 and IBMD groups in both trials were not different (p#88050.05). There were no differences (p#88050.05) between the Week 4 Cp lesion scores of the ICR100 and IBMD groups in each trial and both were significantly better (p#88040.05) than their respective NIC groups. ICR200 broilers performed slightly better than ICR100 broilers (Trial 1) . This study suggests that challenged and non-challenged broilers fed diets supplemented with CRINA at 100 ppm had live weights, feed conversion and mortality rates that were similar or better than identically managed broilers fed BMD 55 ppm with both groups better than the Cp infected untreated controls.

Key Words: Essential Oils, Broiler, *Clostridium perfringens*

675 Comparison of direct-fed microbial products Avi-Lution or Avi-Lution Custom to bacitracin methylene disalicylate or no additive in diets of broiler chickens exposed to *Clostridium perfringens*. D. Spangler[1], J. Corley[2], G. F. Mathis[3], M. D. Sims[4], and D. M. Hooge*[5], [1]*Agri-King, Inc., Fulton, IL,* [2]*Prince Agri Products, Inc., Quincy, IL,* [3]*Southern Poultry Research, Inc., Athens, GA,* [4]*Virginia Scientific Research, Inc., Harrisonburg,* [5]*Hooge Consulting Service, Inc., Eagle Mountain, UT.*

The objective was to evaluate direct-fed microbials versus an antibiotic or no supplement. In 49-d Exp. 1, Ross x Hubbard HiY mixed-sex chicks (2,700), 54/pen (1.22 x 3.05 m; 10 pens/treatment), were on fresh litter then on built-up litter (d 14). Four birds were removed at 21 d (2) and 35 d (2) for necrotic enteritis lesion scoring. The 5 treatment groups had different dietary supplements and *Clostridium perfringens* (Cp)challenge statuses: no-Cp negative control (nCON), Cp inoculated nCON (nCON+Cp), bacitracin-md 55 ppm (BMD+Cp), Avi-Lution 0.05% (AVN+Cp), and Avi-Lution Custom 0.1% (AVC+Cp) treatments. Birds were individually dosed with fresh culture of Cp types A, C, and D (ATTC, Ames, IA) on d 14, 15, 16, and 17. Intestinal lesions were scored 0 best to 4 worst at 21 and 35 d. Body weight (BW), FCR, lesion scores, and mortality (MORT) were improved ($P<0.05$) by AVN+Cp, AVC+Cp, and BMD+Cp compared to nCON+Cp. In 49-d Exp. 2, Cobb x Cobb male chicks (1,400) were placed 40/pen with 5 pens/treatment. Coccidial challenge at 14 d was followed by fresh culture of southeastern field isolate of Cp mixed with feed on d 18, 19, and 20. At 22 and 28 d, 5 birds/pen were lesion scored. The 7 dietary treatments were: nCON, nCON+Cp, AVN(0.05%)+Cp, AVN(0.1%)+Cp, and BMD(55 ppm)+Cp. At 49 d, BW and FCR for the nCON, AVC+Cp treatments, and BMD+Cp were statistically similar ($P<0.05$). The MORT was variable (3.5 to 11.5%) and nonsignificant. The AVC+Cp increased BW 3.7% and decreased FCR 4.5% compared to original AVN+Cp. The 49-d pen drag swab Salmonella concentrations were decreased by AVN+Cp or AVC+Cp compared to nCON+Cp or BMD+Cp. The AVN and to a greater extent AVC resulted in lower Salmonella counts and BW, FCR, and Cp lesion scores similar to BMD for broilers.

Key Words: Avi-Lution, Broiler, *Clostridium perfringens*

676 Growth performance of male broiler chicks fed diets supplemented with Versazyme® in dry and liquid form to 26 days of age. N. H. Odetallah[1], M. H. Fosnaught*[1], and J. C. H. Shih[2], [1]*BioResource International, Raleigh, NC,* [2]*North Carolina State University, Raleigh.*

Two application forms of Versazyme® (VZ), a feed additive enzyme, were evaluated in broiler diets to compare the effect of the dry (D) vs. liquid (L) form on broiler growth performance from 0-26 d. Broilers were fed a basal diet without (Control) or with VZ (D or L). Diets were

formulated to NRC (1994) with the exception of CP (19%) and Amino Acids (110%) as research indicates VZ has protease activity and is optimized at lower CP levels. Diets were fed in the mash form from 0-26 d, and VZ was either added post mixing of original feed (D) or sprayed on top of the feed (L). A total of 168 Ross x Ross male broiler chicks were allocated to 24 pens of a battery brooder in a Completely Randomized Design with 12 replicate pens/control and 6 replicate pens/treatment (D or L); the experimental unit was a pen of 7 birds. Body weight (BW), gain, and feed intake were determined at 14, 21, and 26 d, and mortality used to calculate adjusted feed conversion ratio (adjFCR). Feeding VZ (whether in D or L form) compared to the control diet did increase ($p<.01$) overall Gain (1012^b, 1108^a, and 1087^a g/bird for control, D, and L, respectively) and improve ($p<.01$) overall adjFCR (1.52^b, 1.47^a, and 1.42^a for control, D, and L, respectively). Supplementing VZ in the D form did increase overall ($p=.04$) feed intake (1543^b, 1630^a, and 1545^b for control, D, and L, respectively). FCR at d 14 only was most improved ($p<.01$) by the L form (1.24^a) followed by D form (1.29^b) when compared to control (1.34^c). No difference between the two applications (D vs. L) was observed on mortality, BW, and gain at any age. Supplementing diets with VZ improved all broiler growth parameters measured in this study. These results suggest that VZ supplementation in broiler feed may improve growth performance irrespective of application form (D or L).

Key Words: Versazyme®, Growth Performance, Broiler Chicks

PSA-Nutrition: Layer and Miscellaneous Nutrition

677 The influence of restricted intake of energy and fat on egg solids in laying hens. J. A. Arthur*[1], K. S. Kreager[1], N. P. O'Sullivan[1], and H. J. Kuhl, Jr.[2], [1]*Hy-Line International, Dallas Center, IA,* [2]*Nest Egg Nutrition, Gardnerville, NV.*

Restriction of feed or energy intake has been noted to have an association with a reduced proportion of solids in liquid egg. Hy-Line variety W-98 and W-36 hens were fed rations designed to restrict energy and fat intake by 10% (Low group) for each variety, compared to hens fed a measured amount of feed in accordance with expected intake level for that variety (High group). The amount of feed provided to the W-98 High, W-98 Low, W-36 High and W-36 Low groups was 104.3, 95.2, 95.2 and 86.2 g/bird/day. The energy intake was 297, 265, 276 and 243 kcal/bird/day. The intake of crude fat was 3.45, 3.15, 4.36 and 3.93 g/bird/day. All other critical nutrients were fed at approximately the same level to both High and Low groups within variety. After nine weeks (period one), the feed given to each group was reduced by a further 10% for eight weeks (period two). Eggs were sampled five times during a pre-trial period, 5 times during period one and 8 times during period two, at intervals of one week or more. Egg weight (EW), % yolk (PY), white solids, yolk solids (YS) and total liquid solids (TS) were determined. Body weight (BW) was measured biweekly. Feed consumption (FC) and % production (PD) were measured daily. Results during the experimental period were corrected for differences between groups within variety during the pre-trial period. During period one, not all the feed was consumed and the % restriction was somewhat less than planned. The effect of energy and fat restriction on solids was not significant in period one, but was in period two. In period two there was a significant reduction of 0.32% in TS in the Low group (P#88040.001). TS were reduced because of reduced YS and PY (P#88040.01 and 0.0004, respectively). PD was reduced by 13% (P#88040.0001). Comparison of varieties over both experimental periods showed significant differences for W-36 in contrast with W-98 of 0.81% higher TS, 0.75% lower YS, 2.93% higher PY, 3.89 grams lower EW, and 0.14 Kg. lower BW (P#88040.0001 for each trait).

Key Words: Egg Solids, Energy Restriction, Fat Restriction

678 Evaluation of prediction equations and modeling metabolizable energy intake for commercial strains of laying hens. M. A. Jalal*, S. E. Scheideler[1], and D. Marx[2], [1]*Department of Animal Science,* [2]*Department of Statistics, University of Nebraska, Lincoln.*

A study was conducted to assess and contrast the accuracy of 4 existing metabolizable energy intake (MEI) prediction equations (Combs, 1968; Emmans, 1974; NRC, 1981, and NRC, 1994) and our Jalal model using our production data to derive equations for individual strains. Three strains of White Leghorn hens (Hy-Line W-36, Hy-Line W98, and Bovans) were fed 2 levels of dietary ME in a 2 x 3 factorial arrangement in a an augmented block design. A total of 60 hens were used for this trial with 10 replicate cages (hen/cage) per dietary treatment. Modified models were derived by reparamatizing parameter estimates of explanatory variables in originak models using nonlinear regression. Results of model assessment showed that Combs model had significantly (P#88040.05) greater bias and mean square error (MSE) values for all strains, and was least accurate predictor of MEI among models evaluated. Therefore, Combs was excluded from further evaluation. NRC models were the best predictors and had the least bias and MSE, with Emmans and Jalal in close second and third. Pooled data results showed modified models predicted MEI more accurately in contrast to original models for Hy-W36, while only modified Emmans and Jalal were more accurate for Hy-W98 and Bovans. An F-test showed significant differences among strain-derived equations for all models. These equations were tested using 2 sets of field data per strain acquired from a commercial layer facility. Testing of strain-derived models using field data showed no significant differences in bias or MSE estimates for Emmans, NRC or Jalal models for accuracy of predicting MEI. The results indicated that the models fit the field data well for all strains. The NRC models were the best predictors of MEI for the present data set for all strains. Testing of the strain-derived equations using field data showed that Emmans, NRC and Jalal were accurate predictors of MEI as demonstrated by non-significant comparisons of bias and MSE.

Key Words: Prediction Equations, ME Intake, Strain

679 Effect of enzyme supplementation in laying hens on egg weight and commercial egg classification. M. I. Gracia*[1], G. L. Campbell[2], E. McCartney[3], J. Peinado[1], and P. Medel[1], [1]*Imasde Agropecuaria, S.L., Spain,* [2]*GNC Bioferm, Canada,* [3]*Pen&Tec Consulting, Spain.*

Four experiments involving a total of 1,820 laying hens distributed in 108 replicates evaluated the efficacy of an enzyme complex (Endofeed DC, EC No 25) containing 1,100 U/g of Endo-1,3(4)-β-glucanase (EC 3.2.1.6) and 1,600 U/g of Endo-1,4-β-xylanase (EC 3.2.1.8). A completely randomized design was applied in each study using two experimental treatments: 1) basal diet (control), and 2) basal diet with 125 mg/kg of enzyme, the recommended commercial dose. Selected data on egg weight (at 34, 46, and 54 wks of age) were combined in a meta-analysis. The original data used for the statistical analysis were the mean egg weight per replicate, and enzyme supplementation and experiment were considered as main effects. At 46 wks of age enzyme supplementation significantly increased mean egg weight (68.30 *vs* 66.07 g; $P<0.001$). At 34 and 54 wks of age, no statistically significant differences were detected between treatments, but hens supplemented with enzyme laid eggs that were numerically heavier than controls (65.90 *vs* 64.97 g; $P=0.19$, and 67.76 *vs* 66.63 g; $P=0.20$; for 34 and 54 wks of age, respectively). To assess the commercial significance of these improvements, a second meta-analysis was carried out using individual egg weight data at 42 wks of age, obtained from two of the experiments. Each egg was classed according to commercial categories: S (<52.5 g), M (52.5-62.5 g), L (62.5-72.5 g), and XL (>72.5 g). Enzyme supplementation significantly increased the percentage of XL eggs (15.2 vs 5.3 %) at the expense of other commercial categories ($P<0.01$). In conclusion, the data from these studies suggest that enzyme supplementation improves mean egg weight, allowing classification into larger egg classes.

Key Words: Enzyme Meta-Analysis, Egg Commercial Categories, Laying Hens

680 Enzyme supplementation of laying hens fed diets containing barley and wheat. P. Medel*[1], L. Pastrana[2], J. Méndez[3], E. McCartney[4], and M. I. Gracia[1], [1]*Imasde Agropecuaria, S.L., Spain,* [2]*Universidad de Vigo, Spain,* [3]*Coren, S.C.L., Spain,* [4]*Pen&Tec Consulting, Spain.*

A study was conducted to evaluate the efficacy of a feed enzyme additive (Endofeed DC, EC No 25) containing 1,100 U/g of Endo-1,3(4)-β-glucanase (EC 3.2.1.6) and 1,600 U/g of Endo-1,4-β-xylanase (EC 3.2.1.8) in laying hens. A total of 1,170 Isa Brown laying hens (30-54