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Annual Meeting

July 16–19, 2006
Edmonton, Canada
*Author Presenting Paper

SYMPOSIA AND ORAL SESSIONS

Ancillary Scientists Symposium: Functional Genomics: Building the Bridge Between the Genome and Phenome

1 Analysis of global gene expression in the avian neuroendocrine system. T. E. Porter*, L. E. Ellestad, M. Muchow, S. A. Jenkins, and M. S. Byerly, University of Maryland, College Park.

The pituitary gland and hypothalamus of the brain comprise the central components of the neuroendocrine system. This system plays an important role in the control of growth and metabolism. Traditionally, regulation of gene expression within the neuroendocrine system has been studied one gene at a time. In recent years, we have developed and used chicken cDNA microarrays to study gene expression profiles for thousands of genes simultaneously. This review will summarize our use of microarrays for expression profiling in the chicken pituitary and hypothalamus. We have studied ontogenic changes in global gene expression within the neuroendocrine system during late embryonic and early posthatch development. We have analyzed effects of treatments on gene expression in cultured pituitary cells. We have identified differentially expressed genes in the neuroendocrine system of chicken lines genetically selected for body composition (high versus low body fat) or size (high versus low body weight). Our findings have allowed us to focus our research on numerous candidate genes that might function within the neuroendocrine system to control growth and metabolism in chickens and other vertebrates.

Key Words: microarray, hypothalamus, pituitary

2 Functional mapping of gene networks controlling growth and metabolism. L. A. Cogburn*, University of Delaware, Newark.

The chicken has now reached model organism status with the recent completion of the genome sequence, a comprehensive catalog of expressed genes and genome-wide microarrays. We have developed an integrated systems cDNA microarray for transcriptional profiling across metabolic and somatic tissues. Temporal gene expression scans have been taken in divergently selected broiler lines (i.e., fat vs. lean and high vs. low growth) and in perturbation models (i.e., embryo-to-hatching transition and during fasting and re-feeding). One of the greatest challenges in understanding these vast volumes of microarray data is development of models to reconstruct functional gene networks and regulatory pathways. Using gene clustering and computational analyses of time series transcriptional profiles, we have identified a number of functional genes in key metabolic pathways that could control important phenotypes in the chicken. Several clusters of functionally related genes (i.e., metabolic enzymes, transcription factors, nuclear receptors, adipokines, transport proteins, signal transducers, etc.) have been identified that control major metabolic pathways. Furthermore, a number of these differentially expressed genes map to quantitative trait loci identified in our novel resource populations. These studies have given us the first picture of the transcriptional landscape of the chicken and some insight into the gene networks and regulatory pathways that control somatic growth and body composition. The discovery of a large number of obesity-related genes and adipokines could provide a better understanding of genes that contribute to excessive fitness in chickens and promote the use of this new model organism for study of human metabolic disorders (i.e., diabetes and metabolic syndrome).

Key Words: microarray, gene networks, transcriptome
3 Genetic mechanisms regulating feed intake, energy balance and body weight in poultry. M. P. Richards*, USDA, ARS, ANRI, Growth Biology Laboratory, Beltsville, Maryland.

In order to maintain a constant body weight, feed intake and energy expenditure must be coordinated and tightly regulated. This may not hold true for some poultry species intensively selected for such economically important traits as growth and meat production. For example, the modern commercial broiler does not adequately control voluntary feed intake to meet its energy requirements and maintain energy balance. As a consequence, feeding must be limited in these birds to avoid over consumption and excessive fattening during production. It is important to determine a genetic basis to help explain this situation and to offer potential strategies for producing more efficient poultry. This review summarizes what is currently known about the control of feed intake and energy balance at the gene level in birds. Highly integrated regulatory systems have been identified that link the control of feeding with energy status. How such systems function in poultry is currently being studied. One example recently identified in chickens is the AMP-activated protein kinase pathway that links energy sensing with modulation of metabolic activity to maintain energy homeostasis at the cellular level. In the hypothalamus, this same pathway may also play an important role in regulating feed intake and energy expenditure commensurate with perceived energy needs. Genes encoding key regulatory factors such as hormones, neuropeptides, receptors, enzymes, and transcription factors are some of the types of molecular components that comprise intricate networks of signaling, sensing, and metabolic pathways linking peripheral tissues with the central nervous system. Moreover, coordinate expression of specific gene groups can establish functional pathways that respond to and are regulated by such factors as hormones, nutrients, and metabolites. Thus, with a better understanding of the genetic basis for regulating feed intake and energy balance in birds important progress can be made in developing, evaluating, and managing new and more efficient commercial poultry lines.

Key Words: feed intake, energy balance, gene expression

4 Application of macrophage and intestinal cDNA microarrays to study innate mucosal immunity in avian coccidiosis. H. Lillehoj*, United States Department of Agriculture, Animal and Parasitic Diseases Laboratory, Beltsville, Maryland.

Coccidiosis is recognized as the major diarrheic disease of poultry and is caused by the apicomplexan protozoa Eimeria. Coccidiosis seriously impairs the growth and feed utilization of infected animals resulting in loss of productivity. Conventional disease control strategies rely heavily on chemophylaxis and to a certain extent on live vaccines. These factors combined inflict tremendous economic losses to the world poultry industry in excess of $3 billion annually. Increasing regulations and bans on the use of anticoccidial drugs coupled with the associated costs in developing new drugs and live vaccines urges the need for developing novel approaches and alternative control strategies for coccidiosis. Recent technological advances in high-throughput molecular approaches to identify disease resistance genes and molecular/cell biological pathways associated with complex biological phenomenon now enable the development of an alternative strategy to combat these diseases. Recently, application of functional genomics has led to the identification of avian genes associated with resistance to coccidiosis. In this report, I will describe new findings using the chicken macrophage and intestinal cDNA microarrays that led to the identification of host genes which influence innate immune responses to Eimeria in the gut. Enhanced understanding of how Eimeria interact with host macrophages and intestinal immune system at the molecular and cellular levels will contribute to novel control strategies against coccidia. These EST sequences from Eimeria-stimulated intestinal IEL transcripts will be used to study global gene expression profiling and to identify novel immune-related genes during avian coccidiosis and in other enteric diseases of poultry. Those genes with significant differences can also be used as potential candidate genes influencing disease susceptibility traits.

Key Words: coccidiosis, global gene expression, innate mucosal immunity

5 Analysis of quantitative disease-resistance traits. S. J. Lamont*, Iowa State University, Ames.

Most of the important economic traits in poultry, including genetic resistance and immunity to disease, are quantitative traits. Thus, the genetic architecture of these traits is complex and difficult to elucidate. To enhance poultry welfare and food safety, however, improvement in host genetic resistance to disease is desirable. Understanding the functional genomics of host resistance to pathogens will enable poultry breeders to develop populations that are more innately resistant to disease. To accomplish this goal, the genes and chromosomal regions associated with disease resistance must be identified and characterized. In some instances, sufficient is known about the mechanisms of resistance from comparative studies to enable a targeted approach of analyzing specific biological candidate genes in poultry, such as the major histocompatibility complex. In other instances, the discovery process is better served by screening the genome comprehensively for genes or chromosomal regions associated with disease-resistance traits. The broad QTL scans may be based on structural variation such as microsatellites or single-nucleotide polymorphisms (SNP). Analysis of associations of structural variation with disease-resistance traits can be complemented by functional genomics studies that evaluate differential gene expression among groups. Similar to studies of structural variation, gene-expression analysis can be conducted in a targeted fashion on a small number of candidate genes, such as cytokines, or in a global fashion by using microarrays. In addition to the use of complementary genetic analysis approaches, the generation of novel resource populations for evaluation can greatly facilitate the process of discovering associations between disease-resistance traits and genes or markers. The use of these genetic analysis approaches will be presented via examples of their successful application in elucidating the genetic basis of resistance to Marek’s Disease and Salmonellosis.

Key Words: disease resistance, QTL, genome


Microarrays have been widely implemented across the life sciences although there is still debate on the most effective uses of such transcriptomic approaches. In genetical genomics, gene expression measurements are treated as quantitative traits and genome regions affecting expression levels are denoted as expression quantitative trait loci or eQTL. The detected eQTL can either represent a locus that lies...
close to the gene that is being controlled (cis-acting) or one or more loci that are unlinked to the gene that is being controlled (trans-acting). One powerful outcome of genetical genomics is the reconstruction of genetic pathways underlying complex trait variation. The potential of pathway reconstruction has now been demonstrated in some model species despite the small sample size in eQTL experiments to date.

In order to maximise the efficiency of future eQTL studies, we outline an experimental strategy that is particularly suitable for poultry. The improved efficiency is achieved by targeting the eQTL study at a functional trait for which QTL have been detected and combining this with a fine mapping study for the functional QTL. The proposed strategy has three components: 1) from a resource population, individuals that are non-recombinant for markers flanking the QTL region, are selected for the eQTL experiment. 2) Individuals that are recombinant for the QTL region are utilised for further fine mapping of the QTL. 3) Additional expression studies are carried out for some of the recombinant individuals to confirm or evaluate positional candidate genes underlying the QTL. The underlying assumption of the proposed strategy is that QTL with major effects on the phenotype for a functional trait will often have major effects on expression of one or more genes. In the build-up towards full-blown eQTL studies, we can study the effects of known candidate genes or marked QTL at the gene expression level in more focussed studies. To demonstrate the potential of genetical genomics, we have identified the cis and trans effects for a functional body weight QTL on GGA4 in breast tissue samples of chicken with opposite QTL genotypes.

Key Words: gene expression, QTL, transcriptomics

7 Functional annotation of genomic data with metabolic inference. R. L. Walzem*, Texas A & M University, College Station.

Metabolomics is emerging as a post genomic science with applications to production agriculture. The metablome is the quantitative complement of all low molecular weight molecules present in cells or body fluids in a particular physiologic or developmental state. Although the tools of metabolomics are not fully developed, they have already proved insightful to gene function identification, description of the metabolic sequelae of toxicological, pharmaceutical, nutritional and environmental interventions.

Lipids are important metabolites essential for the function of both cells and the whole bird. The structural and energetic lipids present in blood and tissues are a particularly informative class of metabolites for diagnosing and understanding changes in energy balance and transport caused by different selection strategies or feeding regimens.

A key advantage of quantitative lipid metabolomics is the prior knowledge of most of the biochemical pathways responsible for lipid synthesis, metabolism and catabolism. High precision measurements of the concentration of individual lipid metabolites, including oxylipids such as eicosanoids, allow estimation of steady-state metabolite profiles.

Once developed, profiles are mapped using pathway knowledge for use alone or for the functional annotation of changes in gene expression. In this way a detailed understanding of both selection and environmentally imposed impacts on poultry production is developed. Such a deep understanding of the metabolic inference arising from specific selection strategies provides predictive capabilities to prevent or minimize unintended outcomes or identify appropriate diets or environmental conditions to optimize production outputs. Examples will be provided, including outcomes for selected samples from an ongoing discovery project that employs microarrays and gene expression profiling of chickens selected for extremes in growth rate (fast and slow) and abdominal adiposity (high and low).

Key Words: metabolomics, lipids, poultry

8 Using proteomics to understand avian systems biology and infectious disease. H. Liu*, North Carolina State University, Raleigh.

In an effort to understand the cellular systems and the roles of their constituents in different physiological states, proteomic studies have provided a greater understanding of the function of proteins within a global, cellular context, along with the more conventionally delineated molecular functions. In this presentation, we will focus on using Marek’s disease as an example to demonstrate how we implement proteomics to understand avian infectious disease. Some of the mechanisms that govern the response of chicken cells to viral infection function by altering protein abundance levels and/or by inducing changes in protein modulation via post-translational modifications. Consequently, it is very important to be able to measure these fluctuating changes using proteomics. We have utilized mass spectrometry in protein mining experiments to evaluate protein expression in chicken embryo fibroblast cells infected with Marek’s disease virus (MDV). As it is very likely that MDV proteins must interact with specific host proteins for pathogenesis to progress and for the virus to evade the host immune responses, it is thus also crucial to identify host proteins that interact with MDV proteins. We have used yeast two-hybrid assays to screen chicken spleen libraries and have identified chicken cDNA-encoded prey proteins that interact with virus-encoded bait proteins. The combination of mass spectrometry and yeast-two hybrid assays provides a powerful proteomic approach for understanding systems biology and infectious disease.

Key Words: proteomics, mass spectrometry, yeast two-hybrid

National Extension Workshop: National Poultry Extension Workshop


The 2006 Annual Extension Special Recognition Award is presented to Dr. Theresia Lavergne, (LA), who has made many significant leadership contributions in the areas of environmental protection and extension programming. I encourage you to participate in multi-state research committees, which will increase in importance with the ever-reducing number of poultry faculty. For example, the WERA-204/ temp1361, (Animal Bioethics), and the NCR-131, temp 1981 (Applied Animal Behavior and Welfare) are important committees that complement other activities at Land Grant Universities. The Southern Region Poultry Extension Workshop (Triennial) committee is more national in character and will meet next in 2009. Ken Anderson, is Chair of that committee and they request you provide comments, and volunteer. The 2006 National Poultry Waste Management

Symposium
is in Springdale, AR, and is coordinated by Susan Watkins (AR); with Casey Ritz (GA) Coordinator for 2008. The 2006 Future Trends in Animal Agriculture (FTAA) symposium is the sixth since 2001. The FTAA creates opportunities for positive dialogue between industry and animal activists. Proceedings are available. The 2005 Food and Biobased Cafeteria-aware Composting for Federal Facilities in Washington, DC round table will be followed with a more in-depth symposium in 2006, and continued the theme of composting and biobased materials from the workshop, Biobased Plant Nutrient Products: Quality Assurance, Marketing, and Regulations, held in 2004. Proceedings are available for both workshops.

Key Words: recognition award, animal welfare, National Poultry Waste Management Symposium


A program to certify expertise in designated areas of specialization for professionals in the animal sciences will be presented. The American Registry of Professional Animal Scientists (ARPAS) was established in 1984 to certify expertise in various areas of specialization for qualified professionals in the animal sciences. ARPAS was founded with the support and affiliation of the Poultry Science Association, American Society of Animal Science, American Dairy Science Association, American Meat Science Association, and the Equine Science Society. To qualify as a Professional Animal Scientist, and be authorized to use the designation PAS, requires a minimum of a B. S. degree in one of the animal sciences or closely related field, passing a comprehensive exam in at least one of the 12 areas of specialization, one to four years of appropriate experience in the animal sciences depending on level of education, completion of at least 16 hours of approved continuing education each year, and following a stringent code of professional ethics. ARPAS members that have completed at least a M. S. degree in the appropriate discipline may apply to be Board Certified in one of five disciplines. Board Certification requires a M. S. degree in the discipline and passing a comprehensive examination in that discipline. Board Certification is offered in Animal Behavior, Animal Food Science, Animal Genetics, Animal Nutrition, and Animal Physiology. Successful applicants are authorized to use the designation of Board Certified in that discipline. ARPAS also publishes a peer reviewed journal bi-monthly titled: The Professional Animal Scientist.

Key Words: certification, professional, ethics
M1 Dietary conjugated linoleic acid enhanced spleen PPAR-γ mRNA expression in chicks. H. J. Zhang, Y. M. Guo*, Y. Yang, and J. M. Yuan, China Agricultural University, Beijing, China.

This experiment was aimed at investigating the anti-inflammatory effects of conjugated linoleic acid (CLA) in broilers challenged repeatedly with lipopolysaccharide (LPS). Day-old broiler chicks were allotted into 3 (0, 5.0 or 10.0 g CLA/kg diet) treatments. Six chicks from each treatment were injected with LPS (0.25 mg/kg body weight) at 16, 18 and 20 day of age. Cyclooxygenase (COX) and inducible nitric oxide synthase (iNOS) activities, and prostaglandin E2 (PGE2) and nitric oxide (NO) production as well as peroxisome proliferator-activated receptor-gamma (PPAR-γ) mRNA expression in spleens were examined at 21 d of age.

Results showed that chicks fed 10.0 g/kg CLA diet had significantly lower COX activities and PGE2 production than the controls. Dietary 10.0 g/kg CLA did not significantly diminished LPS-induced enhancement of COX-2 activities, but remarkably inhibited the subsequent elevation of PGE2 production. Regulation of COX-1 activities contributed to the difference of PGE2 production. CLA did not remarkably attenuate the elevation of iNOS activities and NO production due to LPS challenge. Chicks fed CLA had significantly lower iNOS activities and NO production than the controls. Dietary CLA significantly activated PPAR-γ mRNA expression. Compared to control group, chicks fed CLA had significant elevation of PPAR-γmRNA expression after LPS administration.

These results suggested that dietary CLA had immunomodulatory effects in spleen by restricting basal PGE2 and NO at lower levels and enhancing PPAR-γ mRNA expression. During inflammatory response, dietary CLA did not alleviate the elevation of COX-2 and iNOS activities but significantly enhanced PPAR-γ mRNA expression.

Key Words: conjugated linoleic acid, broiler chicks, cyclooxygenase

M2 Effects of dietary cellulose on excreta moisture and egg production in laying hens. A. Arti* and T. K. Smith, University of Guelph, Guelph, ON, Canada.

It has been hypothesized that the problem of sticky droppings in laying hen flocks may be influenced by dietary levels of non-starch polysaccharides (NSP). A study was conducted, therefore, to determine the effects of feeding different levels of NSP in the form of cellulose, on excreta moisture content and egg production in laying hens. Two hundred and forty, 35-week-old commercial strain (Shaver) laying hens were fed corn-soybean meal diets including: (1) 0% cellulose (2) 1% cellulose (3) 1.5% cellulose (4) 2% cellulose (5) 2.5% cellulose (6) 3% cellulose. Egg production was monitored daily. Excreta was collected for 24h after 21 days of feeding. Excreta moisture loss was measured over 98h following collection. A randomized complete block design was employed with Tukey’s multiple range tests to separate means. Egg production was not significantly affected by diet. The feeding of 2% cellulose, however, resulted in the highest numerical value for excreta moisture. Excreta moisture tended to be higher for layers fed diets containing 2% and 2.5% cellulose. Average rate of excreta moisture tended to be greatest in birds fed diets containing 1% and 1.5% cellulose. Although the effects of dietary cellulose were not statistically significant with respect to excreta moisture content and rate of excreta moisture loss (P > 0.05) the results indicate that the use of an appropriate level of NSP in laying hen diets will reduce the problem of sticky droppings.

Key Words: non starch polysaccharides, laying hens, excreta moisture

M3 Effect of probiotic on broiler performance and blood factors. M. R. Abdollahi* and F. Zaefarian, Tehran University, Karaj, Tehran, Iran.

The microbial populations in the gastrointestinal tracts of poultry play a key role in normal digestive processes and in maintaining animal health. Disease- and stress-induced changes in the physicochemical environment in the gastrointestinal tract, or simple changes in feed management practices can significantly influence the microbial populations and their effects on animal performance and health. In the last five decades, increased knowledge of the factors that influence the activities of microorganisms in the alimentary tract has helped to define the critical role of these symbiotic organisms. Probiotics, competitive exclusion and direct-fed microbial feed supplements can be used as a strategic tool for managing these microbial populations. The aim of this trial was study of effect of different levels of bacterial probiotic on broilers performance and some of blood factors.

This experiment was conducted in a randomized complete block design (RCBD) and included 600 Ross broiler chicks (male and female) which were divided into four groups with five replicates. This experiment was conducted in two periods starter 0-21, and grower 22-42, days. All of the diets were isocaloric and isonitrogenous. In this experiment, the birds received 0, 800, 1000, 1200 g probiotic per ton diets in the starter period, and 0, 320, 400, 480 g probiotic per ton diets in the
M4  Dietary tocopherols attenuate hepatic triacylglycerol content and cyclooxygenase-2 expression in the cardiac tissue of mtat-Type chickens challenged with lipopolysaccharide.

G. Cherian*, Z. Ma, and M. P. Goeger, Oregon State University, Corvallis.

Eicosanoids are lipid mediators of inflammation derived from n-6 and n-3 fatty acids. Our previous research demonstrated that the dietary n-6:n-3 fatty acid ratio affects the synthesis of proinflammatory eicosanoids in poultry. Cyclooxygenase (COX) is a key enzyme in eicosanoid synthesis. Two isoforms (COX-1, COX-2) have been identified. COX-1 is constitutive and COX-2 is induced upon cell activation and its expression is associated with inflammation. The current study investigates the effect of feeding n-6 fatty acids and tocopherols on lipopolysaccharide (LPS)-induced alterations in hepatic lipid metabolism and COX-2 expression in the cardiac tissue of meat-type chickens. A total of forty-eight one-day-old broiler chicks (n=12/treatment) were randomly assigned to a corn soybean meal-based diet containing 31, 62, 124 and 248 IU/Kg tocopherols. The n-6:n-3 fatty acid ratio of the diet was 13:1. LPS injection led to an increase in hepatic total fat and triacylglycerol in birds fed 31 IU/Kg tocopherols when compared to birds fed 62 or 248 IU/Kg tocopherols (P < 0.05). The COX-2 protein level was lower (P < 0.05) in cardiac tissue of birds fed 248 IU/Kg tocopherols when compared to 31 and 62 IU/Kg tocopherols. No effect of tocopherols or LPS on liver weight was observed (P > 0.05). During inflammation, lipid substrates for the activated immune system are provided by triacylglycerol-rich lipoproteins. Therefore, dietary strategies directed at attenuating hepatic lipid and triacylglycerol content and COX-2 expression may prove beneficial in reducing inflammatory diseases and in increasing production performances in meat-type chickens.

Key Words: broilers, probiotic, blood factors


The use of endo-P-1,4-arabinoylases to improve the nutritional value of wheat-based diets for broilers is well accepted by the poultry industry and the mode of action is considered to be well elucidated. However, the use of xylanases to improve the nutritional value of diets for laying hens is not as comprehensively accepted by the industry. This may be due to the fact that laying hens have a more mature gastrointestinal tract than broilers and so are less adversely affected by the presence of high concentrations of soluble polysaccharides in the diet. In order to assess the effect of a new xylanase on laying hen performance a 42 week production study was conducted using a total of 384 Lohmann brown laying hens. The hens were split at 20 weeks of age into 3 treatment groups of 32 replicate cages with 4 birds in each cage. The control group received a wheat/soy-based diet (2730kcal/kg AME; 150g/kg crude protein) and the remaining two experimental groups received the same diet supplemented with either 625 or 2500 U/kg of a new thermotolerant xylanase from Trichoderma reesei. Feed consumption, changes in body weight, egg mass, egg numbers, mortality and egg quality were assessed from week 20 to week 62. Treatment effects were established using ANOVA and means separated using Tukeys LSD (P<0.05). Ingestion of the diets containing xylanase reduced (1.4%; P<0.05) feed intake and improved (4.1%; P<0.05) egg production compared with the control resulting in a significant improvement in FCR (2.32 vs. 2.21). In general, 2,500 U/kg of exogenous xylanase proved more effective than 625 U/kg but the lower inclusion concentration still elicited a significant improvement (2.1%) in egg production compared with the control. The xylanase used in this trial is inherently thermostable and although this is a trait that may be considered inconsequential in layer nutrition, the changes in enzyme conformation, the strength of ionic bonds and the degree of glycosylation in inherently thermostolerant enzymes can detrimentally alter bioefficacy. This is an accepted compromise for broiler production due to the benefits arising from improved recovery following conditioning, but it is important, in diets that are not pelleted, to demonstrate a high degree of efficacy. These data demonstrate that this new Trichoderma xylanase is effective in improving nutrient retention and egg production in Lohmann brown laying hens over a full 42-week production cycle and so is an effective nutritional tool to improve the profitability of egg production.

Key Words: enzyme, laying hen, wheat

M6  Ideal protein based turkey diets result in substantial cost savings. J. D. Firman*, University of Missouri, Columbia.

An experiment was conducted to determine if diets formulated to digestible amino acid specifications based on the Missouri Ideal Protein Ratio would perform similarly to an industry standard diet. Four treatments consisted of a control diet based on industry specifications (A), the second (B) was the exact requirements (digestible amino acids) with no safety factor, the third treatment (C) was B + 5% additional amino acids (recommended diet with safety factor included) and the final treatment was B + 10% additional amino acids. Thirty-two pens of 25 tom pouls were fed for 18 weeks in a curtain-sided two stage building. Body weight, feed:gain and mortality were recorded with diet changes occurring at 3 week intervals and processing yield data at the
conclusion of the trial. All data were analyzed with ANOVA followed by LSD for mean separation. Performance of the ideal protein diet was slightly reduced at 3 wks of age. The addition of 5 or 10% amino acids brought growth back to even with the industry diet at that time. No differences in performance were noted through 15 weeks. At 18 weeks, the ideal protein fed group was significantly lighter in weight (4.8%) than the industry diet while the diets with 5 or 10% AA additions did not differ from the control. Small differences in feed efficiency occurred through different phases of the trial, but there were no differences at the conclusion of the trial. These data would indicate that the exact requirements were slightly low, but the addition of a safety factor overcame this. Cost savings when comparing the ideal + 5% with the industry standard diet were dramatic. Cost savings per ton of feed ranged from $10.64 to $17.03 depending on phase. These data would indicate that ideal protein based turkey diets can be successfully fed with significant cost savings possible.

Key Words: turkey, amino acids, ideal protein


Feed constitutes the majority of investment in organic poultry production. Past research has demonstrated that broilers have the ability to self-regulate nutrient intake based on individual metabolic requirement and changes in environmental conditions. Incorporating a choice-feeding management system and utilizing grains produced on-farm may improve broiler performance and reduce production cost for small-scale organic broiler producers. The objective of this study was to evaluate performance and production cost of choice-feeding management using one of two different grains. Three hundred one-day-old Cobb 500 broilers were reared from 0-to-3-weeks in floor pens and fed a certified organic diet that met all NRC recommendations. On day 21, broilers were transferred to houses located on the West Virginia University certified organic farm. Broilers had access to pasture 12 hours daily and were exposed to natural fluctuation in environmental conditions. Experimental grower diets were certified organic and formulated to contain 30% grain and 70% of a complementary grain-specific premix. Broilers with no choice feeding option exhibited improved live weight gain (LWG), gain:feed (G:F), and carcass weight (CW) compared to broilers with a choice feeding option (P = 0.0054, 0.0001, and 0.0020, respectively). Broilers fed oats exhibited improved G:F (P = 0.0309) and smaller fat pad weights (P = 0.0052) compared to broilers fed corn. Grain type did not affect LWG (P = 0.7605). When utilizing a choice-feeding system, broilers fed oats consumed a grain to premix ratio more similar to formulated values (oats- 21.3 to 78.7 vs. corn- 58.1 to 41.9). However, the cost of the oat premix was approximately twice that of the corn premix. These results demonstrate that utilizing oats, a grain that may be produced on-farm, can improve broiler performance. However, choice-feeding may not be a viable economic option for small-scale poultry producers.

Key Words: organic, choice-feeding, oats

M8 Laying hen diets formulated with meat and bone meal and different amino acid digestibility coefficients. E. M. Casartelli*, O. M. Junqueira, R. S. Filardi, A. C. Laurentiz, and V. Assuena, Universidade Estadual Paulista/FCAV, Jaboticabal, SP, Brazil.

The objective of this study was to evaluate the performance and egg quality of laying hens fed diets formulated with a high quality meat and bone meal (MBM) and different amino acid (AA) digestibility coefficients. Formulation on a digestible AA basis allows for the formulation of diets with better precision and use of alternative ingredients more efficiently. During 4 periods of 28 days, 150 Isabrown hens 28 weeks of age were distributed in a completely random experiment with 5 treatments and 5 replicates of 6 birds each. The experimental treatments were: T1 and T2 diets were formulated with corn and soybean meal (CSB) with T1 formulated on total AA (TA) and T2 formulated on digestible AA (DA); T3, T4 and T5 diets were formulated with 6% MBM with TA (T3), diets formulated with DA coefficients determined in a previous experiment (T4), and diets formulated with DA recommended by Brazilian Standards (T5). DA was determined in a previous experiment using Acid Insoluble Ash as the indigestible marker. The parameters observed were feed intake (FI), egg production (EP), egg weight (EW), feed conversion (FC), Haugh units (HU), shell thickness (ST) and specific gravity (SG). Statistical evaluation of experimental data was done by GLM process from SAS®. Means were compared with 5% probability through orthogonal contrasts: C1 – T1 vs T2; C2 – comparison of the treatments T3, T4 and T5 and C3 – T1 and T2 vs T3, T4 and T5. Under the conditions of this experiment, the use of digestible as opposed to total AA values did not affect EP, EW, HU or SG. TA formulation promoted higher and lower values for FI and ST (P < 0.05), respectively in the C1 contrast. In the C2 contrast the lowest value for FC (P < 0.05) was obtained for T4. The diets formulated with MBM diets decreased FI (P < 0.05) in comparison with CSB diets (C3). While the use of digestible AA values in general is to be recommended, when feed ingredients of high digestibility are employed, improvements in performance maybe difficult to observe.

Key Words: laying hens, amino acids, meat and bone meal

M9 Evaluation of guar meal TME<sub>a</sub> using feed-trained roosters. O. Gutierrez*, A. Haq, J. C. Wood, and C. A. Bailey, Texas A&M University, College Station.

A preliminary study was conducted to determine the nitrogen-corrected true metabolizable energy (TME<sub>a</sub>) of guar meal. Varying slightly from Farrell’s method, 12 Single Comb White Leghorn roosters were trained to voluntarily consume a daily feed allocation of guar meal in less than two hours. Over a two month period, roosters were adapted to consuming high levels of guar meal by blending increasing proportions with ground corn, eventually reaching a maximum level of 40% inclusion. A total of eight roosters were placed in non-adjacent cages equipped with individual feeders, drinkers, feed spillage trays, and fecal collection trays. Following a 48 hour period during which no feed was administered, a 24 hour fecal collection was taken in order to determine endogenous energy losses. Test diets, consisting of ground corn mixed with guar meal (0, 10, 20, 30, and 40%) were administered on consecutive days, beginning with the 0% guar diet and increasing to the 40% guar diet. For each diet, birds were administered approximately 40 g of feed and allowed a two hour voluntary feed consumption period, after which remaining feed was weighed in order to determine individual feed consumption. Water was available ad libitum. Fecal
samples were frozen for later lyophilization and calorimetry. A Parr adiabatic calorimeter was used to determine gross energy of feed and feces, and a Vario elementar C/N analyzer was used to determine nitrogen content in feed and feces. When extrapolated to 100%, guar meal TME was calculated at 1987 kcal/kg DM. Although the trend line ($y = -10.772x + 3064; r^2 = 0.686$) demonstrated an overall decrease in TME as guar levels increased, individual observations for guar meal between 10 and 30% actually increased to a maximum of 2393 kcal/kg DM at 30% inclusion. This observation may be explained by gut adaptation that possibly occurred during the training period when roosters were fed high levels of guar, followed by an abrupt change in feed composition when the energy trials began in earnest.

Key Words: TME, guar meal, SCWL rooster


Studies were conducted to determine the effects of variable levels of dietary protein on the growth and composition of broiler chickens. Ross 708 broiler chickens (8 birds per treatment) were fed eleven combinations of dietary protein levels. In one experiment, birds were fed diets containing 24% protein from 0 to 14 days of age, 18 or 21% from 14 to 26 days of age and 12 or 18% protein until 35 days of age. In a second experiment, birds were fed diets containing 12, 24 or 30% protein from 0 to 35 days of age; in addition, at day 26 birds fed the 12% protein diet were switched to 30% protein, birds fed 30% protein were switched to 12% protein, and birds fed 24% protein were switched to either 12 or 30% protein. Birds were killed at day 35 and dual X-ray absorptiometry (DXA) was used to approximate body composition. Lower levels of protein during early growth periods resulted in lower BWt at day 35. Body weights for the diet groups ranged from 747 g (12% protein diet) to 1865 g (24% protein diet, $P < 0.05$). The same pattern was observed between diet and total body lean mass, thus, lean mass was highly correlated with body weight ($r = 0.98$). Percentage of body fat was not correlated with body weight ($P = 0.20$), but was influenced by the level of protein in the diet. The percentage of body fat ranged from 8.4% (30% protein diet) to 19.5% (24-21-12% protein diet, $P < 0.05$). Total body bone mineral content (BMC) and density (BMD) were highly correlated with body weight ($r = 0.91$ and 0.79). The results of this study demonstrate that as the level of protein in the diet is altered, lean mass and bone mineral deposition are closely associated body weight gain while fat deposition is more dependent on the pattern in which the level of protein in the diet is altered.

Key Words: broilers, body composition, DXA

M11 Fate of Cry3Bb1 protein in laying hens fed diets containing MON 863. S. E. Scheideler,1 P. Weber*1, K. Sok1, R. E. Hileman2, and G. F. Hartnell2, University of Nebraska, Lincoln, Monsanto Company, St. Louis, Missouri.

Two trials were conducted to assess the fate of the Cry3Bb1 protein from YieldGard® Rootworm corn (MON 863) when fed to laying hens. Two diets, one formulated with MON 863 and one with conventional corn, were fed to laying hens for 8 wk during the first trial. Diets were formulated to be equal in all nutrient requirements for laying hens. Each corn treatment was fed to birds in 12 replicate cages with 4 hens/cage. Daily feed intake (FI) and egg production (EP) were measured during the trial and body weight (BW) at the beginning and 2-wk intervals. At the end of week 4 and 8, egg and fecal samples were collected from each pen and tested for the presence of Cry3Bb1 protein using a double antibody sandwich format lateral flow strip test. Corn and diet samples were also tested for the protein. At the end of the trial, 12 hens/diet were euthanized and hepatic and pectoralis tissue samples tested for the Cry3Bb1 protein. The corn source had no significant effects on FI, EP, or BW in this experiment. Feces from hens fed diets containing MON 863 were all positive for the Cry3Bb1 protein or proteolytic fragments of the Cry3Bb1 protein. Feces from hens fed diets containing conventional corn were all negative for the Cry3Bb1 protein. These findings were expected since proteins from corn and soybean meal are not totally digested in the chicken. Cry 3Bb1 protein could not be detected in eggs due to the presence of an interfering protein in all test and control eggs. Hepatic and pectoralis tissue samples were all negative for the presence of Cry3Bb1 protein in both corn treatments. A second trial was conducted to further study the presence of Cry3Bb1 protein in the digesta of hens fed a diet containing MON 863. The same test and control diets used in the first trial were used and fed to 12 hens each. Six hens/treatment were sampled after 7 and 28 days. Digesta samples were collected from the crop, small and large intestine, and ceca. Feces and blood samples were also collected. Cry 3Bb1 protein could not be detected in blood due to the presence of an interfering protein in all test and control blood samples. The results from the second trial confirmed that detectable levels of Cry3Bb1 protein and/or partially digested fragments were found in all sections of the chicken's digestive tract. We calculated that 98 to ≥ 99% of the dietary Cry3Bb1 protein was digested based on the level of Cry3Bb1 and/or fragments that were detected in the feces and on estimates of corn protein digestion. This degree of digestion is greater than the reported literature values (84-90%) for dietary protein. Thus, Cry3Bb1 protein is highly digestible in laying hens with only small amounts being detected in the feces. Overall, MON 863, when fed to laying hens, had no significant effects on FI, EP, or BW. Cry 3Bb1 protein was extensively digested similar to that of other dietary protein and was not detected in hepatic or muscle tissue.

Key Words: Cry3Bb1 protein, rootworm corn, laying hens


This experiment was conducted to evaluate the effect of inclusion of coconut meal (CM) in diets on nutrients digestibility, bird performance, and egg characteristics of laying hens. A total of 150 laying hens at 76 weeks of age were weighed and distributed in a completely randomized design with five treatments and five replicates of six birds in each experimental unit. Treatments consisted of one diet without CM and four diets containing 5, 10, 15, and 20% CM. Values for ether extract, crude fiber and gross energy increased with the inclusion of CM in diets. Related to digestibility it was observed a quadratic effect of CM inclusion levels on metabolizable coefficients for dry matter (MCDM), nitrogen (MCN), and gross energy (MCGE). Quadratic effects were also verified for the values of apparent metabolizable energy (AME) and nitrogen corrected apparent metabolizable energy (AMEn). The maximum inclusion level found for energy utilization by birds was 15%. Values of AME and AMEn were higher in diets containing 10,
15, and 20% CM than in that without CM. Egg production, egg weight (g) and egg mass (g) were not affected by the inclusion levels of CM. However feed intake (g/bird/day) decreased and feed conversion (g feed/g egg) improved as CM level increased in diets. According to the estimated point of maximum utilization of energy, CM can be used in laying hens diets in levels up to 15%.

Key Words: alternative feed, egg characteristics, metabolizable coefficients

M13 Tibia quality of broilers fed diets with phytase and reduced nonphytate phosphorus levels. M. C. Oliveira1, R. A. Gravena2, R. H. Marques3, A. B. Traldi2, and V. M. B. Moraes+2, 1Universidade de Rio Verde, Rio Verde, GO, Brazil, 2Universidade Estadual Paulista, Jaboticabal, SP, Brazil.

An experiment was carried out to evaluate the morphometry, breaking strength and mineral content of tibia from broilers fed diets containing reduced nonphytate phosphorus (NPP) levels and phytase. The broilers were distributed in a factorial arrangement (2 x 3) with two phytase levels (0 and 25 U/kg) and three NPP levels (100, 85 and 70% of bird requirement), totaling six treatments with five replicates in a completely randomized design. The phytase inclusion improved (P < 0.05) the bone weight and the reduction of NPP in the diet to 70% of the bird’s requirement decreased (P < 0.02) bone strength compared with birds of the treatments with 100 and 85% of the NPP requirements. There was no effect (P > 0.05) of phytase, NPP or interaction on length, diameter and mineral content. It was concluded that it is possible to use diets with 85% of NPP requirements, supplemented with 25 U/kg phytase, with no negative effect on tibia quality.

Key Words: bone strength, bone mineralization, enzymes

M14 The effect of a novel phytase to improve phosphorus utilization of wheat-based diets. H. Shah+1, M. M. Harris2, C. Fodor1, N. Wall1, A. Smykot3, J. Remus2, and D. R. Korver1, 1University of Alberta, Edmonton, AB, Canada, 2Danisco Animal Nutrition, St. Louis, Missouri.

A 2x2x2 factorial arrangement of treatments was used to investigate the effect of a novel phytase in wheat–based diets. Basal diets containing either normal (Normal; wheat-soy diet) or high (High; wheat-soy-canola meal diet; 0.05% higher) phytate were formulated. Within each phytase level, negative control (NC) diets were formulated to provide 28 to 38% lower P and Ca values than the positive control (PC) diet within each diet phase. The decrease was based on the expected effect of phytase on P and Ca availability. Within each phytase/nutrient density diet, half of the basal diet was supplemented with phytase (Phyzyme XP; 500 U/kg feed); the other half was not supplemented. A xylanase (Avizyme 1302) was added to all diets. Each of the 8 diets was fed to 8 replicate pens (75 chicks/pen) of Ross 308 broiler chicks. The diets were fed as a starter (0–10d), grower (11–28d) and finisher (29–37d). Body weight (BW), gain, and feed intake and feed conversion efficiency (FCE; gain g/ feed g) were measured. At 37 d of age, bone mineral density (BMD) was determined using quantitative computed tomography on the femur of 1 bird per pen. The Normal phytase diets increased feed intake (P < 0.05) and FCE (P < 0.001) during the grower phase relative to the High diets but had no effect on BW and gain. High dietary phytate reduced (P = 0.04) BMD at 38 d of age. The PC birds had increased BW (P < 0.05), gain (P < 0.05) and feed intake (P < 0.05) relative to the NC birds. Phytase increased (P < 0.001) body wt, gain (P < 0.001), feed intake (P < 0.001) and FCE (P ≤ 0.001) throughout the study, and BMD at 38 d of age (P < 0.02). There were phytate×nutrient density and phytate×phytase interactions (P < 0.05 and 0.01, respectively) for FCE over the entire experiment. The NC treatment decreased FCE in the High-, but not in the Normal phytate diet relative to the PC treatment (P < 0.05). Phytase supplementation in the High phytate diet increased FCE, but not in the Normal phytate diet (P > 0.01). Phytase increased BMD in the NC groups but not in the PC groups. Phyzyme XP improved performance and BMD of broilers fed wheat-based diets.

Key Words: phytase, broiler, bone mineral density


Growth trials were conducted with the Ross 708 broiler chicken to corroborate the relationships between changes in the growth curve (7 to 35 days) and in vitro metabolic parameters. These in vitro parameters also included estimates of the expression of certain genes regulating proteins implicated in the regulation of lipogenesis. Birds were fed diets containing 24% protein from 0 to 14 days of age, 21% from 14 to 26 days of age and 18% protein until 35 days of age (Exp 1). Birds were fed diets containing 24% protein from 0 to 14 days of age, 18 or 21% from 14 to 26 days of age and 12 or 18% protein until 35 days of age (Exp 2). Birds were fed diets containing 12, 24 or 30% protein from 0 to 26 days of age. The 12% group was switched to 30% protein and the 30% group to 12% protein. The 24% group was switched to either 12 or 30% protein (Exp 3). Birds were selected and killed at ages corresponding to protein changes. Dual X-ray absorptiometry (DXA) was used to approximate body composition of birds at day 36. The switch from the starter protein level of 24% crude protein to the only slightly lower protein grower diet (21% crude protein) increased both in vitro lipogenesis and malic enzyme activity. A similar observation was noted when the birds were switched to the 18% crude protein finisher diet. These same switches also elicited initial increases in malic enzyme, fatty acids synthase and acetyl CoA carboxylase gene expression that were not sustained following adaptation to the dietary change. Data also show that DXA can be used to estimate body composition of this type of birds.

Key Words: metabolism, gene expression, finisher

M16 The effect of different levels of fat and L-carnitine on performance and serum composition of male broiler chicks. M. Rezaei*, A. Attar1, A. Ghodratnama2, and H. Kermanshahi3, 1Mazandaran University, Sari, Mazandaran, Iran, 2Center of Khorasan Agricultural Researches, Mashhad, Khorasan, Iran, 3 Ferdowsi University, Mashhad, Khorasan, Iran.

An experiment was carried out to investigate the effect of 3 levels of fat (1, 3, 5%), and 2 levels of L-carnitine (0, 250 mg/kg) on 360 male Ross broiler chicks in a factorial arrangement (2 x 3). A completely randomized design with 6 treatments replicated 4 times with 15 chicks per replicate was used. Diets were fed to chicks from 1 to 42 days...
of ages. During the experiment, feed intake, body weight gain, and feed conversion ratio were measured weekly. Mortality was measured throughout the experiment. At 42 days of age, blood samples were collected from 4 birds in each treatment. Data of the experiment were analyzed by GLM procedure of SAS. Increasing fat in the diets significantly improved performance of chicks during the grower (1 to 21 days) and whole period (1 to 42 days) of the experiment (P < 0.05). Adding L-carnitine to diets significantly decreased the level of triglyceride (TG), cholesterol, very low density lipoprotein (VLDL) of chick blood serum (P < 0.05). The level of serum TG, VLDL, and glucose were also affected by fat level (P < 0.05). Interaction between fat and L-carnitine on serum TG, and glucose was significant (P < 0.05). Results of the present study indicated the positive effect of fat on performance and significant effect of L-carnitine on decreasing of serum TG, cholesterol, and VLDL of male broiler chicks.

Key Words: fat, L-carnitine, broiler


A precision feeding experiment was conducted to compare the effect of feeding three dietary activities of phytase (Quantum: Syngenta Animal Nutrition Inc.) on endogenous secretions, measured as sialic acid (SA), from the gastrointestinal tract (GIT), and true metabolisable energy (TME) of the diets when fed to young turkeys. Forty BUT 6 female turkeys, weighing approximately 2.5 kg were used in this experiment. Five treatments (control diet based on a maize/soy diet, control + 250 IU phytase, control + 500 IU phytase, control + 2500 IU phytase, and glucose for endogenous loss estimation) were used in this study and each treatment was replicated eight times in a randomised block design. The concentration of excreted SA decreased (P < 0.05) when the amount of phytase in the feed increased. The amount of SA excreted also tended to decrease (P = 0.066) when comparison was made between the negative control and 250 FTU supplemented vs 500 and 2500 FTU diets. TME tended (P < 0.05) to increase two treatments (250 and 500 IU phytase) in comparison with the control diet. A negative linear relationship (P = 0.001) between dietary TME and sialic acid excreted for 48h was determined. An increase in the turnover and production of the GIT is biologically very expensive for the birds and involves losses of endogenous amino acids. It can be concluded that a decrease of secretion from the gastrointestinal tract is one of the mechanisms involved in the mode of action of dietary phytases.

Key Words: phytase, turkeys, endogenous losses

M18 Effect of pelleting temperature and phytase type on phytase survivability and broiler performance. R. Angel1, N. Ward2, and A. D. Mitchell1.1University of Maryland, College Park, 2DSM Nutrition Products, Inc., Parsippany, New Jersey, 3USDA, BARC, Beltsville, Maryland.

A two part study was conducted to determine survivability of phytases when subjected to pelleting and their subsequent. A basal corn-soy diet was used. To achieve all Ca, P, and phytase concentrations, monocalcium phosphate, calcium carbonate, phytase, and Celite® (marker and filler) were used. Diets were: 0.24, 0.32, and 0.40% non-phytate P (nPP), no added phytase diets and 8 diets with added phytase at different concentrations to the 0.24% nPP diet. Ronozyme (P) CT® (R) and Quantum Phytase TM 2500 D (Q) were tested. Q was added at 250, 500, and 1000 U/kg and R at 500 U/kg. Enzymes were added based on analyzed activity and added either pre-or post pelleting (PreP, PostP) resulting in 8 diets. Pelleting was done at 70, 80, or 90 C. Only diets pelleted at 90 C were fed. Ross 308 broilers were allocated, at hatch (H), to battery pens, 7 pens (7 b/pen) per diet. BW, FC, and feed/gain were determined at 8 and 18d of age. At 18 d, 3 b/pen were frozen and bone mineral content and density determined using dual energy X-ray absorptiometry. Toes and right tibia were removed and dry-defatted ash determined. Excreta were collected, to determine apparent P retention, excreta P solubility. Enzyme survivability during pelleting was 61.8, 25.4, and 7.1% for Q and 77.2, 67.1, and 57.7% for R at 70, 80, or 90 C, respectively. The greatest BW (P<0.01) was in broilers fed the 0.40% nPP diet (731.4 g), followed by those fed the PreP Q1000 diet (685.9 g). Broilers fed the PostP Q500 and R500 diets had similar weight at 18 d (688.1 and 684.1 g). Tiba ash was greatest (P<0.01) in broilers fed the 0.40% nPP diet and the PreP Q1000 diet (51.12 and 50.04%), followed by those fed the PreP Q500 and R500 diets (49.86 and 48.82%). Broilers fed the PostP R500 and Q1000 diets had similar tibia ash (47.91 and 47.53%). P retention was similar (P>0.05, 57.5 and 54.7%) for birds on the pelleted R 500 and Q500 diets and was lower (P<0.01) for birds fed the 0.40% nPP diet (47.9%). The R enzyme survived pelleting better than the Q enzyme. Apparent efficacy of the enzymes after pelleting was similar, while the Q enzyme had better efficacy than the R enzyme if fed in PreP diets.

Key Words: phytase, pelleting, broiler

M19 The effects of vitamin D supplementation to peak-producing hens fed diets containing different fat source and level on laying performance, metabolic profile, and egg quality. L. Turgut1, A. Hayirli2, S. Çelebi1, M. A. Yörük2, M. Gül3, M. Karagoğlu1, and M. Macit1.1Atatûrk University, Erzurum, Turkey, 2Atatûrk University, Erzurum, Turkey.

This experiment was designed to examine the effects of supplemental vitamin D on laying performance, metabolic profile and egg quality of hens fed diets containing different fat source and level. Lohman strains (n=480) were assigned to one of 10 diets: diets containing 0, 2.5 and 5.0% sunflower oil (SO) or tallow (T), and these diets with 3-fold vitamin D. Each diet was tested in 12 replicate cages of 4 hens, from wk 30 to 44. Both fats decreased feed intake (FI) as compared to basal diet. Increasing SO and T levels linearly decreased and quadratically increased FI, respectively. Diets did not affect egg production (EP) and egg weight. Vitamin D supplementation increased and decreased EP when diets contained SO and T, respectively. Feed conversion ratio (FCR) for hens fed SO was lower than for hens fed T. However, increasing T level improved FCR, whereas increasing SO level worsened FCR. Serum vitamin D concentration was higher for hens fed SO than for hens fed T. Vitamin D supplementation increased serum vitamin D concentration. Increasing fat level linearly increased TG and VLDL concentrations. Increasing SO level linearly decreased cholesterol concentration. Vitamin D supplementation did not alter lipid metabolites. Diets did not affect serum Ca, and P concentrations. As compared with control diet, SO decreased dry tibia and ash weight more than T. Vitamin D supplementation tended to increase dry tibia weight and decreased tibia ash weight. Most of egg quality parameters were not responsive to the diets. Eggshell strength quadratically
increased with increasing T level. Yolk color for hens fed SO was lower than for hens fed T. Increasing SO level quadratically decreased yolk C18:2 concentration. Vitamin D addition increased and decreased yolk C18:2 concentration when diets contained SO and T, respectively. In conclusion, increasing fat level improved laying performance without adverse effects on metabolic profile and egg quality. Vitamin D supplementation had minor alteration effects on parameters in response to fat feeding.

**Key Words:** sunflower oil, tallow, vitamin D


The objective of this research was to investigate mRNA abundance of sugar transporters in the small intestine of two genetic lines of broilers, selected on corn-soybean (Line A) or wheat based (Line B) diets. The genes examined included SGLT1, SGLT5, GLUT5, and GLUT2. Intestine was collected from four males from each line at the following time points: embryo day 18 (e18) and 20 (e20), day of hatch (doh), and d 1, d 3, d 7 and d 14 after hatch. After hatch, birds were given ad libitum access to a low-protein, corn-soy based diet, as this has been shown to accentuate differences in body weight between the two lines. At e18 total intestine was collected, and thereafter, intestine was divided into duodenum, jejunum, and ileum. Total RNA was isolated and mRNA abundance was assayed using real time PCR and the absolute quantification method. Data were analyzed using the PROC MIXED procedure of SAS. The model included the main effects of bird line, intestinal segment and age, and appropriate interactions. Segment differences were evaluated by the Tukey test. For SGLT1, GLUT5 and GLUT2, mRNA levels were greatest in the jejunum (P = 0.0001). For SGLT5, mRNA was greatest in the ileum and lowest in the duodenum (P = 0.0001). Quantities of SGLT1 mRNA were approximately sixfold greater than SGLT5, suggesting an important role for SGLT1 in apical membrane glucose transport. For GLUT5, GLUT2, and SGLT1 there was an interaction of age x segment (P = 0.008), with mRNA increasing most dramatically with age in the jejunum. For GLUT2 there tended to be an age x line interaction (P = 0.0549), with line B mRNA increasing more dramatically after d3. In conclusion, sugar transporter mRNA was expressed the greatest in the mid-region of the small intestine, except for SGLT5, which was greatest in the distal region. Quantities of SGLT5 mRNA were higher in Line A.

**Key Words:** glucose transporter, real time PCR, broiler

**M21** Morphometry of intestinal mucosa in 21 day-old broiler chickens fed mannan-oligosaccharides and a blend of enzymes. M. C. Oliveira*, R. A. Gravena, R. H. Marques, L. C. Cancherini, E. A. Rodrigues, and V. M. B. Moraes. 1University of Rio Verde, Rio Verde, GO, Brazil, 2State University of Sao Paulo, Jaboticabal, SP, Brazil.

This experiment evaluated the morphometry (height and perimeter of villi and crypt depth) of intestinal mucosa in broiler chicks fed mannan-oligosaccharides (MOS) and a blend of enzymes (BE) at 21 days of age. Seven hundred fifty day-old Cobb chicks were randomly assigned to a 2 x 2 + 1 factorial design - two levels of MOS (0 and 0.1%), two levels of BE (0 and 0.05%) plus a positive control diet for a total of five treatments with five replicates each. Positive control contained colistin sulphate (125 ppm) and virginiamycin (10 ppm) as growth promoters, and salinomycin (51 ppm) as anticoccidial. BE was comprised of cellulase, protease and amylase. After 12 h of fasting, five birds per treatment were euthanized, and a 3-cm sample of each small intestine segment were collected. Height and perimeter of villi, and crypt depth were measured under light microscopy. A MOS x BE interaction was observed for perimeter (P < 0.002) and height (P < 0.002) of duodenal villi, which were larger compared with those of negative-control chickens. Addition of MOS to the diet increased (P < 0.05) the perimeter of the jejunal villi. Perimeter (P < 0.04) and height (P < 0.05) of ileal villi from chickens fed non-additive diets were both smaller. The high proliferation of bacteria in intestine of broilers fed diets without antibiotic, MOS and/or BE probably damaged the intestinal mucosa. The stimulatory effects of MOS were attributed to the reduction of pathogens in the gut together with the production of short chain fatty acids after fermentation of digest in the distal intestine. The inclusion of enzyme to the diet quantitatively lowered the available substrate to the bacteria growth, usually high in the lower segment of the small intestine. Compared with chickens fed an antibiotic-treated diet, duodenal villi from birds of MOS group had larger perimeter (P < 0.02), larger height (P < 0.005), and deeper crypt (P < 0.02). In conclusion, it was observed that the use of MOS and/or BE improved the integrity of intestinal mucosa in broilers from 1 to 21 days of age.

**Key Words:** additives, intestinal morphology, prebiotic

**M22** Effect of supplementing a probiotic feed additive on performance and digestibility of broilers. J. Sánchez*, A. Quiles, A. E. Espinel, D. Diaz, and M. I. Gracia. 1Imasde Agropecuaria S.L., Madrid, Spain, 2Universidad de Murcia, Spain, 3Norel S.A., Madrid, Spain.

A total of 960 Ross 308 d-old broilers were used to study the efficacy of a probiotic feed additive (Ecobiol®) containing 1 x 10^9 CFU/g of Bacillus coagulans CECT 5940. A randomized complete design was applied using four experimental treatments: T1 designated as control (no added probiotic), and T2, T3 and T4, the control diet with 100, 500 and 1,000 mg/kg of probiotic, supplying 1 x 10^9, 5 x 10^8 and 1 x 10^8 CFU/kg feed, respectively. The experimental design was applied to 10 pens of 24 broilers (half males and half females) per treatment in both the starter (0-21 d) and the grower (21-42 d) phases. The experimental diets, based on barley, wheat and soya, were presented as mash, did not contain any coccidiostat or growth promoter and were fed ad libitum to the chicks. At the end of the trial, four birds per replicate were sacrificed, the ileum content collected and freeze-dried. Apparent ileal digestibility (AID) of crude protein, ether extract, starch and crude fiber were calculated using acid insoluble ash as indigestible marker. Body weight, mortality, weight gain, feed intake, feed to gain ratio, the available substrate to the bacteria growth, usually high in the lower segment of the small intestine. Compared with chickens fed an antibiotic-treated diet, duodenal villi from birds of MOS group had larger perimeter (P < 0.02), larger height (P < 0.005), and deeper crypt (P < 0.02). In conclusion, it was observed that the use of MOS and/or BE improved the integrity of intestinal mucosa in broilers from 1 to 21 days of age.

**Key Words:** additives, intestinal morphology, prebiotic
lower doses. It is concluded that B. coagulans probiotic feed additive at 1,000 mg/kg improves performance and AID of broilers fed wheat-barley/soya diets.

Key Words: probiotic, ileal digestibility, broilers

M23 Screening of selected probiotic isolates for phytase activity and effects on poultry when fed low phosphorus diets. A. Torres Rodríguez1, G. Gaona*2, A. Wolfenden2, G. Tellez2, and B. Hargis2, 1Cobb-Vantress, Siloam Springs, Arkansas, 2University of Arkansas, Fayetteville.

Selected probiotic strains of lactic acid bacteria were screened for phytase activity with an agar plate staining technique. The staining technique is based on the color reaction between free phosphate and ammonium molybdate (Yanke et al., 1998). Agar plates containing phytate substrate (1% w/v) were used to grow 11 strains of lactic acid bacteria (LAB) selected for their ability to exclude Salmonella enteritidis from the gastrointestinal tract of poultry with improvements in performance. The presence of the enzyme phytase was confirmed in 9 of the 11 selected LAB strains. Experiments were conducted with turkey pouls fed low phosphorus diets alone or supplemented with LAB. Preliminary trials using ten day-old pouls reared with regular turkey starter feed prior to feeding phosphorus-deficient diets for periods of at least two weeks indicate that pouls receiving a low phosphorus diet supplemented with LAB and lactose may grow at similar or higher rates than the P-deficient and unsupplemented counterparts. No apparent statistical significances were detected in tibia bone ash and tibia diameter, although the latter tended to be greater in the probiotic-supplemented group.

Key Words: probiotic, phytase

M24 High glucose levels in ovo causes damage to embryos. A. A. Pedroso*, L. S. Chaves, V. T. Barbosa, I. B. Maciel, and C. E. Barbosa, University of Goias, Goiania, Goias, Brazil.

High glucose levels were tested as in ovo feeding to chick embryos. An experiment was carried out using 600 fertilized eggs. The eggs were identified, weighed, and allocated into five incubators regulated at 65% RH and 37.5°C. At the 15th incubation day, eggshells were drilled in air chamber region and the solution was manually injected with a sterile syringe. Each egg was injected with either 0, 100, 200 or 300 mg of glucose dissolved in 300 ml of saline solution (0.9%). The glucose was deposited in the amniotic liquid. Entire eggs represented the control group. The experiment consisted of five treatments with 120 eggs used in each treatment. Each egg represented an experimental unit. After inoculation, the eggs were packed individually in tulle and relocated into the incubators until hatch. The treatments 100, 200 or 300 mg of glucose cause damage to embryos. High mortalities were observed in later embryonic phase (from 15 to 20 days of incubator). Possibility, glucose altered the egg osmotic balance, and damaged the embryonic cells. Glucose levels did not improve hatchability, relation of chick:egg, and chick weight.

Key Words: in ovo feeding, chicks, carbohydrate


A study was conducted to investigate the effects of dietary enzymes on growth performance, intestinal enzyme activities. Ninety broiler chicks were assigned to one of two dietary treatments (with or without Avizyme 1502) from d 0 to 21. Sixteen chicks were weighed from each treatment at d 7, 14, and 21. Half (n = 8) were used to collect digesta from the jejunum and ileum to determine amylase and protease activities. Remaining chicks were used to obtain duodenum, jejunum, and ileum tissues to evaluate maltase, sucrase, and aminopeptidase N activity. There were no significant differences between dietary treatments in body weight. Jejunal amylase activity in enzyme supplemented chicks at d 7 and 21 was higher (P < 0.05) compared to control chicks (d7, 93.40 vs. 160.86 U/g wet digesta; d 21, 92.78 vs. 162.45 U/g wet digesta). There was no significant difference in ileal amylase and protease activity at any age. Duodenum maltase activity on d 21 was higher (P < 0.05) compared to d 14 and 7 (9.85 vs. 5.55 and 2.50 U/mg protein, respectively) with activity on d 14 being higher than (P < 0.05) d 7. Duodenum aminopeptidase N on d 21 was higher (P < 0.05) compared to d 7 (0.58 vs. 0.41 U/mg protein). Jejunal maltase activity on d 21 was greater (P < 0.05) compared to d 14 and 7 (3.61 vs. 1.44 and 1.39 U/mg protein, respectively). Ileum maltase activity on d 14 was higher (P < 0.05) compared to d 21 (0.95 vs. 0.50 U/mg protein). There were no differences observed in maltase activity between control and enzyme supplemented chicks in duodenum (5.45 vs. 6.45 U/mg protein), jejunum (2.25 vs. 2.04 U/mg protein), and ileum (0.59 vs. 0.86 U/mg protein). Also noted was a trend of decreasing maltase activity from duodenum to ileum. Jejunal sucrase activity on d 7 was higher (P < 0.05) compared to d 14 and 21 (0.022 vs. 0.014 and 0.014 U/mg protein). Ileal sucrase activity on d14 was greater (P < 0.05) compared to d 21 (0.037 vs. 0.020 U/mg protein). This study indicates supplementing chicks with Avizyme 1502 will increase digesta amylase activity but not protease, disaccharidase or aminopeptidase N.

Key Words: broiler, amylase, disaccharidase

M26 Maternal dietary conjugated linoleic acid had no adverse effects on progeny development. V. A. Leone* and M. E. Cook, University of Wisconsin, Madison.

We have previously shown that decreased hatchability of eggs from hens fed conjugated linoleic acid (CLA) could be prevented by the addition of monounsaturated (MUFA) or polyunsaturated (PUFA) fats. While linoleic acid (LA) addition to the diet prevented CLA-induced embryonic mortality, the feeding of both CLA and LA (both inhibitors of stearoyl CoA desaturase, SCD-1) dramatically reduced egg yolk MUFA. Studies involving SCD-1 knock-out mice have demonstrated altered lipogenesis; however, no study has reported the effects of maternal CLA (with particular reference to the hatchability in the presence of rescue oil) on post-hatch growth and development. Hence a study was conducted to investigate the effects of rescue oil type with or without CLA, on post-hatch development. Hens (48) were randomly assigned to 4 diets in a 2x2 factorial: 3.5% Safflower Oil (SO, 80% 18:2), 3.5% Olive Oil (OO, 80% 18:1), 3% SO+0.5% CLA (SO+CLA, CLA-60, 30% e9, t11 and 30% t10, c12 isomers), and 3% OO+0.5% CLA (OO+CLA). After two weeks on diet, hens were inseminated. Eggs were collected, held at 15 degrees C for one week, and incubated.
Egg production, fertility, and hatchability were recorded. Newly hatched chicks were separated by treatment and 50 chicks were assigned to 5 pens per treatment (10 chicks per pen). Individual chick weights and feed intake were monitored for 21 days. Maternal dietary CLA plus oil high in LA or OA had no adverse effects on egg production, fertility, or hatchability. Three experiments were performed to measure chick growth, feed consumption, and 21-day feed conversion. Data were pooled and analyzed for main effects of CLA and oil type, as well as CLA x oil interactions. Although not significant, a 6% improvement in 21-day feed conversion was seen in chicks hatched from hens fed OO+CLA in comparison to other treatment groups. CLA in the presence of rescue oil had no adverse effects on chick growth or 21-day feed conversion. Therefore, it appears that changes in fatty acids in the yolk associated with maternal CLA and rescue oils had no adverse effects on post-hatch chick development.

Key Words: maternal conjugated linoleic acid, progeny, development

M27 Investigating possible interactions between phytase and xylanase in wheat-based diets for broilers. T. A. Woyengo*$1,
W. Guenter1, J. S. Sands2, and C. M. Nyachoti1, 1University of
Manitoba, Winnipeg, MB, Canada, 2Danisco Animal Nutrition, St.
Louis, Missouri.

An experiment was conducted to determine the effect of combining phytase and xylanase on nutrient utilisation and broiler performance. Three hundred and twenty male Ross-by-Ross broiler chicks were divided into 80 groups of 4 birds balanced for body weight (BW) and fed 10 wheat-based diets (8 groups/diet) from 1 to 23 d of age. The 10 diets were a control and a nutrient reduced (Ca and P) diet supplemented with phytase at 3 levels, 0, 250 and 500 FTU/kg and xylanase at 3 levels, 0, 1250 and 2500 XU/kg in a 3x3 factorial arrangement to give 9 treatment combinations. Chromic oxide (0.3%) was added to the diets as an indigestible marker to determine nutrient digestibility and retention at 3 weeks of age. There were no significant interactions (P>0.05) between phytase and xylanase on any of the parameters measured. ADFI and ADG were not affected by enzyme supplementation but FCE was improved only by phytase supplementation at 250 FTU/kg. Birds fed non-enzyme supplemented nutrient reduced diet had lower (P < 0.05) ADFI (37.2 vs 45.3 g) and ADG (28.9 vs 34.6 g) than the positive control. Phytase, but not xylanase, increased (P < 0.05) ileal digestibility and retention of P from 35.1 to 41.3 % and 47.3 to 51.4 %, respectively. However, there was no effect (P>0.05) of increasing the level of retention of P from 35.1 to 41.3 % and 47.3 to 51.4 %, respectively. However, there was no effect (P>0.05) of increasing the level of retention of P from 35.1 to 41.3 % and 47.3 to 51.4 %, respectively. However, there was no further effect (P>0.05) at higher levels of phytase (56.8 vs 55.0 %) and xylanase (57.6 vs 55.8 %) on Ca retention.

Key Words: wheat, phytase/xylanase, nutrient digestibility

ABSTRACTS OF PAPERS

M28 Effect of folic acid supplemented diets with and without enzyme on folate deposition in the egg yolk. T. M. Dickson*, W. Guenter, and J. D. House, University of Manitoba, Winnipeg, MB, Canada.

Previous research has shown that egg folate deposition is a saturable process. One potential regulatory mechanism exists at the level of intestinal folate absorption. Feed constituents can influence nutrient absorption: Diets high in non-starch polysaccharides (NSPs) are poorly digested, leading to increased intestinal viscosity and, potentially, reduced folate absorption. The objectives of the current trial were 1) to determine the effect of the addition of dietary enzymes to a wheat/rye-based diet on egg folate content, and 2) to determine the effect of enzyme and wheat-based rations supplemented with crystalline folic acid on the egg folate content. To address these objectives, 120 Hy-Line CV20 laying hens (n = 12 per diet) received a 40% (of grain) rye and wheat ration containing 0, 0.5, 1.0, 2.0, or 4 mg of crystalline folic acid/kg of diet for five 7-day periods. Response criteria included measures of in vivo viscosity and measures of egg folate content. Data was analyzed as a completely randomized design, which revealed that the enzyme had significant (P < 0.0001) main effects on in vivo viscosity. Folate data was analyzed as repeated measures design using the mixed procedure which revealed that the addition of enzyme to the diet had no significant (P > 0.05) effect on egg folate levels. Egg folate content significantly (P < 0.0001) increased 2.2-fold; from 1.30 micrograms of folate/gram of yolk with an unsupplemented diet without enzyme to 2.96 micrograms of folate/gram of yolk when supplemented with 4 mg folic acid/kg of diet and no enzyme. Average egg folate levels over the 5 periods were 1.3, 1.7, 2.1, 2.5, and 2.6 micrograms/gram of yolk for respective rations containing 0, 0.5, 1.0, 2.0, and 4 mg of crystalline folic acid/kg of diet without enzyme. While folate levels in the egg increased as the amount of supplemental dietary crystalline folic acid increased, the intestinal viscosity did not affect folate deposition.

Key Words: egg, folate, intestinal viscosity

M29 EU promoted development of a multi-component feed additive for the safe use in poultry production. V. Klose*1, R. Plail1, M. Mohml1, S. Nitsch2, and G. Schatzmayer1, 1University of Natural Resources and Applied Life Sciences, Tulln, Austria, 2Biomin GmbH, Herzogenburg, Austria.

Assessment of the main criteria for evaluation of probiotics in terms of identity, efficacy and safety is an essential part in the development of zootechnical feed additive for use in European broiler production. An EU-promoted project (C-EX QLK-CT-2002-71662) was initiated to develop a well-defined multi-component product combining various effective strains. A large pool of gut bacteria was isolated out of the intestine of healthy broilers and classified by combining morphological, physiological and genotypic methods along the route of a polyphasic approach in order to obtain optimal strains for a competitive exclusion product. 121 strains were selected as representatives based on differences in whole cell protein patterns and screened for antagonistic properties by using a co-cultivation assay. A reduced number of 20 strains exhibited the ability to inhibit several common poultry pathogens (Salmonella enteritidis, S. choleraesuis, E. coli serotypes, C. jejuni and C. perfringens). Five effective strains (Pediococcus acidilactici, Enterococcus faecium, Bifidobacterium animalis ssp. animalis, Lactobacillus reuteri, L. salivarius ssp. salivarius) were
chosen for the combined use in the final product (Biomin® PoultryStar) and further evaluated with regard to the European safety requirements. The probiotic candidates were sensitive to the majority of clinically effective antibiotics. Single resistances were proven to be intrinsic (e.g. vanA) and not transferable. Positive effects of Biomin® PoultryStar have been shown in vivo with a feeding trial which revealed a statistically significant (P<0.05) increase in average body weight as well as in weight gain (~7.6%).

Table 1. Results of the feeding trial with mixed sex Ross 308 broilers obtained at day 35

<table>
<thead>
<tr>
<th>group</th>
<th>control</th>
<th>Biomin® PoultryStar</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of broilers</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>live weight (g)</td>
<td>1875a</td>
<td>2017b</td>
</tr>
<tr>
<td>daily weight gain (g)</td>
<td>52a</td>
<td>56b</td>
</tr>
<tr>
<td>feed conversion rate</td>
<td>1.66</td>
<td>1.61</td>
</tr>
<tr>
<td>mortality (%)</td>
<td>1.25</td>
<td>0.42</td>
</tr>
</tbody>
</table>

a, b significant difference (P<0.05)

Key Words: competitive exclusion, European registration, safety assessment

M30  The effect of Tasker Blue on shelf-life of fresh broiler chicken carcasses. S. M. Russell*, The University of Georgia, Athens.

A study was conducted to evaluate the effect of Tasker Blue (sulfuric acid, ammonium sulfate, and copper sulfate) on the shelf-life of fresh broiler chicken. To mimic application of the product in the scalder, chillers, and as a post-chill dip, the following were prepared: two 55 gallon drums were filled with scaler water (S), 2 with water from chiller 1 (CH1), 2 with water from chiller 2 (CH2), 2 with water from chiller 3 (CH3), and 2 with tap water (DIP) after 5 h of run-time in a commercial poultry processing facility. One of each of these pairs of drums was used as a control and one was dosed with Tasker Blue to a pH of 2.0 and copper content of 2.0 ppm, except the chiller water drums were dosed to a pH of 3.2 and a copper content of 2.0 ppm. Eighteen carcasses each were exposed to the control or treated S for 2 min, CH1 for 17 min, CH2 for 15 min, CH3 for 45 min, and DIP for 10 s, allowed to drip for 1 min, individually placed into sterile bags, and packed on ice in a cooler. The carcasses were transported to the laboratory and held at 4°C for 6 days. At Day 6, 8, 10, 12, 14, and 16, three carcasses each from the control and treated groups were evaluated by a three-member panel for odor score where 1=no off odor, 2=questionable with regard to acceptability, and 3=unacceptable. Additionally, psychrotrophic counts (PPC) were conducted. Odor scores were 1, 2, 3, 3, 3, and 3 for controls and 1, 1, 1, 2, 2, and 3 for treated samples on Day 6, 8, 10, 12, 14, and 16, respectively. Log10 PPC were 7.3, 7.6, 11, 11, 11, and 11 for controls and 5.2, 5.1, 6.8, 7.7, 8.1, and 11 for treated samples on Day 6, 8, 10, 12, 14, and 16, respectively. Odor scores were significantly (P<0.05) reduced for treated carcasses at Day 8 through 14 of storage. PPC were significantly (P<0.05) lower on treated carcasses at Day 6 through 14 of storage. Tasker Blue dramatically suppressed the growth of spoilage bacteria with a 99.99% reduction at Day 10 and a 99.9% reduction at Day 12 of storage. Tasker Blue prevented any spoilage defect from occurring on carcasses until Day 12 (4 days later than controls) and prevented complete spoilage from occurring until Day 16 (6 days later than controls). These data clearly indicate that Tasker Blue had a significant impact on spoilage of broiler chicken carcasses.

Key Words: shelf-life, Tasker Blue, chicken


The objective of this USDA Higher Education Challenge Grant is to establish a large library of video assets for the food processing industry, including poultry. These assets will be short videos from 5 to 30 sec showing unit operations and general overviews of food processing facilities. The assets are being supplied by the food industry, mainly suppliers. It is being reviewed and edited to obtain the most pedagogically useful items. The web site has search capabilities and contributor information. Users can “store” clips for later review or class sharing. The temporary site is open to the professional community. Additional assets are being processed. In addition, model active learning materials featured on the site will suggest ways that instructors can use the site to optimize learning by engaging the student. An instructional designer is working with us to optimize how these models can be used to optimize learning and enhance teaching. A set of active learning materials for poultry are based on input obtained from a group of American poultry faculty. Three active learning models have been developed. The first model is a PowerPoint based detailed flow chart of a poultry processing plant with metalinks to the video assets. The other two models involve metalinks embedded within the chapter text and outline on poultry processing written by Dr. Dan Fletcher at the University of Georgia in Athens. These active learning models and assets are at the temporary site www.seeker.doit.wisc.edu/foodsci. We are looking for feedback from the poultry community to improve these materials before completing the permanent web site.

Key Words: video clips, active Learning, poultry processing


Influence of post-mortem (PM) deboning time on breast meat yield and quality of broilers was assessed at two market weights. A total of 1600 male broilers were raised in 32 floor pens to 56 d of age. At 42 and 56 d of age, 10 birds were randomly selected from each pen, processed and chilled in static slush ice. At each age, one-half of the birds (5 birds/pen) were deboned immediately after static chilling (2 h postmortem; PM) and the remaining after overnight aging in a cooler at 4 C (24 h PM). Whole carcass, abdominal fat, parts (wings, leg quarters) and deboned breast (fillet and tender) yields were determined. Deboned breast fillets were individually bagged and stored at 4 C for drip loss (12 h and 48 h), cook loss, and water holding capacity (WHC) measurements. Breast fillet color (L*, a*, b*) was determined at 56 d age.

At 42 d of age, no significant treatment effects were detected (P>0.05) for whole carcass and parts yields. However, breast fillet and total breast (fillet + tender) yields were significantly higher in the 2 h PM (25.7 and 30.8%) than in 24 h PM (25.2 and 30.3%) treatments, respectively. Conversely, at 56 d of age, birds deboned 2 h PM had...
significantly higher parts yields than those deboned at 24 h. Deboned breast yields (fillet, tender and fillet + tender) were significantly different between the PM treatments (2 h PM; 26.2, 5.1 and 31.3%, 24 h PM; 25.2, 4.9 and 30.1%). As expected, drip loss (12 h), and WHC were higher for 2 h than 24 h PM treatments, both at 42 and 56 d of age. Cook loss differed between the PM treatments at 42 d, but not at 56 d of age. Breast fillets deboned 2 h PM were significantly darker (L* = 54.8) as compared to those deboned at 24 h (L* = 56.5). The yield advantage (0.5-1.2%) in breast meat from early deboning (2 h PM) observed at 42 and 56 d of age may be lost upon refrigerated storage and cooking.

Key Words: broilers, market quality, meat weight

M33 Effects of proteolysis on textural properties and water-holding capacity of heat-induced turkey breast meat gels. X. Li*, Z. Pietrasik, and P. J. Shand, University of Saskatchewan, Saskatoon, SK, Canada.

Protein denaturation and degradation early postmortem are major defects of pale, soft, and exudative (PSE) turkey meat, however the relationship between degradation and gelation is unclear. The purpose of this research was to investigate the effect of an exogenous protease on textural properties and water-holding capacity (WHC) of heat-induced gels prepared from normal and PSE turkey breast meat.

Breast meat from normal and PSE turkeys was used to make low-fat high moisture meat gels. To create different extent of proteolysis in the meat, α-chymotrypsin (EC3.4.21.1) was added to the meat batters at 0, 2.5, 5 and 10 ppm levels. Then meat batters were stuffed into 50 mL tubes, held at 37°C for 30 min and cooked to 80°C in a water bath.

SDS-PAGE of meat gels showed no visible changes in banding patterns with 2.5 ppm α-chymotrypsin, but protein hydrolysis became apparent at higher levels. At the highest protease level, band density of the myosin heavy chain (MHC) decreased up to 43% and 38% for normal and PSE samples, respectively. Actin and other proteins were also hydrolyzed to a lesser extent. Texture profile analysis and torsional analysis of the cooked meat gels showed an incremental deterioration in texture with increasing enzyme level. For instance, hardness decreased by 10%, 22%, and 75%, and shear stress decreased by 15%, 26%, and 72% for normal meat gels, respectively. Smaller decreases in texture were observed for gels made from PSE meat, which may have been related to its inferior initial quality. No significant difference in cook loss was observed either between normal and PSE groups or among treatments. Expressible moisture (EM) of PSE gels was higher (p < 0.05) than that of normal gels and increased with enzyme level. Pearson correlation coefficients indicated gel textural properties and EM were highly correlated to the degree of proteolysis, especially to that of MHC (p < 0.001). Even a low extent of proteolysis had a dramatic effect on textural properties of turkey breast meat gels.

Key Words: proteolysis, textural properties, WHC


Oxidative stress, a result of an imbalance between oxidants and antioxidants, causes macromolecular damage which results in diseases and other abnormalities. Though it has been implicated in many diseases in mammals, it has been little studied in economically important poultry species. Here, our objective was to compare the oxidant (thiobarbiturate acid reacting substance, TBARS, as biomarker) and antioxidant (plasma uric acid, PUA, and glutathione, GSH as biomarkers) status of three poultry species including turkey (Meleagris gallopavo), Japanese quail (Coturnix japonica), and guinea fowl (Numida meleagris). At 2 months-of-age, oxidant levels in the three species were significantly different, with the quail having the highest at 0.72mg/mL, and the turkey having the lowest at 0.31mg/mL. At this age, the antioxidant levels were also significantly different with guinea fowl showing the highest value of 10.4 mg/dL and 75.6μM for PUA and GSH respectively. At 6 months of age, lipid peroxidation as reflected in the TBARS values, about 5mg/L, was not significantly different among the three species. Differences in the antioxidant levels, however, varied with biomarker. Guineafowl had the highest PUA level of 7.6mg/dL and quail the lowest of 5.1mg/dL. Guinea fowl also had the highest GSH level of about 660.6μM though the differences between the turkey and quail were not significant. Though not consistent, the data suggests that the quail has the highest oxidant status while the guinea fowl the lowest antioxidant level. They appear to suggest that on the average oxidative stress is highest in the quail and may not be very different in the turkey and guinea fowl.

Key Words: antioxidant, oxidant, poultry

M35 Effects of feeding grains naturally contaminated with fusarium mycotoxins on brain regional neurochemistry of laying hens, turkey poults, and broiler breeder hens. M. Yegani*, S. R. Chowdhury1, N. Oinas2, E. J. MacDonald2, and T. K. Smith1, 1University of Guelph, Guelph, ON, Canada, 2University of Kuopio, Kuopio, Finland.

Three experiments were conducted in order to compare the effects of feeding blends of grains naturally contaminated with Fusarium mycotoxins on brain regional neurochemistry of laying hens, turkey poults, and broiler breeder hens. In experiment 1, thirty-six 45-wk-old laying hens were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% polymeric glucamannan mycotoxin adsorbent (GMA) for 4 wk. Concentrations of brain neurotransmitters and metabolites were analyzed in pons, hypothalamus and cortex by high performance liquid chromatography with electrochemical detection. Neurotransmitters and the metabolites measured included dopamine (DA), 3, 4-dihydroxyphenyacetic acid (DOPAC), homovanillic acid (HVA), serotonin (5-HT), hydroxyindolacetic acid (5-HIAA), epinephrine (EPI), and norepinephrine (NE). The feeding of contaminated grains significantly increased concentrations of serotonin (5-HT) and decreased the ratio of 5-HIAA: 5-HT in the pons region in the brain stem. Dietary supplementation with GMA prevented these effects. There was no effect of diet on concentrations of other neurotransmitters or metabolites in the pons, hypothalamus or cortex. In experiment 2, thirty-six 1-d-old turkey poults were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% GMA for 4 wk. Hypothalamic, pons, and cortex neurotransmitter concentrations were not affected by diet. In experiment 3, forty-two 26-wk-old broiler breeder hens were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% GMA for 15 wk. There was no effect of diet on neurotransmitter concentrations in the pons, hypothalamus, or cortex. It was concluded that different effects of diet on brain neurotransmitter concentrations might explain.
the intra-species differences in the severity of Fusarium mycotoxin-induced reductions in feed intake.

**Key Words:** fusarium mycotoxin, brain regional neurochemistry, broiler breeder hen

**M36** Effects of feeding grains naturally contaminated with fusarium mycotoxins on performance and metabolism of broiler breeders and efficacy of a polymeric glucomannan mycotoxin adsorbent. M. Yegani1, T. K. Smith1, S. Leeson1, and H. J. Boermans2,3,1University of Guelph, Guelph, ON, Canada, 2University of Guelph, Guelph, ON, Canada.

A study was conducted in order to investigate the effects of feeding grains naturally contaminated with Fusarium mycotoxins on performance and metabolism of broiler breeders. Forty two 26-wk-old broiler breeder hens and nine roosters were fed diets including: (1) control (2) contaminated grains and (3) contaminated grains + 0.2% polymeric glucomannan mycotoxin adsorbent (GMA) for 12 wk. The major contaminant was deoxynivalenol (12.6 mg/kg feed) with lesser amounts of zearalenone and 15-acetyl deoxynivalenol. Feed consumption and body weights were not affected by diet. The feeding of contaminated grains did not significantly affect egg production. Decreased eggshell thickness was seen, however, at the end of week 4 and dietary supplementation with GMA prevented this effect. There was no effect of diet on other egg parameters measured. There was a significant increase in early (1-7 d) embryonic mortality in eggs from birds fed contaminated grains at week 4 but mid (8-14 d) and late (15-21 d) embryonic mortalities were not affected by diet. There were no differences in newly hatched chick weights or viability. The ratio of chick weight to egg weight was not affected by the feeding of contaminated grains. Weight gains of chicks fed a standard broiler starter diet at 7, 14 and 21 days of age were not significantly affected by previous dietary treatments for the dam. There were also no differences in weekly or cumulative feed efficiency of the progeny. There was no effect of diet on the relative weights of liver, spleen, kidney, and testes. Blood biochemistry and hematological parameters were not affected by the feeding of contaminated grains. It was found that rooster semen volume and sperm concentration, viability and motility were not affected by the feeding of contaminated diets. The feeding of contaminated grains decreased antibody titers against infectious bronchitis virus at the end of week 12 and this was prevented by dietary supplementation with GMA. There was no effect of the diet on serum antibody titers against Newcastle disease virus. It was concluded that the feeding of diets containing Fusarium mycotoxins to broiler breeders impair reproductive performance and immune status and much of these effects can be prevented by the feeding of GMA.

**Key Words:** bone mineralization, dual-energy X-ray absorptiometry, broilers

**M37** Bone mineralization in four commercial strains of meat-type chickens. P. Talaty1, M. N. Katanbaf2, and P. Y. Hester*3,1Purdue University, West Lafayette, IN, 2Cobb-Vantress, Inc., Monticello, Kentucky.

The objective of this study was to determine life cycle changes, including variability, in bone mineral density (BMD) of the tibia and humerus of four different strains of male and female commercial meat-type chickens from 4 to 8 wk of age. Broilers were raised using standard management practices and consumed commercial diets and water ad libitum. Bone mineralization was determined in birds by scanning the humerus and tibia using dual energy X-ray absorptiometry (DEXA). Birds to be scanned (3 chickens per pen with 3 replicate pens/strain) were selected randomly at 4 wk of age and repeated measurements done on the same birds at 4, 6, and 8 wk of age. Totals of 104 to 108 scans were performed on each strain of commercial broiler. The BMD was analyzed using an analysis of covariance with body weight as the covariant. Strain and sex of the bird were main plots with bone and age of the bird as subplots. The mixed model of SAS was employed. The BMD did not differ among the four strains of commercial broilers (0.212, 0.218, 0.209, and 0.207 for Cobb 500, Cobb 500T, Ross 308, and Cobb 700, respectively, SEM = 0.003, P=0.11). Interactions with strain of chicken were non-significant indicating that all strains of chickens responded similarly with respect to age (4, 6, and 8 wk of age), sex, and type of bone (humerus vs tibia). The BMD of broiler males decreased at 8 wk of age when compared to 4 and 6 wk of age, while the BMD of females showed little change from 4 to 8 wk of age resulting in a significant sex x age interaction (P < 0.02). The decrease in BMD observed in males at 8 wk of age was most likely due in part to the inability of some males to reach the feeders due to lameness. Only healthy birds without defects were selected at 4 wk of age for DEXA scanning; however, a few males developed leg abnormalities by 8 wk of age. Coefficients of variation for BMD ranged from 15 to 16% indicating a potential use of DEXA for selection to improve skeletal integrity.

**Key Words:** fusarium mycotoxin, broiler breeder, eggshell thickness

**M38** Properly reporting religious slaughter in the scientific literature. J. M. Regenstein*, Cornell University, Ithaca, New York.

With the current interest and emphasis on animal welfare, including poultry, within the agricultural and processing communities, the issue of religious slaughter and its evaluation, mainly kosher (Jewish) and halal (Muslim), continues to be studied by the scientific community. In the literature many different methods of religious slaughter are used. The pre-slaughter equipment that is used with ritual slaughter are very different from one situation to another, including animals being presented for slaughter right-side up, hanging (shackling), or upside down. These animals may be in various states of calm or stress at that time. The persons doing the slaughter may have very different skill sets and sometimes even use different techniques. They may be the actual person doing the religious slaughter, while others are researchers attempting to mimic religious slaughter. The details for evaluating the above issues and the additional information that would be needed to critically evaluate the impact of these factors on religious slaughter are not being reported. Many of these papers do prove that the particular system used at one time in one place may be inhumane and requires change. But, this information is often unfairly generalized to question all religious slaughter. The lack of sufficient detail about critical methods makes it difficult to determine the inherent humaneness of religious slaughter. These data do serve to show that the system is not being optimized and that improvements are needed. Thus, this project is designed to work with the religious community and the research community and those actually involved in slaughter to accomplish two goals: To improve the animal welfare of religious slaughter consistent with religious requirements and to look critically at the impact of religious slaughter when done using best available methodology. A set
of standardized reporting requirements are being developed. The input of the scientific community is desired.

Key Words: kosher slaughter, halal slaughter, scientific reporting

M39  Turkey beak trim and feed form. 1. Effect on turkey performance. S. L. Noll*1 and H. Xin2, 1University of Minnesota, St. Paul, 2Iowa State University, Ames.

Commercial turkeys undergo beak trimming at the hatchery prior to placement on the farm. The practice has come under scrutiny as an animal welfare issue. The research was conducted to assess methods of beak trimming and feed form on early tom poult performance and subsequent performance to market. Large White male turkey poults (1600 total, Hybrid strain) were obtained. At the hatchery, poults were beak trimmed via methods of electric arc (E), hot blade (HB) or infrared (I). A non-trimmed control (C) was also obtained from the same lot of poults. Turkeys within each beak trim treatment were fed a commercially prepared diet. Diets were fed either in mash (M) or as crumbles/pellets(CP). Crumbles were fed to 6 wks of age with pellets fed to 18 wks of age. For each treatment combination there were 8 replicate pens. A completely randomized block design was used for assignment of treatments and a factorial model used in the analyses of variance. The level of statistical significance is set to 0.05 unless stated otherwise. Live weight at 18 wks of age was improved by the feeding of CP by 5.3% and cumulative feed efficiency by 9.5%. Beak trimming did not affect body weight. Feed efficiency was improved in beak trimmed birds as compared to the non-trimmed controls when fed mash feed only. Higher mortality to 6 wks of age was observed with the birds that had beaks trimmed by hot blade as compared to the non-trimmed control (P<.06). The greatest effect of beak trim treatment was the incidence of damage related to pecking and the amount of birds that were removed from the experiment due to pecking injuries. Removals averaged 19, 7, 11, and 21% for the untrimmed controls, and poults trimmed by E, I, and HB methods, respectively. Turkeys beak trimmed by HB exhibited more regrowth of the beak. The results indicate that beak trimming did not negatively affect production performance with the exception of the hot blade treatment. Beak trimming substantially reduced the incidence of pecking damage and culling when regrowth did not occur. Commercial market tom turkeys responded favorably to the feeding of pellets with increased body weight most likely as a result of increased early intake.

Key Words: turkey, beak trim, feed form

M40  Turkey beak trim and feed form. 2. Effect on turkey behavior. H. Kassube*, E. Hoerl Leone2, I. Estevez2, H. Xin3, and S. Noll1, 1University of Minnesota, St. Paul, 2University of Maryland, College Park, 3Iowa State University, Ames.

Commercial market turkeys undergo beak trimming at the hatchery prior to farm placement in order to decrease aggressive activities, such as feather pecking and cannibalism, which lead to mortality. Limited research has been done to determine the effect this procedure has on turkey poults. The objectives of this study are to assess the method of beak trimming and feed form on turkey behavior. The hypothesis is that feed form and beak-trimming will modify feeding and aggression behavior. Male Large White commercial turkey poults were obtained from a hatchery following beak trimming by hot blade, electric arc, and infrared methods, along with a set of birds that were not beak-trimmed. The poults were randomly assigned to 16 replicate floor pens per beak treatment with eight pens each fed mash or crumbled pelleted feed to 18 wks of age. Behavior observations were conducted using Observer software package (Noldus) and a time budget was created for each focal bird. Three birds per pen were observed, for a total of 24 replicate focal birds per feed/beak-trim treatment combination. Statistical analyses were conducted with SAS (V.9). Feed form was found to modify the time budget. Results indicate that poults fed the mash feed spent a larger percentage of their time feeding than those fed pellets (9.3 vs. 2.9%), along with less time resting and standing. Beak trim treatment did not affect the time budget nor were there any interactions of beak trim treatment with feed form. No significant interaction between feed form and beak trim method was detected. However, there was a significant interaction between feed form and period for the percentage time spent standing and preening while sitting. There was also an interaction between beak-trim method and age period on the amount of time spent drinking and foraging. Finally, a three-way interaction of beak trim, feed form and observation period was observed for the time spent preening while standing. In conclusion, feed form was found to alter the time budget of the turkeys primarily by changing the amount of time spent eating.

Key Words: turkey, behavior, beak trim

M41  The influence of exercise on the bone mineral density of laying chickens consuming a marginally deficient calcium diet. N. P. Johnston*1, G. Aduviri2, R. T. Davidson1, S. Fullmer1, and B. Curfew1, 1Brigham Young University, Provo, Utah, 2University of San Andres, La Paz, Bolivia.

Research suggests that exercise in addition to diet has a positive influence on bone mineral density. It was hypothesized that as space and the opportunity for activity increased laying chickens would deposit progressively denser bones during the period of lay. To test the hypothesis individual laying hens were housed in either a standard research cage (38 x 51 x 47 cm, floor space, 1,938 cm2, area 91,571 cm3), modified turkey cage (61 x 81 x 72 cm, floor space 4,494 cm2, area 358,223 cm3), or floor pen (122 x 122 x 76 cm, floor space 14,884 cm2, area 1,071,864 cm3). In the turkey cage the birds had to mount a perch to eat and drink while in the floor pen a nest box and a perch were available. Twenty 18 wk old SCWL were equally divided into four treatment groups. In treatment 1 and 2 they occupied research cages and in 3 and 4 turkey cages and floor pens respectively. Treatment 1 received a complete diet with 3.5% Ca and served as the control while the remaining three treatments received a similar diet but with 3.0% Ca. The later was done to place a degree of stress on the cortical-trabecular bone system of treatment birds. Feed and water were provided ad libitum, ambient room temperature was 18o C with a light dark cycle of 14L:10D. The humerus, tibial, and tarsometatarsus bones were scanned for density using a GE Lunar DEXA at 20 wks, 35 wks, and 42 wks of age. All treatment bone densities were similar at the outset. At 35 wks humerus bones were denser (P<0.05) for turkey caged (0.201 g/cm2) and floor pen (0.205 cm2) birds than treatment 2 research cage (0.184 cm2) at 42 wks of age humerus bones were denser (P<0.05) for the floor pens (0.228 cm2) than both research cage groups (0.209, 0.205 cm2) and tibial bone density was greater for floor and turkey (0.362, 0.370 cm2) than treatment 2 research (0.335 cm2). In conclusion, as hypothesized, birds provided greater space and opportunity for exercise produced denser bones.

Key Words: bone, density, space
M42 Differences in light intensity by cage location and tier level affect egg production and quality. A. Yıldız, A. Hayırıl*, E. Laçin, and M. Macit, Ataturk University, Erzurum, Turkey.

This experiment was conducted to determine the effects of cage location and tier level with respect to light intensity on egg production and egg quality of hens housed in semi-confined facility. ISA Brown hens (n=225), 75 wks of age, were placed into 3-tier cages as top (T), middle (M), and bottom (B) tiers located in cages either illuminated artificially (EI), by window (FW), or between corridors (C) for 2 mo. The light intensity was measured monthly for each cage from a 5 cm-distance from feeders every 6 hrs. Egg production was recorded daily and egg quality was assessed biweekly. The light intensity was the greatest for cages at FW (151.9, 119.8, and 89.8 lux for tiers T, M, and B, respectively), followed by EI (52.6, 54.5, and 51.0 lux for tiers T, M, and B, respectively), and C (44.5, 23.4, and 4.7 lux for tiers T, M, and B, respectively). Hens at location EI had greater egg production than hens at FW and C. Egg production for hens at tier T was also greater than for hens at tiers M and B. Egg production for hens at EI and C decreased quadratically whereas that for hens at FW decreased linearly from tiers T to B. Cage location but not tier level affected egg weight. Hens at EI and FW produced heavier eggs than hens at C. Shape index, yolk color, and yolk index were independent from cage location and tier level. Hens at EI and FW produced eggs with thinner and weaker shell than hens at C. Moreover, eggshell strength increased linearly from tier T to B. Both albumen index and Haugh unit were independent from location and cage size. In conclusion, variation in light intensity in multi-tier cage system in semi-confined laying hen houses may be contributing factors for depressed laying performance and egg quality.

Key Words: light intensity, cage location, tier level

M43 Efficacy of sodium bisulfate as a litter amendment to reduce paw burns in broiler chickens. M. Nagaraj*, J. B. Hess, and S. F. Bilgili, Auburn University, Auburn, Alabama.

Broiler house environment, especially volatile ammonia content has a significant effect on paw burns in chickens. The objective of the present research was to evaluate the efficacy of sodium bisulfate (SB) [PLT; Jones-Hamilton Co.] in reducing paw burns in broilers. 960 straight-run day old chicks were randomly assigned to 16 environmental chambers with four different levels of SB (4 chambers per treatment). The treatments comprised of Trt 1 (control; no litter amendment), Trt 2 with SB applied at 1x rate at the day of placement of chicks, Trt 3 with SB applied at 2x rate at the day of placement of chicks and Trt 4 with SB applied at 1x rate at the day of placement of chicks and at 1x rate on day 21. Birds were raised for a period of 49 days on a four stage feeding program of high protein and all vegetable diets, which have been shown to induce high incidence of paw burns. At 35 d the litter was moistened artificially to see the effect of SB on ammonia volatilization. Body weight, feed conversion and mortality were determined on 42 & 49 d. Ammonia concentration (ppm) in the chambers was measured prior to placement of chicks and on a weekly basis throughout the experiment. Paws were scored on 42 & 49 d of age and the severity was recorded as none (no ulcerating lesion), mild (lesions of <1.5 cm), and severe (lesions of >1.5 cm). No differences in live performance of the birds was observed throughout the study (P>0.05). Sex had significant effect on incidence of paw burns (P<0.05), with females showing higher incidence of paw burns than males. However, males had higher proportion of severe burns compared to females. SB had a significant effect on ammonia volatilization in the chambers (P<0.05). Ammonia concentration was significantly reduced in all treatments, except the control (Trt 1). SB had no significant effect on ammonia levels after 35 d upon addition of moisture to the litter. Although not significant (P>0.05), using SB as a litter amendment appeared to reduce the incidence and severity of paw burns. Use of litter amendments to convert volatile ammonia to an inert form may help in a program designed to reduce paw burns in broilers.

Key Words: broiler, paw burns, litter amendment

M44 Improving drag swab detection of Salmonella in broiler litter. R. J. Buhr*, L. J. Richardson, J. A. Cason, and N. A. Cox, USDA-ARS Russell Research Center, Athens, Georgia.

For the past 25 years drag swabs have been used to sample litter in broiler growout houses to predict Salmonella status of the flocks. A drag swab consists of a cotton gauze swab attached to a cord, moistened with double strength skim milk, and dragged across the surface of the litter as the sampler walks through the house. Recent reports have indicated that litter sampling with a shoe cover or sock (worn over disposable plastic boots) has detected Salmonella–positive litter with better sensitivity. In the present study, Salmonella–positive litter was sampled by intermittently stepping on drag swabs (ISODS) as well as the traditional drag swab and sock methods described above, to test whether increased contact of the sampling surface with the litter increases detection of Salmonella. Chicks in each of 12 pens had been challenged with Salmonella on the day of placement. At 6 wk of age, ceca were Salmonella–positive from 87/120 (73%) of the broilers sampled (10 per pen). Litter was sampled at 7, 8, and 9 wk of age. At 7 and 8 wk the pens were occupied with broilers and at 9 wk the pens had been vacant for 1 wk. At 7 wk, 11/12 drag swabs, 11/12 ISODS, and 12/12 socks were Salmonella–positive. With high levels of Salmonella present in the litter, all sampling methods were equally able to detect Salmonella from the litter. At 8 wk, 4/12 drag swabs, 8/12 ISODS, and 7/12 socks were Salmonella–positive and at 9 wk, 1/12 drag swabs, 6/12 ISODS, and 5/12 socks were Salmonella–positive. When sampling at 8 and 9 wk the ISODS and the sock sampling methods recovered more than twice as many Salmonella–positive samples when compared to traditional drag swab sampling. Intermittently stepping on drag swabs while sampling litter in broiler houses may increase detection of Salmonella in broiler flocks at no additional cost.

Key Words: Salmonella detection, litter sampling, drag swabs

M45 Influence of housing system, grain type and particle size on Salmonella colonization and shedding in broilers fed triticale- and corn-soybean meal diets. F. Santos*, A. Santos, Jr, P. Ferket, and B. Sheldon, North Carolina State University, Raleigh.

The present study focused on determining the effect of feeding whole grains and housing design on cecal Salmonella colonization, growth performance and carcass yield of broilers fed triticale/ or corn/SBM-based diets. Broilers reared either in a cage-based house (Broilermatic System®) or a conventional house (litter floor) from 0-42 d were assigned to 1 of 4 dietary treatments (trt): 1) ground corn-SBM (C, 560μ), 2) coarse ground-corn-SBM (CC, >1700μ), 3) ground triticale-SBM (T, 560μ), and 4) whole triticale-SBM (WT). A 4-strain
cocktail of *Salmonella enterica* was orally-gavaged into each chick at placement. Cecal populations were estimated on 7, 14, 21, 28, 35, and 42d. Growth performance was measured on 14, 28 and 42d. Broilers responded differently to the dietary treatments according to housing system. At 42d, birds reared on litter had better body weights when fed ground grain (2.87, 2.86, 2.73, 2.69 kg; trt 3, 1, 4, 2, respectively; P=0.004, no statistical difference between T and C); however, broilers reared in the Broilermatic cages were heavier when fed T (2.75, 2.67, 2.65, 2.61 kg; trt 3, 4, 2, 1, respectively; P=0.01), no statistical difference between WT, CC and C trt. Compared to Broilermatic, raising broilers on litter improved the 1-42d FCR (1.71 vs. 1.81 g/g, P=0.0001). Independent of housing system, relative eviscerated carcass weights of birds feed T were equivalent to the C fed birds and heavier than CC and WT fed broilers (0.764, 0.760, 0.752, 0.752 g/g, respectively; P=0.01). Feeding whole/coarse ground grains decreased cecal *Salmonella* populations in broilers (3.8, 3.9, 4.4, 4.4 log MPN/g; trt 2, 4, 1, 3, respectively; P=0.05). Housing type also influenced cecal *Salmonella* populations. At 42d, birds reared on litter had lower populations than broilers reared in cages (3.8 vs. 4.4 log MPN/g, P=0.002). In conclusion, triticale appeared to be a good alternative feed ingredient to corn resulting in improved body weights and reduced *Salmonella* colonization. Moreover, raising broilers on litter greatly reduced cecal *Salmonella* populations.

**Key Words:** *salmonella*, broilermatic, triticale

**M46 Cytogenetic telomere array profile analysis comparing different chicken genotypes.** T. H. O’Hare* and M. E. Delany, *University of California, Davis.*

The degree to which telomere arrays, including both terminal and interstitial categories, vary for size, number, and position among different genotypes is unknown. This could be an important source of genetic variation determinative of genome stability, impacting growth, development, disease, and cellular aging. In the chicken genome, in addition to the standard-sized telomere arrays which exhibit shortening with the absence of telomerase, a category of extremely long telomeres (100s to 1,000s of Kb in length) known as mega-telomeres have been described. The objective of this study was to investigate the uniformity of telomere array profiles among different chicken genomes to better understand telomere length regulation and its impact on chicken biology. Here we report on initial studies focusing on two cell lines of high utility for applied and basic poultry biology research (DT40 and DF-1); results from the cell lines were compared to the inbred line UCD 003. Telomere array profile comparisons were achieved by fluorescence in situ hybridization (FISH) using a telomeric-DNA probe applied to mitotic chromosomes; the resulting images were analyzed for number and distribution of arrays on macro and microchromosomes as well as the sex chromosomes. Interestingly, the telomerase-negative cell line, DF-1 exhibits a greater amount of telomeric DNA and a higher number of mega-telomere signals than DT40 which is telomerase positive. DF-1 appears to have a similar number of mega-telomeres as compared to UCD 003 (4-5 loci) but initial analysis indicates that the chromosomal location of the mega-telomeres differs and that in fact the number and location may vary within the cell line. DT40 exhibited a lower number of mega-telomere signals (3-4 loci) as compared to both UCD 003 and DF-1. The telomeric DNA signals in DT40 were of reduced intensity suggesting an overall altered telomere profile. Mechanisms for such differences will be discussed, including the contribution of karyotype anomalies in both cell lines.

**Key Words:** telomere, DT40, DF-1

**M47 Understanding eggshell matrix protein genes for improvements in shell quality.** M. Hincke*,1, H. Esmai1, G. Ansa2, and A. Kulenkamp, 1*University of Ottawa, Ottawa, On, Canada, 2Shaver Poultry Breeding Farms Ltd., Cambridge, On, Canada.

The objective of this research project was to characterize genes of eggshell-specific matrix proteins that are involved in the formation and properties of the eggshell, and investigate whether polymorphisms were correlated with eggshell phenotypes such as shell strength or thickness. We studied a uterine-specific matrix protein (ovocleidin-116, OC-116) and a mineralization-specific protein (Osteopontin, OPN). Eggshell matrix proteins influence shell biomechanics and strength due to their influence on calcium carbonate crystallization patterns. Shell was collected from 100 randomly selected pedigree white leghorn layers at 72 weeks of age. Birds producing eggshell of poor, average and superior strength were identified. Blood was collected from birds in each group for sequencing of these genes and identification of SNP’s. Correlation analysis of polymorphisms with shell quality parameters was performed: specific gravity, breaking strength, deformation under load, thickness, egg weight, egg length and egg weight. Sequencing of the Ovocleidin-116 and Osteopontin genes identified 2 alleles in each case, OC-116 - A, B and OPN - 0, 1, which were found to be highly linked. Breaking strength was not significantly different for eggs from the homozygotes (AA or BB) or the heterozygote group (AB); however, shell thickness and specific gravity were higher for BB than for AA groups, while AB was intermediate. These differences were significant for shell thickness. Egg indices (weight, length and width) were all higher for BB than for AA and AB. Overall, the relationship between AA00, BB11, and AB01 was the same as for AA, BB and AB. Breaking strength was the same for all groups, but BB11 birds have larger, thicker, and heavier eggs with highest specific gravity and lowest deformation. We have identified gene polymorphisms that are associated with differences in egg and eggshell properties. Therefore, selection based on OC-116 gene will be a novel tool to identify hens with superior production traits. (We acknowledge collaborative input from the EU EggDefence consortium, and financial support for these studies by NSERC and PIC).

**Key Words:** eggshell matrix, Ovocleidin-116, osteopontin

**M48 Pedigree and microsatellite marker analyses are comparable methods for estimating inbreeding in an inbred strain of Japanese Quail.** S. H. Kim*,1, K. M. Cheng1, C. Ritland1, K. Ritland1, and F. G. Silversides2, 1*University of British Columbia, Vancouver, BC, Canada, 2Agriculture and Agri-food Canada, Agassiz, BC, Canada.

Accurately estimating the level of inbreeding in a population is essential because inbreeding reduces fitness, fertility, viability, hatchability, and other production traits in populations. Inbreeding has been estimated by analyses of pedigrees and genetic markers. The objective of this study was to evaluate the accuracy of the two methods in an inbred strain of Japanese quail. The inbred strain was derived from a randombred (QQ) strain and maintained for 17 generations by pedigreed matings of brothers to groups of sisters. Data from analysis of 14 microsatellite markers, GUJ0001, GUJ0002, GUJ0030, GUJ0034, GUJ0040, GUJ0044, GUJ0057, GUJ0059, GUJ0060, GUJ0065, GUJ0068, GUJ0070, GUJ0071, and GUJ0085, were obtained. Pedigree data were used to calculate the inbreeding coefficient (F<sub>ST</sub>), which is the level of inbreeding based on a reference ancestor. From the microsatellite locus data, the population differentiation (F<sub>ST</sub>) of the two strains caused
by inbreeding was calculated as $F_{ST} = 1 - (H_{E(INB)/H_{E(RAND)}},$ where $H_{E(INB)}$ and $H_{E(RAND)}$ are the expected heterozygosity of the inbred and randombred strains, respectively. The $F_{IT}$ was then calculated as $F_{IT} = F_{ST}^2 + (1 - F_{ST}) F_{ST},$ where $F_{IS}$ is the level of inbreeding within the inbred strain. The heterozygosity observed by analysis of the microsatellite markers of the randombred and inbred strains was 0.414 and 0.193, respectively, and the number of alleles was 3.24 and 1.87, respectively, demonstrating that genetic diversity was reduced in the inbred strain. The $F_{IT}$ of the inbred strain from the pedigree and microsatellite marker analyses was 0.687 (±0.069) and 0.567, respectively. These results suggest that pedigree and microsatellite analyses are comparable methods for estimating inbreeding in an inbred strain of Japanese quail. Further studies will be required to investigate reasons for the slight difference.

Key Words: inbreeding, microsatellite, FIS-FIT-FST


Understanding genetic mechanisms that govern growth in chickens has important implications for poultry production. Many processes that control growth and metabolism are regulated by hormones produced by the anterior pituitary gland. The objective of the current study was to use cDNA microarrays to assess global gene expression patterns in the anterior pituitary gland during the first 7 weeks of post-hatch growth in two lines of chickens genetically selected for high growth (HG) and low growth (LG). Total RNA was isolated from pituitaries of each line at 1, 3, 5, and 7 weeks of age, and mRNA was amplified by reverse transcription with an oligo-dT primer containing the T7 RNA polymerase promoter followed by in vitro transcription using T7 RNA polymerase. Amplified RNA was then analyzed with cDNA microarrays containing 14,053 genes. Expression levels of 1,631 mRNAs were significantly different by line or for the line-by-age interaction (P≤0.05; n=4). Of these, 263 genes were substantially different, where the highest expression level in one line was at least 160% greater than the lowest expression level in the other line. Four of the six hormones produced by the anterior pituitary gland were included in this set of differentially expressed genes. Thyroid-stimulating hormone β-subunit (TSHβ), luteinizing hormone β-subunit (LHβ), and follicle-stimulating hormone β-subunit mRNA levels were higher in the HG line; growth hormone (GH) mRNA was elevated in the LG line. Real-time PCR was used to confirm differences in expression of TSHβ, LHβ, and GH, as well six other genes. The identification of a large number of differentially expressed genes in the anterior pituitary of chicken lines with differing growth characteristics indicates that this gland plays a major role in regulating metabolic differences between the HG and LG lines that contribute to the divergent phenotypes.

Key Words: growth, RNA, cDNA


The objective of this study was to evaluate the developmental expression of RNA for preproghrelin, the ghrelin receptor GHS-R, and the obestatin receptor GPR-39 in the intestine of chicken lines that had undergone long term selection for high or low 8-week body weight. High and low line chickens (HH and LL) and their reciprocal crosses (LH and HL) were used in this experiment. Chicks were reared in batteries with ad libitum access to feed and water. Chicks were weighed and killed on embryonic day 20 (e20), day of hatch (DOH), and days 3, 7, and 14 post hatch (D3, D7, and D14, respectively). Duodenum, jejunum, ileum and liver were collected. DNA extracted from liver was used to sex birds by PCR. RNA was extracted from the intestinal segments of four males from each line and time point except e20 HL (n=3). cDNA was made using reverse transcription and was used in real-time PCR for relative quantification of RNA. There was no change over time in preproghrelin and GHS-R RNA expression in the selected and crossbred lines. GPR-39 RNA expression increased with time in all lines (P < .01). In a subpopulation of LL birds, LL birds with greater preproghrelin RNA expression at D3 and D7 also had greater GHS-R expression at these time points. In summary, preproghrelin, GHS-R and GPR-39 are expressed in the small intestine of these populations of chickens, with GPR-39 developmentally regulated. In a subpopulation of the LL line, preproghrelin and GHS-R may be co-regulated.

Key Words: preproghrelin, GHS-R, GPR-39

M51 Identification of differentially expressed genes in pituitary glands of day 24 turkey embryos following stimulation with VIP. M-K. Ho1, B. Leclerc1, D. Zadworny*2, N. Kansaku2, and U. Kuhnlein1, 1McGill University, Montreal, QC, Canada, 2Azabu University, Fuchinobe, Sagamihara, Japan.

Around the time of hatch, circulating levels of prolactin (PRL) increase in turkey embryos as lactotrophe cells differentiate. Although the increased levels of PRL are likely to modulate many physiological processes associated with final maturation and the adaptation of the poult to ex ovo life via the circulation, PRL may also act in an autocrine and/or paracrine fashion to affect adenohypophysial function. In order to investigate the transcription of genes that may be induced/suppressed by PRL in the adenohypophysis (AP), libraries from VIP stimulated or control AP were constructed using suppressive subtractive hybridization (SSH). Stimulation with VIP (10-7 M) of AP isolated from day 24 turkey embryos for 4 h resulted in a 2.8 and 5.7 fold increase in AP and media content, respectively, of PRL and a significant increase in the glycosylated isoform (from 13 % to 44 % of total PRL). The changes in PRL were consistent with endogenous levels of PRL observed just prior to hatch. Total RNA from VIP stimulated and control AP was used to construct both forward (control cDNA as driver) and reverse (VIP stimulated cDNA as driver) SSH libraries. Random clones (n=96) from each library were sequenced and compared to data banks. A total of 66 and 79 non-redundant putative genes were identified in the forward and reverse libraries, respectively, of which about 50 % had unknown function. Real time PCR was used to confirm the differential expression of a selected number (n=21) of these genes in VIP treated and control AP. Since the majority of these genes were expressed
M52 Antimicrobial activity of the anseriform outer eggshell.
O. W. Labadie*, J. Picman, and M. T. Hincke, University of Ottawa, Ottawa, ON, Canada.

The avian eggshell cuticle is an organic layer which regulates gas exchange and inhibits microbial contamination of the interior contents by preventing the entry of contaminated water into the eggshell pores. In this study, we investigated the antimicrobial activity of eggshell cuticle proteins from four Anseriform species. Eggs of four anseriform species were analysed: wood duck (Aix sponsa), hooded merganser (Lophodytes cucullatus), Canada goose (Branta canadensis) and mute swan (Cygnus olor). Cuticle was removed from washed eggs by treatment with either 8Murea/50mMTris-HCl pH 7.5 for 1 hour or 1NHCl for 5 minutes. Extracts were concentrated by dialysis and lyophilization. Protein samples were analysed by SDS-PAGE, western blotting and by an antimicrobial assay. Distinct differences were observed between the protein profiles for avian eggshell cuticle and egg white. SDS-PAGE analysis revealed that prominent bands at 32kDa and 14kDa were present in extracts from all species. Western blotting revealed that the 32kDa band reacted to antibodies raised against Gallus gallus ovocalyxin-32 and confirmed the identity of the 14kDa band as c-type lysozyme. However, ovalbumin and ovotransferrin were absent from outer eggshell extracts of all species. Mute swan urea extract (50ug/ml) was found to inhibit the growth of B. subtilis, S. aureus and E. coliD31. Canada goose urea extract was found to inhibit the growth of P. aeruginosa while HCl extract inhibited the growth of B. subtilis. Hooded merganser urea extract completely inhibited the growth of B. subtilis and S. aureus while showing lower inhibition of P. aeruginosa and E. coliD31. The results indicate that the outer eggshell proteins present in the avian cuticle possess antimicrobial properties, and that hooded merganser urea extract posses the greatest antimicrobial activity which did not correspond to lysozyme or ovotransferrin. Surprisingly, Canada goose cuticle was found to contain c-type lysozyme immunoreactivity while the egg white from this species is known to contain g-type lysozyme. On the other hand, both cuticle extracts and egg white from wood duck contain only c-type lysozyme. (Supported by NSERC and PIC).

Key Words: eggshell, antimicrobial, cuticle

M53 Ovocalyxin-36 is a novel chicken eggshell protein related to lipopolysaccharide-binding proteins (LBP) bactericidal permeability-increasing proteins (BPI), and Plunc family proteins.
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The avian eggshell is a composite biomaterial composed of non-calciifying eggshell membranes and the overlying calcified shell matrix. The shell is deposited in a uterine fluid where the concentration of different protein species varies at different stages of its formation. The role of avian eggshell proteins during shell formation remains poorly understood, and we have sought to identify and characterize the individual components in order to gain insight into their function during elaboration of the eggshell. In this study, we have used direct sequencing, immunochemistry, expression screening and EST database mining to clone and characterize a 1995 full-length cDNA sequence corresponding to a novel chicken eggshell protein that we have named Ovocalyxin-36 (OCX-36). Ovocalyxin-36 mRNA and protein were only detected in the regions of the oviduct where eggshell formation takes place; OCX-36 message was strongly upregulated during eggshell calcification. OCX-36 localized to the eggshell membranes was most abundant near the calcified shell and could be detected in decalcified eggshell matrix. Database searching indicates that there is no mammalian version of OCX-36; however, it possesses homology with proteins associated with the innate immune response: lipopolysaccharide-binding proteins (LBP), bactericidal permeability-increasing proteins (BPI) and Plunc family proteins. Moreover, the genomic organization of these proteins and OCX-36 appear to be highly conserved. These observations suggest that OCX-36 is a novel and specific chicken eggshell protein related to the superfamily of LBP/BPI and Plunc proteins. OCX-36 may therefore participate in natural defense mechanisms that keep the egg free of pathogens. We acknowledge support from the European Commission (EggDefence, QLRT-2001-01606) (JG, YN), NSERC and PIC (MDM, MH).

Key Words: ovocalyxin-36, eggshell, antibacterial

M54 Diversity and relationship among APEC within the GI tract and APEC of diseased turkey poult.

Avian pathogenic Escherichia coli (APEC) are normal inhabitants in the gastrointestinal (GI) microflora of turkeys and can cause colibacillosis in young turkey poult. There is a lack of understanding of the relationship between APEC in the GI tract and strains known to cause colibacillosis in poult. Previous research has identified virulence genes associated with colibacillosis: ius, iucC, tsh and cvaC. The aim of this research was to study the relatedness among APEC within the GI tract and APEC pathotypes isolated from tissues and organs of diseased turkey poult. Three turkey poult from 15 houses of an integrated turkey operation in Missouri were isolated for PCR analysis. An additional 22 E. coli from turkeys that had died at the same operation were received from the Missouri Diagnostic Laboratory in April, 2005. These 22 diagnostic isolates came from the following: eight from tissue, seven from heart, three from lung, two from liver, one from thigh and one from spleen. Of the 115 GI E. coli, 67.8% (78/115) had two or more of the four virulence genes and were considered pathogenic. Of the 22 diagnostic E. coli, 100% had two or more genes present, 13 of which had all four genes present. Random Amplified Polymorphic DNA (RAPD) PCR was used to determine the diversity of these 100 APEC isolates and indicated that the 100 isolates belonged to 11 clusters at a similarity coefficient of 50%. Eight clusters only contained E. coli from the GI tract and two clusters had only diagnostic isolates. The largest cluster contained 54 E. coli isolates; 38 from the GI tract and 16 from the diagnostic lab. These results suggest that some APEC in the GI tract are closely related to APEC pathotypes causing colibacillosis. Understanding of the relationship among APEC isolates in the GI of poult is a prerequisite to develop more efficacious treatments for this disease.

Key Words: APEC, turkey
Characterization of Extraintestinal Invasive *Escherichia coli* (ExIEC) strains isolated from a Mexican Poultry Integration.

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Seventy-six *Escherichia coli* *ipaH*+ were characterized. Biochemical identification shows positive reactions for lactose fermentation (100%), lysine decarboxylase (98.7%) and motility (67.1%) properties that do not correspond with those described to the EIEC group. Regarding the serotyping, the most common O antigens were O2 (*n* = 20), OR (*n* = 11) and non-determined O? (*n* = 10). The O2:NM serotype was the most common. Sixty-six percent (*n* = 50) of the *ipaH*+ *E. coli* produced colicins, of them, 26 (34%) produced Col V and other colicins, 13 (17%) produced colicins other than Col V, and 11 (14.5%) produced Col V only. Trimethoprim/Sulfa (72%), ampicillin (64.5%), enrofloxacin (55.3%), and ciprofloxacin (47.4%) were the major antimicrobial resistance frequencies observed. Twenty-five different multiresistance patterns were observed, where sixty-six strains (86.8%) were included. An invasiveness assay showed that the predominant alterations were changes in shape and staining, and in most of the specimens, a partial monolayer detachment was also seen. Fifteen strains invaded more than 30% of the monolayer cells, causing the formation of intercellular bridges or filipoidal-like protrusions. Ribotyping showed four main clusters, the last one being the most homogeneous, basically formed by O2 strains. Using PCR with the IS630 primers only eight isolates were positives. In the embryo lethality assay 095785 strain, a representative isolate of the fourth cluster, produced mortality in 86.6% of embryos and, consequently, was classified as a virulent strain. Additionally, it presented the highest growth (8.25 ± 0.39), almost twice that of the negative control (6.89 ± 0.92). The results suggest the existence of specific clone complexes derived from EIEC strains adapted to the avian host. To our knowledge, this is the first study that demonstrates the presence of extraintestinal invasive *E. coli* (ExIEC) strains.

**Key Words:** *escherichia coli*, virulence factors, invasiveness
Environment and Management: Broilers and Turkeys

11 Effect of egg position and turning frequency during storage and incubation on hatchability of broiler hatching eggs. J. T. Brake*1, O. Elibol2, and K. U. Sarıyüz1, 1North Carolina State University, Raleigh, 2University of Ankara, Ankara, Turkey.

A series of experiments was conducted with broiler hatching eggs to learn more about egg position during storage and egg turning during both storage and incubation. Broiler breeder flocks at 62 wk of age supplied eggs that were stored for either 3 d or 14 d at 18 C and 75% RH in either the large end up (LEU) or small end up (SEU) position and then turned 24 (24X) or 96 (96X) times per day to 18 d of incubation in Experiment 1. Experiment 2 was conducted similarly with eggs from a 60-wk-old flock. The longer storage period decreased fertile hatchability due to an increased percentage early and late embryonic mortality. Storage in the SEU position improved fertile hatchability. There was a significant storage position by storage period interaction due to better fertile hatchability for the SEU eggs stored 14 d but not 3 d. There was a significant interaction of storage period with turning frequency in Experiment 1 due to an increased fertile hatchability with 96X turning in incubation after 14 d, but not 3 d, of storage. Although this interaction was not repeated statistically in Experiment 2, fertile hatchability was improved by 96X turning as compared to 24X turning (74.1% versus 71.0%). This effect was due primarily to reduced early embryonic mortality. The data of Experiments 1 and 2 suggested that long storage in the SEU position or turning LEU stored eggs 96X daily produced similar results. Eggs from broiler breeder flocks at 64 and 58 wk of age were then stored for either 3 d or 14 d at 18 C and 75% RH in either the LEU or SEU position and turned 0 (0X) or 4 (4X) times daily during storage in Experiments 3 and 4. The longer storage period decreased fertile hatchability in Experiments 3 and 4, as expected. Although SEU storage or turning 4X daily in storage significantly improved fertile hatchability in Experiment 3 only, there was a significant storage position by storage turning interaction in both Experiments 3 and 4 due to lower fertile hatchability for the unturned LEU eggs when compared to the other combinations. The data of Experiments 3 and 4 suggested that turning LEU eggs 4X daily during storage was equivalent to storing eggs SEU with or without turning.

Key Words: egg turning, hatchability, egg storage length


Historically, incubator air and egg temperatures have been assumed to be similar. However, recent investigations have found eggs to exhibit temperatures above those of the machine air temperature set point. Egg temperatures in excess of the optimum have been shown to adversely affect embryonic development. Since egg temperature has been closely related to ventilation rate and egg capacity within the incubator, it was hypothesized that altering the ventilation pattern or number of eggs within hatching baskets might ameliorate the adverse effects of high egg temperatures on embryonic development. An experiment was conducted to evaluate the effects of ventilation pattern and egg number on embryological development. Ross 344 x Ross 508 SF broiler eggs were incubated to maintain an internal egg temperature of 37.6C and then transferred on E17 to two hatchers. Four treatments that consisted of combinations of restricted or normal ventilation patterns and high or low egg stocking densities were utilized. The restricted ventilation treatment was created by applying tape to the top perimeter of each basket (TT) while also inserting a cardboard divider above the eggs in the basket such that air could only pass through the tray at the level of the eggs. The normal ventilation treatment (CN) utilized standard hatching baskets with no modifications. Egg density was either 90 or 180 eggs in each basket. There were four replicate baskets per treatment. Egg temperatures were monitored daily from E17 to hatching using a Braun Thermoscan infrared thermometer. At hatching, BW, and weights of the yolk, heart, liver, proventriculus, gizzard, and small intestines were determined. In spite of the absence of a significant effect on BW and yolk weight, the chicks from the TT-180 treatment consistently exhibited lower relative heart, gizzard, proventriculus, and small intestines weights while higher relative organ weights were generally observed in the TT-90 treatments.

Key Words: organs, ventilation, egg temperature


The impact of genetic strain, egg size, and flock age on hatching egg characteristics, fertility, hatchability, and broiler growth were analyzed. Eggs were collected from two strains (Ross308 (R), Cobb500 (C)) (n=1380/strain) and three egg sizes (small (S), medium (M), large (L)) (n=460/strain/weight) from 29 wk old flocks. Thirty eggs/strain/egg size were used to assess egg characteristics with remaining eggs incubated. After 21.5 d of incubation, all saleable chicks were weighed, and unhatched eggs broken open to calculate fertility and hatchability. Two groups of 119 chicks/strain/egg size were grown out on floor pens for 6 wk. Daily mortality and 3 and 6 wk feed consumption and body weights were recorded. Data were analyzed using SAS proc Mixed (P ≤ 0.05). The R eggs had greater specific gravity (R=1.079±0.0005; C=1.069±0.0005), wet (R=15.4±0.1 g; C=14.9±0.1 g) and dry (R=8.09±0.07 g; C=7.48±0.07 g) yolk weights, and wet (R=5.33±0.04 g; C=4.76±0.04 g) and dry (R=5.3±0.04 g; C=4.71±0.04 g) shell
weights. Large eggs had greater specific gravity (L=1.075±0.0006; M=1.075±0.0006; S=1.072±0.0006), wet (L=18±1.1g; M=15±0.1g; S=14.4±0.1g) and dry (L=8.25±0.09g; M=7.74±0.08g; S=7.36±0.08g) yolk weights, and wet (L=5.44±0.05g; M=5.08±0.05g; S=4.61±0.05g) and dry (L=5.41±0.05g; M=5.02±0.05g; S=4.58±0.05g) shell weights. The R eggs were heavier (R=57.7±0.1g; C=53.8±0.1g) and had better fertility (R=96.8±0.9%; C=76.7±0.9%) and hatchability (R=81±1.3%; C=64.7±3.3%). Large eggs also had better fertility (L=89.1±1.1%; M=85.9±1.1%; S=85.1±1.1%), but higher late embryonic mortality (L=10.8±1.1%; M=6.5±1.1%; S=3.6±1.1%) than other egg sizes. Heavier chicks hatched from R (R=39.44±0.09g; C=37.35±0.09g) and L (L=41.8±0.1g; M=38.2±0.1g, S=35±0.1g) eggs. The R broilers had greater early average broiler body weight gains (R=718.18±7.2g; C=679.83±7.2g). The data show that strain and egg size influence hatchability and broiler growth. Future studies should examine incubation conditions that are tailored to each strain and egg size in order to improve hatchability and broiler production.

**Key Words:** genetic strain, egg size, chick quality

### 14 Influence of egg weight on the uptake of residual yolk in Ross 708 broilers.

R. A. Renema*, N. J. Wolanski, and F. E. Robinson, University of Alberta, Edmonton, AB, Canada.

Residual yolk sac in a chick is affected by factors such as maternal age and egg size. It is less clear if it positively affects growth. The impact of egg size on residual yolk sac size and utilization was examined. Ross 708 hatching eggs from a single collection were weighed and sorted into 3 g size ranges (52-54, 55-57, 58-60, 61-63, and 64-66 g) (1200 eggs total). Three incubation trays of each size were incubated and hatched (252 eggs/size). Hatchability traits were determined. Chicks were weighed and assigned to a processing age (0, 1, 2, 4, 6, 8, or 10 d of age) and divided among 3 pens. At each processing age, chicks were weighed, and residual yolk sac and gut weight determined. Sex of chicks was determined at processing.

Hatch of fertile did not differ among egg sizes. However, chick weight differed for all size ranges, from a high of 45.8 g from 64-66 g eggs to a low of 36.7 g from 52-54 g eggs. The 27% greater size of the chicks from larger eggs did not last — stabilizing at an approximately 15% size advantage through to 10 d of age, when 64-66 g egg chicks weighed 215 g compared with 186 g for chicks from 52-54 g eggs. Female BW was greater than male BW by 4 d of age, which is typical for high-breast yield strains. At Day 0, residual yolk sac correlated well with chick wt. (r=0.63). By Day 2 the relationship was much weaker (r=0.27) and after 6 d there was no relationship. Residual yolk sac weight was more strongly correlated with original chick weight than with processing BW already by 1 d of age. At hatch, residual yolk sac as a % of egg weight increased with egg size. This likely reflects a larger proportion of yolk in the larger egg sizes. Residual yolk sac weight became similar among chicks from all egg size groups at 2 d of age and stabilized at approximately 0.1 g at 10 d of age. Whereas large chicks had a larger yolk sac, it did not appear to deliver a growth advantage. Chicks from 52-60 g eggs increased BW 5.1-fold by 10 d compared to a 4.6-fold increase by chicks from 61-66 g eggs. Chick size appears to affect growth rate more than residual yolk sac does.

**Key Words:** chick quality, growth rate, residual yolk sac

### 15 Foot pad lesions, pasture condition, and bacterial pathogens in free range heritage vs. commercial turkey varieties.

B. McCrea1, M. Leslie2, L. Stevenson2, K. Macklin2, L. Bauermeister3, and J. Hess1, 1University of California, Davis, 2Auburn University, Auburn, Alabama.

A study was performed to compare the performance of heritage (Bourbon Red, BR) and commercial (Broad Breasted White, BBW) turkey varieties in a free-range management system. Before bird placement, pens were seeded with a mixture of Tall Fescue and Bermuda Grass. The turkeys were maintained in 4.27 m x 21.34 m pens and processed at 17 weeks of age. For each variety, sixty-six straight run turkeys were divided equally into 3 pens. Poults were brooded indoors to four weeks of age and then moved outdoors into pens for the remainder of the growout period. Foot pad lesions were scored at 4, 7, 10, 13, and 17 weeks of age. Colostral swabs were taken from a subset of each variety and used to assess the presence of both Salmonella and Campylobacter. In addition to the pathogens already listed, carcass rinsate was cultured to determine aerobic and enteric bacteria counts as well as the presence of Clostridium perfringens.

There were no significant differences between foot pad lesion scores for the two varieties at 7, 10, and 13 weeks. At 4 and 17 weeks of age, BR turkeys had a significantly lower number of birds with mild foot pad lesions than BBW turkeys. The majority of Bourbon Red turkeys never acquired foot pad lesions and no birds of this variety acquired severe lesions.

For Campylobacter recovery, cloacal swabs and rinsates were both enriched and direct plated. All Salmonella samples were enriched with tetrationionate-Hajna broth. Salmonella was not recovered from cloacal swabs or carcass rinses. Campylobacter was recovered from enriched carcass rinsates in both BBW (n=5) and BR (n=5) turkeys. Blood agar plates yielded a significant difference between BBW and BR turkeys with 3.07x10^4 cfu/ml and 1.20x10^5 cfu/ml, respectively. C. perfringens was recovered from 58.3% of BBW carcasses but BR carcasses did not yield the organism. The average recovery of total enterics from BBW and BR turkeys was 8.79x10^5 cfu/ml and 4.54x10^5 cfu/ml, respectively. The results indicate that there is very little difference between turkey varieties with regard to foot pad lesions and microbial load on carcasses.

**Key Words:** turkey, free range, heritage

### 16 Feed conversion, growth rate, and carcass yield in free range heritage vs. commercial turkey varieties.

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A study was performed to compare the performance of heritage (Bourbon Red, BR) and commercial (Broad Breasted White, BBW) turkey varieties in a free-range management system. Before bird placement, pens were seeded with a mixture of Tall Fescue and Bermuda Grass. The turkeys were maintained in 4.27 m x 21.34 m pens with 3.07x10^4 cfu/ml and 1.20x10^5 cfu/ml, respectively. C. perfringens was recovered from 58.3% of BBW carcasses but BR carcasses did not yield the organism. The average recovery of total enterics from BBW and BR turkeys was 8.79x10^5 cfu/ml and 4.54x10^5 cfu/ml, respectively. The results indicate that there is very little difference between turkey varieties with regard to feed conversion and microbial load on carcasses.

**Key Words:** turkey, free range, heritage
13 and 17 weeks of age. The BBW turkeys had higher feed intake, weight gain and BW then the BR turkeys for each of the age periods (p≤0.05). The feed conversion in the BBW turkeys was better than the BR turkeys for all of the age periods except the thirteen to seventeen week period. There was no difference during this period. Turkeys were processed at seventeen weeks of age. The final live weight, carcass weight, and carcass yield were compared for both strains and sexes of turkeys. The BBW turkeys had higher live weights (13.81 kg vs. 8.40 kg), carcass weights (10.90 kg vs. 3.38 kg), and carcass yields (79.11% vs. 71.52%) than the BR turkeys (p≤0.05). There were significant differences between the sexes for live weight and carcass weight, but not carcass yield (p≤0.05). There were significant strain by sex interactions for live weight, carcass weight, and carcass yield (p≤0.05). The BBW males had the lowest live weight and carcass weight, while the BR males had the lowest carcass yield. These results indicate that there are large differences between turkey varieties with regard to live performance and carcass data, but not overall carcass yield.

Key Words: turkey, free range, live performance

17 Withdrawn by author.

18 Use of a feed-grade enzyme in broiler diets to reduce paw burns. M Nagaraj*, J. B Hess, and S. F Bilgili, Auburn University, Auburn, Alabama.

Nutritional and management interventions are needed to reduce the incidence of paw burns in poultry. In this study, enzyme (Allzyme VegPro, Alltech, Nicholasville, KY) supplementation of corn-soybean based broiler diets was evaluated in an effort to reduce total and ammonia nitrogen excretion and its impact on paw quality in broiler chickens. A total of 1600 mixed sex chicks were raised on floor pens in a design involving 2x2x2 arrangement of protein level [PL; high (HP) or low (LP)], protein source [PS; all vegetable (V) or vegetable plus animal (V+A)], and enzyme [with or without enzyme supplementation (0.06%)], on a four stage feeding program (four replicate pens per treatment; 50 birds per pen). Body weight, feed conversion and mortality were determined on 14, 28, 42 and 57 d of age. The feet were scored for paw burns on all birds on 28, 42, and 57 d and the severity was recorded as: none (no ulcerating lesion), mild (lesions of <1.5 cm), and severe (lesions of >1.5cm). Pooled gut samples were collected at 57 d to determine viscosities of fore- and hind-gut contents. Pooled litter samples were analyzed for total and ammonia nitrogen at 14, 28, 42 and 57d.

Live performance of birds did not vary among the treatments (P>0.05). Paw burns were significantly affected by PS at 42 d (P<0.05), with birds fed all V diets showing higher incidence and severity than those fed V+A diets. At 57 d of age, birds reared on V diets with enzyme supplementation showed a lower incidence of mild paw burns compared to other treatments. Fore-gut and hind-gut viscosities were higher in birds fed V diets than those fed V+A diets. Enzyme supplementation reduced viscosity of the gut contents irrespective of the PL or PS. Higher levels of litter total and ammonia nitrogen were observed with HP diets (28 and 42d), V diets (28d) and with enzyme supplementation (28 and 42d). A significant PL by PS interaction at 28 d of age showed highest litter ammonia nitrogen in birds reared on HP and V diets as compared to other treatments. In this study, enzyme supplementation reduced viscosity of the gut contents, but had little effect on litter total & ammonia nitrogen levels and paw burns in broilers.

Key Words: broiler, protein, quality, enzyme

19 Dietary modifications to reduce nitrogen consumption and excretion in broilers. R. Angel*, W. Powers2, S. Zamzow3, and T. Applegate1, 1University of Maryland, College Park, 2Atlantic Poultry Research Institute, Truro, NS, Canada, 3Purdue University, West Lafayette, Indiana.

The impact of feeding broilers reduced protein (LP) and control (C) corn-soy-type diets with industry protein concentrations on broiler performance, breast yield and litter nitrogen (N) content were determined. Ross 308 male broilers were allocated to chambers (8) and grown from hatch to 42 d. Three sequential experiments were conducted; each constituting one flock (F). C treatment (Trt) broilers were fed based on a 4 phase feeding program: starter (St), grower (Gr), finisher (Fn), and withdrawal (Wd) diets. LP Trt broilers were fed based on a 6 phase feeding program: prestarter, St, Gr1, Gr2, Fn, and Wd diets. Formulated protein concentrations were 22.1, 20.0, 17.2, and 16.6% for the C Trt St, Gr, Fn, and Wd diets, respectively while those for the LP Trt PreSt, St, Gr1, Gr2, Fn, and Wd diets were 22.0, 18.6, 18.1, 17.3, 15.8, and 15.0%, respectively. Synthetic Lys, Met, Ile, Thr, Arg, Trp, and Val were included where needed to meet minimum requirements in the LP diets while only Met and Lys were needed in the formulation of the C diets. Concentrations of Lys, Met, Ile, Thr, Trp, Arg, and Val, in the St, Gr1, Gr2, Fn, and Wd LP diets were: 1.22, 0.59, 0.85, 0.82, 0.24, 1.40, 0.90%; 1.14, 0.51, 0.82, 0.68, 0.23, 1.25, 0.90%; 1.06, 0.49, 0.75, 0.74, 0.22, 0.83%; 1.01, 0.49, 0.71, 0.68, 0.20, 0.80%; and 0.96, 0.43, 0.70, 0.68, 0.19, 0.76%, respectively. Performance was determined at the end of each phase and litter weighed and sampled at the start of F 1 and after each F. Litter was analyzed for DM, N and minerals. Broilers on the C Trt weighed more (P<0.05) at 42 d over three F (2.78 kg) than those fed the LP Trt (2.69 kg) but feed/gain ratio was similar. Twenty broilers per chamber were sampled for yield determination in F 3. Dress percent and breast yields were not affected by Trt. Based on analyzed concentrations and data analyzed over the three F, N consumed was 5.1% less and litter N 16.6% less in LP vs. C chambers.

Key Words: broiler, protein, litter

20 Comparison of methods for weighing broilers – manual vs. computerized scales. K. Budgell1, J. Maclsaac2, and B. Rathgeber3, 1Nova Scotia Agricultural College, Truro, NS, Canada, 2Atlantic Poultry Research Institute, Truro, NS, Canada, 3Agriculture & Agri-Food Canada, Truro, NS, Canada.

Accurate and reliable measurement of broiler body weight is a valuable tool for broiler management. In practice, the average weight of the flock is determined by manually weighing a random sample of birds or through automatic weighing using computerized scales. The objective of this study was to determine if using computerized bird scales in a research environment reflected the true weight of broiler chickens. A total of 1824 broiler chicks, 912 each of male and female, were randomly allocated to 48 pens at a stocking density of 0.073m². Birds were grown to 38 days of age. Daily body weights were recorded by computerized platform scales placed in the center of each pen. Each pen of birds was also caught and weighed on a top scale at 14,
24 and 38 days of age. The body weight at 14 days of age was the same regardless of method used to determine it. By day 24 the weights recorded by the scales positioned within the pens (846g) were heavier (p<0.001) than those for the same birds caught and weighed the traditional way (776g). This effect carried through to 38 days of age (p<0.05) where birds weighed manually appeared to be smaller (195g) than those recorded by computerized scale (200g). Larger birds may spend more time resting on the platform as they age, giving smaller birds less opportunity to use the scale. From this study it appears that using bird scales in small research pens results in an overestimation of actual bird weight near market age. These computerized scales are a fast and useful tool for producers to estimate flock weight when determining market age in commercial production facilities but may be less useful in a research environment where a smaller sometimes less uniform population is monitored and bird movement is restricted.

**Key Words:** broiler chicken, body weight, computerized scale

**21 Varying dietary protein level during rearing affects carcass and reproductive traits of broiler breeder hens at sexual maturity.**
L. F. Romero1, R. A. Renema1, A. Pishnamazi1, F. E. Robinson1, and M. J. Zuidhof2, 1University of Alberta, Edmonton, AB, Canada, 2Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.

A total of 250 female broiler breeders of a classic (Ross 308) and a high breast yield strain (Ross 708) were reared to determine the effects of three relative dietary balanced protein (DBP) levels (HIGH = +3%, STANDARD = Control, and LOW = -3%) during one of four periods (1 to 6, 7 to 12, 13 to 18, or 19 to 24 wk of age) on flocking, frame size, fat deposition and reproductive development at sexual maturity (SM). The STANDARD DBP was fed during the remaining periods. Weights of reproductive organs, breast muscle, abdominal fat pad, liver weight and the number of large ovarian follicles were collected at first egg. Shank and keel length were measured to assess frame size. Each period was analyzed separately, with DBP and strain as main factors in the factorial design.

Changing DBP from 1 to 6 wk resulted in changes that approached significance for relative breast weight (P=0.057) and oviduct weight (P=0.056) at SM. When fed 7 to 12 wk, DBP affected relative weight of liver (P=0.046) and ovary weight (P=0.022) at SM, when ovary weight was lower (51 g) in LOW DBP than in HIGH DBP (62 g) birds. However, ovarian follicle size was only lower in LOW DBP birds of the Ross 708 strain. When DBP changed from 13 to 18 wk, relative abdominal fat pad weight of LOW DBP birds was greater than that of STANDARD or HIGH birds, while BW was lower in LOW than in STANDARD birds (P=0.009). Overall, frame, age at first egg, and large yellow follicle counts were not affected by DBP during rearing. Varying DBP at the beginning of rearing period had no clear effects on sexual development and fleshing, whereas varying DBP at the end of rearing had not affect on SM parameters. When fed from 7 to 12 wk, DBP level affected traits associated with reproductive development, and DBP from 13 to 18 wk affected BW and composition at SM.

**Key Words:** broiler breeders, dietary protein, fleshing

**22 Factors affecting egg properties of broiler breeder hens:**
Egg colour, egg quality, egg shape. M. E. Rustad1*, F. E. Robinson1, M. J. Zuidhof2, and R. A. Renema1, 1University of Alberta, Edmonton, AB, Canada, 2Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.

The feeding regime of broiler breeder (BB) hens can impact egg quality. Feed restriction (R) or over-feeding (OF) results in a difference in shell quality, yolk and albumen weights. Strain effects on egg shape, relationship of egg shape with internal quality, and change in time are less clear. This study characterized the relationship between feeding level and strain on egg quality and external traits. A total of 5 eggs were collected at 32, 43, and 54 weeks of age from 288 hens of 8 strains (36 birds/strain). Feed allocation of the 144 OF hens was 20% above R levels from 18 to 56 wk of age. Fresh egg weights were taken and the specific gravity, egg colour (L, a, b scale), shape, albumen height and weight, yolk weight, and shell thickness were assessed the next day.

As hens aged, egg weight increased 14.3% and those from OF hens were 2.67% (1.7g) heavier than the R group. Yolk weight also increased with hen age (5.1g, 3.5%) while albumen decreased. Yolk weight and %yolk were greater in OF hens. Strains 1, 3, 6, and 7 had the highest %yolk. This is due likely to these strains having superior ability to transfer excess nutrients to yolk development. The OF strain 7 had a larger increase in albumen weight (7.8%) than R hens (13.3%). This was a larger increase than the other strain averages. Shell weight increases and thickness decreases with age. The OF strain 2 had the lowest % shell, while the R strain 2 group had the highest. This may be indicative of an inability to maintain shell deposition as the eggs grew larger with age. Shell thickness was only affected by age. The OF eggs had a higher L value (lighter brown color, 56.9) than the R (56.1), which may relate to differences in egg size. Strains 1 and 9 had significantly darker shells than other strains, but were not different from each other. Egg shape decreases as hens age (eggs becoming less round) and is smaller for OF group than R (0.83 vs 0.84). Further study will determine how this change affects hatchability.

**Key Words:** broiler breeder, egg quality, egg shape

**23 Characterization of relationships among broiler breeder male growth, variability, and mortality.**
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Breeder males cost a hatching egg producer $6.52 CDN/chick. Recent work has demonstrated that breeder males display high levels of aggression toward flock mates resulting in mortality losses. This project explores the potential relationships between chick quality and growth traits on potential success of males in the breeder barn. At hatch 550 males were neck tagged and measured for chick length, shank length and an estimation of residual yolk mass. Male body weight at hatch, 4, 8, 12, and 16 wk was recorded. Males were also weighed prior to transfer into the breeder barn at 18 wk of age. All mortality was collected and frozen for analysis at a later date. Postmortem were performed to determine the cause of death. Growth history and chick traits of males which died were compared to that of males which survived past 38 wk.

Mean hatch BW was 42.6 g with a CV of 7.9%. Hatch weight was a poor measure of growth potential as indicated by the low correlation between hatch BW and 4 wk BW (r = 0.13). By 4 wk of age BW correlated more strongly with all subsequent weights (r = 0.46 at 18
ABSTRACTS OF PAPERS

24 Growth characteristics as a predictor of male quality in broiler breeders. A. Herron*1, R. A. Renema1, F. E. Robinson1, and J. L. Wilson2, 1University of Alberta, Edmonton, AB, Canada, 2University of Georgia, Athens.

Selecting quality-breeding males for broiler breeder flock placement is difficult. Understanding growth patterns of male broiler breeders and how they relate to sexual characteristics may help in the pre-selection of males for the breeding barn. In this study broiler breeder males were tracked from hatch to 58 wk to monitor growth and maturation. A total of 165 Ross males were reared according to industry standards and photo-stimulated at 23 wk. Males had BW, keel girth, shank length and width measured at day zero, wk 5, 10, 15 and 20. Males were randomly divided into three kill groups: wk 23, 30 and 58. Carcass morphology and reproductive parameters were measured at each time. Both the hatch measurements and subsequent measurements up to wk 15 were not useful in determining male quality. There was considerable variability in individual growth trajectories during the first 15 wk. The substantial shifts in BW after week 23 can likely be explained by hormonal changes due to photo-stimulation and individual behaviour such as aggression to access or protect food and/or females. Following dissection, it was found that the right and left testes were positively correlated with BW at wk 15 (P<0.028 and P<0.003) and BW at wk 20 (P<0.002 and P<0.001). This suggests that male broiler breeders are beginning to become set in their growth trajectory around wk 15 of growth. Larger males at wk 15 and 20 had larger testes throughout the experiment. Males at 23 wk of age had the largest amount of abdominal fat (0.15% of BW) and breast muscle (19.4% of BW) than 58 wk males (0.04% and 16.8%, respectively). Males cannot be pre-selected for the breeding barn until wk 15 at the earliest. Selecting larger BW males suggest that producers will be selecting a male with larger testis weights.

Key Words: growth rate, male selection, broiler breeders

25 Comparing the economics of protein and energy levels in full fed molting procedures. P. L. Ruszler* and C. L. Novak, Virginia Polytechnic Institute and State University, Blacksburg.

Certain levels of protein and energy should be met in order to achieve optimum performance after molting with or without feed withdrawal (FW). In order to determine the economic impact of achieving these levels, 1152 hens were housed 3 per cage at 464 sq cm/hen. Four strains; Bovans, Hyline W-98, Hyline W-36 and Lohmann were compared. Molt diets used were: A=9.7% CP/1100 Kcal, B=9.7% CP/1430 Kcal, C=11.85% CP/2105 Kcal and D=14% CP/2780 Kcal of energy. The layer diet used was 17% CP/2845 Kcal of energy. The 4 strains were equally assigned to diets A & B for the first two weeks. The first one-third of the A & B diets was changed to the C diet for weeks 3 & 4. The second one-third of the A & B diets was changed to the D diet during the fourth week while the last third remained on the A & B diets. All hens were placed on the D diet during week 5. The original third of the hens remained on the D diet during week 6 while the other two thirds went on the layer diet. All hens were fed the layer diet starting the seventh week through the end of the trial at 24 weeks. Water was given ad libitum. A loss of 20 to 23% BW occurred in week 7. Egg production reached zero during the 2nd week and lasted 1 ½ weeks. It returned to 50% during the eighth week and peaked from 85 to 93% during the eleventh week. The protein needed per bird was 545 to 590g CP to reach 50% production and 1060 to 1090g CP to reach peak production compared to 590 and 1090g CP respectively for 4d FW molting. The energy needed per bird was 9800 to 10200 Kcal to reach 50% production and 18200 to reach peak production compared to 10800 and 19800 Kcal respectively for 4d FW molting. One treatment consumed significantly less energy and produced fewer eggs/hen than the others resulting in a significantly higher cost/doz of 11.3¢ vs. the others averaging 10.7¢. This shows that different formulations can achieve optimal economic performance provided the nutrients are highly digestible and readily available at optimum levels for the hen.

Key Words: molting, economics, energy/protein

Metabolism and Nutrition: Nutrition A - Minerals and Vitamins

26 Does vitamin U have potential to improve feed efficiency or strengthen the intestinal tract of broilers? A. L. Shaw*, K. S. Macklin1, J. P. Blake1, W. V. Narvaez-Solarte2, and P. K. Gunawardana1, 1Auburn University, Auburn, Alabama, 2Universidad de Caldas, Caldas, Columbia.

Vitamin U (DL-methionine methylsulphonium chloride) has previously been found to modulate the immune system and to protect the membrane systems of living cells within the intestinal tracts of humans and swine. Two separate trials were run to determine the effect of Vitamin U on growth performance, feed efficiency, and gut integrity on healthy birds (Trial 1) and coccidia challenged birds (Trial 2). The three Eimeria that made up the cocci cocktail administered in Trial 2 were E. acervulina (125,000/ml), E. maxima (25,000/ml), and E. tenella (15,000/ml). The birds were administered 1 ml of this cocktail on day 10 via oral gavage. For each trial, 384 commercial day-old broiler chicks were randomly allotted to six treatments with eight pens per treatment and eight birds per pen. A corn-soybean meal basal diet
The innate immune system of broilers is immature at hatch, making the chick susceptible to infection. The effects of maternal dietary 25-OH vitamin D₃ (25-OH D₃) on the innate immune function of the chick were determined. Ross 308 hens (N=98) were placed in 4 floor pens and fed diets supplemented with either 69μg of 25-OH-D₃ or 2,760IU vitamin D₃ (D₃) per kg feed (2 pens/treatment) starting at 23 wk of age. At 46-48 wk (mid-production) and 61-63 wk (late production), chicks were hatched; no treatment effects were observed for the late production hatch. Chicks from the mid production hatch had greater phagocytosis at hatch; no treatment effects were observed for the late production hatch. Chicks from the mid production hatch had greater phagocytosis at d1 in the late production hatch; no treatment effects were observed for the late production hatch. Chicks from the mid production hatch had greater phagocytosis at both d1 and d4 than chicks from the early and late production hatches (P<0.0001). The bactericidal activity and oxidative burst response was lower for the late production hatch than the early and mid-production hatches. Maternal 25-OH D₃ improved aspects of the innate immune system in the young broiler chick, indicating an earlier maturation of the cells.

Key Words: vitamin A, broiler, innate immunity, 25-hydroxy vitamin D₃

The vitamin A requirement for optimum growth, egg production, and hatchability in Japanese Quail. K. A. Livingston* and K. C. Klasing, University of California, Davis.

Vitamin A is needed for proper vision and is an important regulator of gene transcription. The vitamin A requirement necessary for optimal growth, egg production and hatchability in Japanese quail is not known. Therefore, 140 quail chicks were hatched and allotted to a rice soybean meal-based diet containing either 825 IU/kg (group 1), 1250 IU/kg (group 2), 1650 IU/kg (group 3), or 3330 IU/kg (group 4) of added vitamin A as retinyl palmitate with 6 pens per diet. At 14 d of age chicks were wing banded and weighed and at 42 d of age, they were weighed and paired (1 female and 1 male from the same diet) resulting in 12 cages per treatment. Egg production was monitored daily and, 2 weeks after hens started laying, eggs were collected and incubated to determine hatchability. Weight gain from 14-42 d of age was not significantly different among treatments (P=0.4). Additionally, feed intake per pen was not significantly different among treatments in the adult quail. However, egg production was significantly lower in group 1 and group 2 (P<0.001) when compared to group 3 and group 4. Moreover, hatchability differed significantly (P<0.0001) with 0.0, 32.3, 56.3, and 64.6% for groups 1, 2, 3, and 4, respectively. Yet, the weight of chicks immediately after hatching was not affected by the level of dietary vitamin A (P>0.5). The results of this study indicate that 825 IU/kg of vitamin A is adequate to maintain proper weight gain of growing chicks; however, a minimum of 1650 IU/kg of vitamin A is necessary for maximal egg production and hatchability.

Key Words: vitamin A, Japanese quail, egg production

Effect of dietary folic acid supplementation on egg folate content throughout the production cycle of laying hens. T. M. Dickson*, W. Guenter, and J. D. House, University of Manitoba, Winnipeg, MB, Canada.

Research has shown that folic acid plays a role in reducing the incidence of neural tube defects. Additionally, folate supplementation has been found to decrease plasma homocysteine, a risk factor for cardiovascular disease. Previous research has shown that supplementing laying hen diets with 4 mg/kg folic acid leads to folate-enriched eggs (3 fold increase) over a short term feeding period. As consistent egg folate deposition is the key to successful marketing, the current study was designed to address the following objective: Can a lower level of folic acid supplementation maximize egg folate content over the full production cycle? To address this objective, 1248 Hy-Line CV20 laying hens (n = 416 per diet), in a completely randomized design, received a barley-based ration containing 0, 2, or 4 mg/kg of crystalline folic acid for eleven 28-day periods. Response criteria included production parameters and measures of egg folate content. Data was analyzed as a repeated measures experiment using the mixed procedure. The analysis revealed a significant (P<0.0001) main effect of folate supplementation on egg folate content. Significant egg folate content differences (P<0.0001) were evident between each of the three rations. As the level of supplemental crystalline folic acid increased in the diets, the egg folate content significantly increased. Average egg folate levels
over 11 periods were 1.4, 2.9, and 3.4 micrograms/gram of yolk for respective rations containing 0, 2, and 4 mg of crystalline folic acid/kg of diet. Production parameters including egg production, egg size, feed consumption, feed efficiency, and egg shell quality were not significantly (P>0.05) affected by dietary folic acid supplementation. This study confirms that egg folate content is maximized when crystalline folic acid is supplemented to the hen’s diet at 4.0 mg/kg diet. Furthermore, folate levels from eggs supplemented with 4.0 mg/kg diet were consistent throughout the production cycle.

Key Words: folate, egg

30 Effect of vitamin E and fat sources on intestinal calcium uptake and production parameters of laying hens. D. Franco-Jimenez¹, R. Renema¹, M. Zuidhof², and F. Robinson¹, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.

Vitamin E can have a positive effect on egg production and egg quality. Additionally, vitamin E may have an antioxidant protective effect on laying hens challenged with a highly oxidative load diets (Restaurant grease or used deep fryer oil). In this study, 250 hens were randomly assigned to cages at 20 wk of age and fed diets varying by fat source canola oil (CO) or Restaurant grease (RG), and Vitamin E level (High) = 65 IU/kg or (Low) = 10 IU/kg. Seventy two of those birds were individually caged to allow collection of detailed data of egg production, laying sequence, feed intake, egg weight, and body weight over time. Intestinal calcium uptake (CaT) was determined at 77 wk of age. The data were analyzed in a 2x2 factorial experiment using SAS. Effect of fat source on total egg production (p=0.013) and CaT (p=0.046) was observed, being the CO better than the RG group. Vitamin E has an effect improving laying sequence and relative ovary and reproductive tract weight (p≤0.05), however it was not sufficient to overcome lower egg production parameters observed in RG group. Feed intake, egg weight, egg shell thickness and egg shell weight was higher (p≤0.05) for the CO-low and RG-high groups. Feed intake (p=0.015) showed a lighter tendency to be higher for the RG group at the peak of production (35-51 wk of age). Body weight was higher (p=0.013) for the CO-low and RG-low group and the CO-high showed the lowest body weight. These results may indicate that higher levels of vitamin E were able to enhance reproduction ability of the birds by increasing relative ovary and reproductive tract weight but not sufficient to protect the birds from the higher load of oxidative reactive substances present in RG to maintain production parameters. Increased feed intake with high levels of vitamin E in the RG group, partially explain the differences for egg weight, egg shell thickness and egg shell weight observed this group in spite of the lower CaT.

Key Words: laying hens, vitamin E, oxidative stress

31 Phase-feeding during the grower and finisher periods: impact of calcium and phosphorus. V. Brewer*, T. O’Connor-Dennie, and J. Emmert, University of Arkansas, Fayetteville.

Phase-feeding (PF) is effective at maintaining broiler growth and yield while reducing cost of production ($/kg gain or breast), but attempts to incorporate a 0.2% reduction in dietary Ca and P levels into a PF regimen have reduced growth. The objective of this experiment was to compare the growth performance of broilers fed PF diets containing adequate or reduced Ca and P levels to that of broilers fed diets based on NRC or industry recommendations. Treatments consisted of 1) NRC recommendations, 2) average industry nutrient levels, 3) diets with phased levels of AA, Ca, and P, 4) diet 3 with a 0.1% reduction in Ca and P, 5) diet 2 with AA reduced by 10%, 6) diet 5 with a 0.1% reduction in Ca and P. For PF, diets were prepared that contained Lys, SAA and Thr levels matching the predicted requirements for birds at 19 d (high nutrient density) and 43 d (low nutrient density). Pelleted high and low nutrient diets were blended to produce rations containing AA levels that matched predicted PF requirements over two-day intervals. Birds were fed diets 1 and 2 from 19 to 43 d; PF diets (treatments 3-6) were switched every other day. Treatments were replicated in 5 pens containing 20 birds per pen. Weight gain, feed intake, feed efficiency, and dietary cost of production ($/kg gain) were calculated. No difference (P>0.05) in weight gain was noted among birds fed diets 1, 2, or 3; weight gain of birds fed treatments 4, 5, and 6 was reduced (P<0.05). Birds fed diets 2 and 4 exhibited highest feed efficiency (P<0.05); feed efficiency of birds fed diets 1, 4, 5, and 6 was reduced (P<0.05). Although the value ($) of feed consumed by birds fed diets 4, 5, and 6 was reduced (P<0.05) compared to birds fed diets 1 and 2, only birds fed diet 3 had a reduced (P<0.05) feed cost per unit weight gain ($/kg; compared to diet 2). The regular PF regimen (diet 3) was effective at maintaining growth and lowering the feed cost of production, but further benefits of lowering dietary Ca, P, and amino acid levels were not observed.

Key Words: phase-feeding, broiler, amino acids

32 Egg storage time before incubation and hen’s age affect the incidence of Phosphorus rickets in broiler chicks. M. Y. Shim*, G. M. Pesti, R. I. Bakalli, and H. M. Edwards, Jr., University of Georgia, Athens.

Two experiments were conducted to confirm that variation in broiler phosphorous (P) utilization is due to hen’s age and egg storage time. Experiment 1 was conducted with chicks hatched from eggs laid by Ross × Ross 308 hens (27 vs. 61 wk old) and stored for 0 or 10 d. The diets were based on corn, soybean meal and soybean oil and contained 1.00 % Ca and 0.25 % available P. Six replicates of 5 chicks from each hen age and egg storage time combination were placed in battery brooders. Hens’ age had significant effects (P<0.05) on 0 – 16 d chick growth (309 ± 17 vs. 226 ± 10 for 27 and 61 wk old hens, respectively). The longer egg storage time of chicks from older hens resulted in higher P rickets score and incidence, but the longer egg storage time of chicks from younger hens resulted in lower P rickets score and incidence (P=0.0455). The longer egg storage time of chicks from older hens resulted in lower bone ash (%), but the longer egg storage time of chicks from younger hens resulted in higher bone ash (%). Experiment 2 was conducted with chicks hatched from eggs laid by Ross × Ross 308 hens (26 vs. 60 wk old) and stored for 0 or 10 d. The diets were same as Experiment 1, but with or without 1α-OH Cholecalciferol (1α-D₃). Six replicates of 10 chicks from each hen age and egg storage time combination were placed in battery brooders. The P rickets-inducing diet without 5 μg/g 1α-D₃ resulted in a much higher P rickets score (P<0.0001) and incidence (P<0.0001) than P rickets-inducing diet with 5 μg/g 1α-D₃. Hens’ age had significant effects (P<0.0001) on 0 - 16 d chick growth (272 ± 7 vs. 339 ± 8 for 26 and 60 wk old hens, respectively), and egg storage time had significant effects (P<0.05) on 0 - 16 d chick growth (295 ± 11 vs. 316 ± 9 for 26 and 60 wk old hens, respectively). The chicks from the older hens showed higher P rickets score (P=0.0186), but egg storage time did...
not affect P rickets score and incidence. The factors influencing the incidence of P rickets in broilers should include hen’s age and egg storage time as well as genetics and dietary levels of Ca, P, and Vitamin D.

**Key Words:** phosphorus rickets, egg storage time, hen’s age

### 33 Calcium particle size effects on excreta, and urinary Ca and P changes in broiler breeder hens.

M. K. Manangi* and C. N. Coon, *University of Arkansas, Fayetteville.*

A six-week experiment was conducted to evaluate the effects of two different Ca particle sizes on: a) Ca and P retention and percent tibia ash in normal broiler breeder hens, and b) total urinary Ca and P excretion in colostomized broiler breeder hens. One hundred and fifty normal and six colostomized broiler breeder hens, 30 wk old, were divided into two groups and fed a standard broiler breeder diet supplemented with either small or large particle size limestone. Two % acid insoluble ash (Celite) was used in the feed as a marker. Diets, excreta and urine samples were analysed for total P and Ca by ICP. The findings from normal birds showed that there is a tendency to reduce P excretion (P = 0.1585) by 1.83 mg P/g DM excreta, improve P retention by 2.09 percentage points, increase Ca retention by 3.69 percentage points, significantly (P < 0.0001) increase tibia ash by 3.22 percentage points, and increase egg specific gravity (P = 0.0382) by 0.002 units by feeding larger Ca particles compared to the smaller size. Data from the colostomized birds indicated that from the total P and Ca excreted in feces and urine for one egg laying cycle of 24 hr the amount of urinary P and Ca was 18% and 9%, respectively, for breeders fed either the small or large particle size limestone. In summary, breeder hens fed large particle limestone may influence Ca and P absorption and retention. Further studies are required to evaluate the effects of larger size Ca particles on P retention with different levels of dietary P.

**Key Words:** colostomy, urinary Ca and P, broiler breeder

### 34 Performance and egg quality of laying hens fed Egg Shell 49 or Replamin.

M. T. Farran*1, A. N. Kadi1, and G. W. Barbour2, *American University of Beirut, Beirut, Lebanon,*2Lebanese Agricultural Research Institute, Beqa’a, Lebanon.

An experiment was conducted to study the effect of Eggshell 49 2X (ES49), produced by Alltech, and Replamin powder (RP), produced by Albion Laboratories Inc., on performance and egg quality of 60 wk old Single Comb White Leghorn layers of ISA White strain for a period of 24 wk. One hundred ninety two laying hens of similar body weight were selected from a floor-reared flock and housed in individual layer cages equipped with a common drinker trough and individual feeders for two weeks, during which body weight and egg production were recorded. The birds were divided into three groups with 64 hens each whereby body weight and egg production means were similar among the three groups. The control group was fed a balanced corn-soybean meal diet containing 2900 kcal ME/kg and 16% CP, whereas the other two groups were fed a similar diet but supplemented with 0.05% ES49 or 0.1% RP to replace corn. Feed intake, egg production, and feed conversion were determined every 28 d sub-period. Egg weight, specific gravity, shell thickness, and Haugh unit and yolk color scores were recorded on all eggs collected during the last three days of each sub-period. Also hen body weight was recorded at the end of the experiment. Sub-period data were pooled and statistically analyzed as one way ANOVA and treatment means separated by Duncan’s Multiple Range test. Body weight change, daily feed intake, egg production, feed conversion, and Haugh unit and yolk color scores were not affected by any of the dietary treatments. Egg weight of birds fed the control and ES49 diets was comparable (69.4 g), but lower (P<0.05) than that of the RP diet (73.1 g). Specific gravity of control eggs was the lowest (1.0750) but significantly different only from that of ES49 (1.0778); RP had an intermediate specific gravity value (1.0771). Egg shell thickness of both RP (0.345 mm) and ES49 (0.342 mm) was higher (P<0.05) than that of control (0.329 mm). Although RP and ES49 in the current trial resulted in comparable performance and egg quality parameters, RP produced larger eggs.

**Key Words:** laying hen, feed additive, egg quality

### 35 Benefit of MINTREX® P blend of organic trace minerals on breaking strength, ash content, tibia dyschondroplasia, synovitis and pododermatitis in heavy weight tom turkeys.

J. Richards*1, M. Quiroz1, W. Williams2, and J. Dibner1, *Novus International, Inc, St. Louis, Missouri,*2Akey, Lewisburg, Ohio.

A field trial was conducted from March through August, 2005 that involved 2 commercial turkey producers, a consulting nutritionist, and Novus International to determine the effect of adding MINTREX P® (registered trademark of Novus International) blend of organic trace minerals (containing Zn, Cu and Mn chelated with 2-hydroxy-4-methylthio butanoic acid) added at 20 ppm each of Zn and Mn and 10 ppm of Cu. Birds were placed on MINTREX P on day of age and fed the full amount for 9 weeks. At the end of 9 weeks, feed blending was begun, which reduced the level of MINTREX P by approximately 10% per week. Birds at ages 0-6 wk, 6-12 wk, 12-16 wk or 16-20 wk were necropsied monthly. Three lame and two normal birds were selected from each flock. Age and weight of individual birds as well as scores for shaky leg, osteochondrosis, breast blister, perosis, tibial dyschondroplasia (TD), rickets, synovitis, and foot pad lesions were recorded. Tibial bones were measured for length, diameter, cortex thickness, bone breaking strength and ash. Incidence of TD, synovitis, and foot pad lesions increased with age, as did bone strength and ash content. Lameness was positively correlated with synovitis (P<.05). Bone breaking strength was significantly correlated with width of cortical bone (P<.0001). Analyses of data from the first location indicated that adding MINTREX P on top of the standard ration containing a trace mineral premix reduced TD incidence (P<.05), and improved foot pad scores (P<.05) over the entire 20 week grow out. Bone breaking strength and ash content were significantly improved by MINTREX in the heaviest weight birds (>14 kg). Other measured parameters were not affected by MINTREX. In addition, the incidence of synovitis was significantly reduced in MINTREX fed birds (P<.05) in the second location. Overall, the studies demonstrated a benefit for MINTREX P on leg quality in turkeys grown to market weight.

**Key Words:** organic trace minerals, MINTREX, pododermatitis

### 36 Growth and mineralization of the femur of the male turkey.

T. J. Applegate*1, P. Jaynes1, J. J. Dibner2, M. Quiroz1, and J. D. Richards2, *Purdue University, West Lafayette, Indiana,*2Novus International, Inc., St. Charles, Missouri.

Turkey femurs were collected from two commercial turkey complexes from 5 to 18 wk of age (n=5-28 per wk). The trial evaluated the
effect of organic Zn, Cu and Mn addition (MINTREX® organic trace minerals) when supplemented in addition to normal inorganic trace mineral concentrations. Femur lengths were measured and cut into three portions: proximal epiphysis (upper 25%), diaphysis (mid-50%), and distal epiphysis (lower 25%). The diaphysis was cut in half for determination of cortical bone thickness. Each bone portion was dried, weighed, defatted, reweighed, and ashed. This methodology, allowed for determination of total and portion bone ash both on a dry and a dry-defatted basis. Femur ash (%) did not change when determined on a dry-defatted basis, yet decreased from 53.6 to 34.9% from 5 to 18 wk of age. Notably, during only three of the 12 sampled weeks was dry ash values correlated with dry-defatted ash values (P<0.05). This lack of correlation could directly be attributed to variability when the bones had not been defatted. For example, the coefficients of variation (CV) for ash determined on a dried-defatted basis were less than 5% from 5 to 12 wk of age. During the same ages, the weekly CV ranged from 7 to 16.4% for femur ash determined on a dry basis. When expressed on a dry-defatted basis, femur epiphyseal and diaphyseal ash did not change considerably between 5 and 18 wk of age. Femur length reached a plateau at approximately 13 wk of age, concomitant with a plateau in the surface area of diaphyseal cortical bone. Cortical bone thickness (diaphyseal) also tended to decline after 14 wk of age. Diaphyseal cortical bone thickness differences between different edges of the femur were also noted throughout the study, ranging from 0.03 to 0.06 cm, but were not associated with the age of the bird. Birds fed diets supplemented with MINTREX® organic trace minerals had increased dry-defatted ash (%) through the entire study. In conclusion, defatting rather than just drying of turkey femurs was critical in removing variability within a treatment as turkeys aged. MINTREX is a registered trademark of Novus International, Inc.

Key Words: bone ash methodology, femur, turkey

37 The relationship between growth of commercial toms and linear skeletal development. M. S. Lilburn*, 1 A. Mitchell2, and J. Anderson1, 1The Ohio State University, Wooster, 2USDA, Beltsville, Maryland.

An experiment was conducted to study the relationship between the growth of commercial toms (Nicholas) and linear skeletal development. All toms were fed a commercial turkey starter diet for the entire experiment. At two week intervals, 10 toms were randomly selected and weighed. The right half of the Pectoralis major (PMAJ) breast muscle was removed and weighed and the tibia and femur were removed for further measurements. All tissue was removed from each bone by boiling and the length was recorded. The width of the bone was determined at the point calculated to be 50% of its respective length. Body weight increased from 405 g at 2 wk to almost 8 kg by 10 wk of age, a 20-fold increase, and there was a consistent 2 to 3 kg increase in BW every two wk between 10 and 22 wk (24.1 kg), representing a three fold increase in BW between these ages. The percentage PMAJ (one side only) almost doubled between 2 wk (3.8%) and 10 wk (7%) but thereafter the increases in relative breast muscle size, while incremental with age, were small and the terminal muscle size, while incremental with age, were small and the terminal muscle percentage remained low (1.95 to 16.86 mm) with only a 20 - 25% further increase through 22 wk (tibia, 20.84 mm; femur, 20.41 mm). From 14 to 22 wk, there was only a 2 mm increase in tibia and femur width but BW increased 10 kg during the time period. In conclusion, the greatest absolute and relative changes in long bone development occur within the first 10 weeks of age. The skeleton is subject to tremendous physical stress from increased BW from 10 to 22 wk (16 kg) and this emphasizes the importance of early skeletal development with respect to minimizing leg weakness at later ages.

Key Words: turkeys, femur, tibia

38 Supplementation with MINTREX® organic trace minerals improves growth performance and leg abnormalities in turkeys. P. R. Ferket*, 1 E. O. Oviedo1, J. L. Grimes1, D. V. Bohorquez1, A. A. Santos1, J. D. Richards2, and V. Felts3, 1North Carolina State University, Raleigh, 2Novus International, Inc., St. Charles, Missouri, 3Goldboro Milling Co., Goldboro, North Carolina.

Leg-related mortality can be >1% per week starting about 15 wk in turkey toms. Dietary MINTREX Pse (MIN) and 25-hydroxycholecalciferol (HyD) supplementation may improve growth performance and reduce the incidence of leg abnormalities. Day-old Nichols 85X700 toms were randomly distributed among 48 pens (4 dietary treatments (trt) x 12 replicates) of 15 poults each. Trts were a 2x2 factorial (0 and .1% MIN; 0 and 92 mcg/kg HyD). MIN provided 40 ppm Zn, 40 ppm Mn, and 20 ppm Cu as methionine hydroxy analogue complex and .3 ppm Se as Se yeast. Diets were formulated to be equal in nutrient content and fed ad lib as 8 feed phases until 20 wk. Body weight (BW) and feed intake were measured at 3, 6, 8, 10, 12, 17 and 20 wk. Incidence of valgus, varus, and Shaky leg defects were determined at 12, 15, 17 and 20 wk. There were no trt effects on BW (Mean 20 wk BW 21.2 kg). At 6 wk, cumulative feed:gain (cFCR) was improved by MIN when HyD was included in the diet (1.432 vs 1.416, p<.05). Only MIN significantly reduced cFCR from 8 wk through 20 wk (20 wk cFCR 2.802 vs 2.722, p<.01). Cumulative mortality at 3 wk was higher among the MIN birds (1.2% vs 5.3%, p=.0001), but it was lower by 20 wk (18.3% vs 15.6%, p<.1). MIN reduced varus defects at 17 wk (1.8% vs 3.3%, p<.05), shaky leg incidence at 12, 15 and 17 wks (13% vs 2.1% at 17 wk, p<.001), and valgus defect incidence at 15, 17 and 20 wk (21% vs 4.3% at 17 wk, p<.001). In contrast, HyD increased valgus defects at 20 wk (11.7% vs 20.5%, p<.05). There were no MIN x HyD interaction effects on leg problems. MINTREX Pse supplementation for turkeys may be an effective way to improve feed conversion, likely by reducing leg problems and late-term mortality. MINTREX is a registered trademark of Novus International, Inc.

Key Words: organic trace minerals, growth performance, leg problems

39 Comparison of inorganic and organic selenium sources on egg quality, performance and reproductive parameters laying hens. J. Purreza* and A. Pishnamazi, Isfahan University of Technology, Isfaha, Isfahan, Iran.

An experiment was conducted to compare the effect of organic and inorganic sources of Se on productive performance and egg quality of Hy-Line laying hens (28-40 weeks of age). Dietary treatments consisted of adding 0, 0.3, or 0.5 ppm organic and inorganic Se and...
one diet including equal mix of these two sources (0.15+0.15), to basal diet free of Se. The basal corn-soybean meal diet was formulated to meet nutrient requirements. Ninny six birds were randomly allocated in twenty four cages in a completely randomized design. Egg production and egg weight were recorded weekly and bi weekly, respectively. Body weight and shell weight, shell thicknesses, yolk weight, albumen height of fresh eggs were evaluated monthly and every six week. Some eggs were produced in 34 and 40 weeks, kept in storage egg room for 14 days and then egg quality test was accomplished. At 40 weeks 2 hens per pen dissected and Pectoralis major and Pectoralis minor, liver, abdominal fat pad, oviduct, and ovary were removed and individually weighed. Responses were statistically significant, for egg production (31.3%), egg weight (9.6%) and body weight (5.6%) and eggs quality (fresh and stored) with increasing amounts of both two sources of selenium in the diet. Dietary supplementation with organic Se increased (p<0.05) shell thickness of fresh eggs at 34 weeks. Sources and levels of Se had no significant effect on body weight, egg production and egg weight, although trend was toward improved with organic Se. Stored eggs quality were not affected by source or levels of Se. The Se level in the diet affected the weights of the Pectoralis major, minor and liver. Reproductive parameters were also not different among the treatments. Birds fed 0.3 ppm inorganic or organic Se had more numbers small yellow follicle. The results of this experiment indicated that organic Se increase egg production, yolk weight and shell thickness compared with inorganic Se.

Key Words: organic selenium, laying hens, reproduction

Metabolism and Nutrition: Nutrition B - Gut Health and Early Nutrition


The growth and health response of chickens to enteric pathogens, such as Salmonella spp. may differ whether they are raised on litter floors or in cages. This difference may be due to the degree of colonization challenge and its effect on gut health and feed passage. Male Ross 308 broilers were randomly assigned to 32 litter floor (L) pens in a curtain-sided house or 32 cages (C) in a total confinement house (25 birds/pen or cage). All the birds were orally inoculated with 106 cfu of a mixture of S. enterica subspp. at 3 day of age. Salmonella colonization levels (MPN), body weights (BW), feed/gain (FCR), bursa, spleen, and liver weights were determined, and gut health was evaluated at 14, 28, and 42 d. Organ weights and health of intestine (incidence of thin and inflamed gut tissues) was scored on 32 birds/house. In comparison to L, C reduced 42 d BW (2748 vs. 2668 g, p<0.001) and increased 1-42 d FCR (1.84 vs. 1.93, p<0.001). There were no house effects on mortality rate. Salmonella MPN was higher in L than C at 14 d (6.452 vs. 5.152 log/g, p<.01), which corresponded with a higher incidence of mucoid (14.1 vs. 1.5%, p<.01) jejunal mucosa, and greater relative spleen and liver size at 28 d by 13% and 11%, respectively (p<.05). In contrast, C had higher incidence of ileal grain chips than L at 14 d (68.4% vs. 31.5%, p<.05), indicating inferior gizzard function. Although birds reared on litter floors may have greater Salmonella-challenge than cage-reared birds, they demonstrate greater disease resistance and less feed passage, resulting in better growth performance.

Key Words: broilers, Salmonella, feed passage

41 Immune, growth and carcass responses to dietary threonine of broilers raised in different litter conditions. A. Corzo*, A. M. Kidd1, G. T. Pharr1, W. A. Dozier III2, and E. A. Koutsos3, 1Mississippi State University, Mississippi State, 1-USDA-ARS Poultry Research Unit, Mississippi State, Mississippi, 2California Polytechnic State University, San Luis Obispo.

Needs for dietary threonine in growing broilers have been well documented, but needs for growth, carcass and immunity reared in different litter conditions are not. Two studies were simultaneously done in the same house, and evaluated digestible threonine (d-Thr) needs of Ross x Ross 708 male broilers reared under two different litter conditions: new vs. used wood shavings (used for 4 previous flocks). Separated by a center aisle, all floor pens from one side of the close-sided house were provided new litter while the other side received used. These broilers were grown in common diets up to 21 d of age, and then fed one of six dietary d-Thr levels that ranged from 0.43 to 0.78%. At 42 d of age birds were processed, and carcass and breast meat yield were measured. As measurements of immunity, a bird from each experimental unit corresponding to either the 0.43% or 0.64% d-Thr were inoculated with SRBC at 28 d of age, and the corresponding primary response measured at 35 d of age. Additionally, at 35 d of age, a blood sample was collected from another bird per experimental unit and analyzed for white blood cell count, peripheral blood monocyte nitric oxide, and HD-11 macrophage nitric oxide. Spleen, thymus and bursa relative weights were measured at 42 d of age from one bird per pen fed either 0.43 and 0.64% d-Thr. Results for live performance and carcass traits are in close agreement with previously reported values in the literature. Quadratic responses were observed for BW gain, feed conversion, carcass and breast meat absolute and relative weights. Depending on the variable, these responses were maximized (95% of maximum response) between 0.63 and 0.66, and 0.65 and 0.70% d-Thr when broilers were raised in new and used litter, respectively. It should be noted that dietary digestible Lys was 1.00%, thus Thr to Lys ratios oscillated between 63 and 66, and 65 and 70 d-Thr for new vs. used litter, respectively. Low d-Thr (0.43%) was without effect on most immune parameters. However, low d-Thr decreased relative thymus weight and increased monocyte nitric oxide production in dirty and clean environments, respectively.

Key Words: litter, threonine, immunity

42 Denaturing gradient gel electrophoresis analysis of 16S ribosomal DNA amplicons to analyze changes in ileum bacterial population of turkeys fed different diets and after infection with Salmonella spp. A. A. Santos Jr.*1, P. R. Ferket1, B. O. Santos4, N. Nakamura2, C. Collier2, and H. R. Gaskins2, 1North Carolina State University, Raleigh, 2University of Illinois, Urbana.

Non-starch polysaccharides (NSP) and dietary exogenous enzyme supplementation may modulate enteric microflora and discourage Salmonella spp. (SAL) colonization by influencing the degree of competitive exclusion. Changes in ileum bacterial populations of SAL-infected turkeys fed different diets were analyzed using polymerase chain reaction (PCR) denaturing gradient gel electrophoresis (DGGE).
Turkeys were fed wheat/SBM- (WS) and corn/SBM- (CS) based diets with and without enzyme preparations (XY1 & XY2, respectively) from 0-126 d. The dietary XY1 and XY2 activity levels were 2500 and 650 EXU/kg feed, respectively (Danisco, UK). Microbial DNA was extracted from the ileum content of 16 wk-old turkeys, and 16S rDNA gene was amplified by PCR and analyzed by DGGE. Diversity indices, including richness (number of species, S), evenness (relative distribution of species, EH) and diversity (Shannon index, H) were calculated. SAL prevalence was determined from fresh fecal droppings collected from each pen. Diversity indices were associated with changes of SAL colonization of turkey intestine. The WS diets resulted in higher microbial diversity indexes than CS diets (S= 10 vs. 12; EH= 0.9 vs. 0.8; H= 2.2 vs. 1.9, P<.05). Likewise, enzyme supplementation stimulated the growth of the overall microflora and increased the diversity indexes in comparison to unsupplemented treatments (S= 13 vs. 10; EH= 0.9 vs. 0.8; H= 2.2 vs. 1.9, P<.05). SAL prevalence was higher (P<.05) in turkeys fed the CS diet (50%, 13%) than the corn-enzyme (13%, 0%) and WS (0%, 0%) dietary treatments at 15 and 18 wk, respectively. Therefore, birds fed the CS diet had lower microflora diversity but higher SAL prevalence than birds fed enzyme-supplemented and WS diets. In contrast, birds fed the WS diets had higher diversity but lower SAL prevalence than CS diets. Evidently, high dietary NSP from wheat, and dietary exogenous enzyme supplementation promoted microbial community diversity and discouraged Salmonella colonization through competitive exclusion.

Key Words: microbial ecology, Salmonella, fiber

43 Modern broilers have a reduced innate immune response compared to random-bred strains when challenged In Vitro with E. coli. R. D. Kirschman*, M. Sung, J. Hottman, J. Gallegos, J. L. Saunders-Blades, and D. R. Korver, University of Alberta, Edmonton, AB, Canada.

The capacity of the innate immune system of broiler chicks to respond to E. coli was examined using three strains of broilers; a modern commercial strain (Ross 308), and two random-bred strains (random-bred since 1977 or 1957). Birds from each strain (n = 30) were bled at 1 day of age and the in vitro activity of phagocytic cells for, E. coli phagocytosis, and total E. coli bactericidal activity, as well as oxidative burst of heterophils were measured. For each strain, a minimum of 87 birds were divided among 8 cages per strain in a battery brooder and grown to 2 weeks of age. The body weight, gain and feed intake of the modern strain were greater than both the 1957 and 1977 strains (P<.0001), whereas the gain:feed was only greater than that of the 1957 strain (P<.0001). The 1977 strain had greater body weights (P<.0001), feed intake (P=0.0059), gain (P=0.0026) and gain:feed (P=0.0003) than the 1957 strain. E. coli uptake per phagocytic cell was not affected by strain, however both the 1957 and 1977 strains had greater total E. coli bactericidal activity than that of the control strain (P<0.002). The heterophils of the 1957 birds also showed a greater capacity for oxidative burst than either the 1977 or modern strains at 5 (P<0.0052), 10 (P<0.0215) and 15 (P<0.0002) minutes of incubation, and more than the modern strain at 20 minutes (P=0.0172). These results suggest that although genetic selection for growth has increased the production traits of modern broilers it may have also decreased the effectiveness of the innate immune system when compared to random bred strains. As such, this could have important implications on the future of disease prevention in the broiler industry.

Key Words: broiler, innate immunity, random-bred

44 Effect of PrimaLac®, direct fed microbial, on ileal absorption, energy expenditure and intestinal microbial fermentation. M. Chichlowski*1, W. J. Croom1, M. A. Froetschel2, M. D. Koci1, B. M. McBride1, R. Qiu1, and L. R. Daniel1, North Carolina State University, Raleigh, 2University of Georgia, Athens, 3University of Guelph, Guelph, ON, Canada.

Previous studies with PrimaLac®, a direct fed microbial (DFM), have demonstrated decreases in whole body and ileal energy expenditures in broilers. This study examined the effects of DFM and salinomycin on ileal glucose and proline absorption and their relationship to GI energy expenditures. GI fluid digesta fermentation products were also measured. In Trial 1, broiler (n=36) were fed a standard starter diet (CON), Con + DFM (PrimaLac®0.3% w/w), and Con + Salinomycin (SAL;0.05% w/w) from hatch to 3 wk. On d 21, birds were euthanized, ileal tissue dissected and glucose and proline uptake estimated. In adjacent tissue, total O2 (TO2) and Na/K ATPase-sensitive O2 consumption (ATPO2) were estimated. Trial 2 was similarly designed except jejunal, ileal and cecal fluids were collected for VFA and D/L lactate analysis (n=54). Treatment did not change active ileal glucose or proline uptake. Passive and total glucose and proline uptakes were increased (p<0.07) by DFM compared to SAL. TO2 and ATPO2 did not change with treatment. However, the percentage of total ileal cell O2 consumption attributed to ATPO2 increased (44%; p<0.04) with SAL. Apparent energetic efficiency of total glucose and proline uptakes were increased (p<0.10) by DFM compared to CON. L-lactate and total lactate concentrations in GI fluid decreased (p<0.01) with DFM compared to CON and SAL while D-lactate increased (p<0.04) with DFM compared to CON. Overall the ratio of L/D lactate did not change amongst treatments. Total cecal VFA concentration was lower (p<0.003) with DFM compared to CON. Total VFA concentrations in jejunum and ileum were different between treatments. Increases in the efficiency of nutrient absorption and decreases in intestinal fermentation with DFM may contribute to previously observed decreases in energy expenditures; however, these contributions are relatively minor, indicating that other physiological mechanisms are involved.

Key Words: direct fed microbial, broiler, intestinal function


Dietary Bacillus subtilis C-3102 spores (Bs) from the direct-fed microbial CALSPORIN® (marketed by Quality Technology International, Inc., Elgin, IL in the U.S., Canada, and Mexico) helps maintain normal intestinal microflora and may enhance performance of broiler breeder chickens. As Bs spores vegetate in the relatively short intestinal tract and deplete the oxygen supply within the digesta, they create a more favorable, anaerobic condition that promotes the proliferation of lactic acid producing bacteria (e.g., Lactobacillus reuteri). Lactic acid inhibits certain pathogens such as E. coli, Salmonella, Clostridia, and Campylobacter. In Exp. 1 at Granja-P Estado de Sergipe, Brazil, Hubbard hens (~12,900/house; 3 houses), 25 or 24 wk of age initially, were fed diets containing an antibiotic (CON; 2 houses) or 0.003% Bs spores (300,000 cfu/g feed; 1 house) to 65 or 66 wk of age (41 to 43 wk total). By treatments, eggs/hen were 173.21 for CON vs 176.32 for Bs spores diets (not analyzed statistically). Eggs hatched/hen were 120.80
ABSTRACTS OF PAPERS


1500 day old Lohmann pullet chicks were divided into 2 groups of 750. One group was fed Bio-Mos in the diet through 18 weeks of age and the other group was fed control pellet feed without Bio-Mos. At 18 weeks of age, 1440 of the birds were moved to the laying cages. During the laying phase of the trial, 360 of the laying hens fed control feed as pullets were fed control feed as layers. 360 laying hens fed control feed as pullets were fed layer feed with Bio-Mos. 360 laying hens fed Bio-Mos feed as pullets were fed layer feed with Bio-Mos and 360 laying hens fed Bio-Mos feed as pullets were fed control layer feed (4 Treatments). Each of the groups of 360 birds were divided into 6 reps of 60 birds. One flat of 30 eggs was collected every 3 to 4 weeks from each of the 24 experimental groups (4 trts x 6 reps/trt). Egg weight was not significantly different between any of the four treatments, however there was a significant increase in egg weights over time. Weekly egg production was not significantly different between any of the treatments, but did decrease significantly over time. And, average specific gravity was not different between any of the treatments, but did decrease significantly over time.

Key Words: Bio-Mos, layers, specific gravity

47 Effects of MOS and avilamycin on broiler performances and carcass yield. M. Haj Ayed1, A. Bessadok2, and M. A. Jarraya1, 1Ecole Supérieure d’Horticulture et de l’évage, Chott Mariem, Sousse, Tunisia, 2Société Tunisienne d’Agriculture, Borj Cédria, Rades, Tunisia.

Probiotics and prebiotics are being used to replace antibiotics as feed additives in animal nutrition in order to improve production levels without compromising animals’ health. The purpose of this study was to compare the effects of supplementing broiler diets with Mannan Oligosaccharide (MOS) or Avilamycin (AV) on birds’ performances and carcass yield to standard (control) diets. Twelve groups of 1 day of age (DOA) Arbor Acres chicks (100/group) were allotted randomly to 3 treatments T1, T2, and T3 (with 4 replications x 100/treatment).

Chicks were fed diets with MOS (DMOS) in T1, with AV (DAV) in T2, and received control diets (C) with neither MOS or AV in T3. Data were collected on body weight (BW), average daily gain (ADG), feed conversion ratio (FCR), and mortality rate (MR) during the 1 to 36 DOA fattening period. At the end of the trial (36 DOA), 60 broilers (5 broilers/group) were randomly chosen and slaughtered to evaluate carcass yield (CY). Growth performance data showed that broilers receiving diet C had the lowest (p<0.05) ADG (49.5 g/day) among all groups. BW of birds (1777 to 1779g) and FCR did not vary with the regimen (p>0.05). MR was also comparable (p>0.05) among all groups and averaged 3.25, 3.75, and 5.75% for broilers receiving DAV, DMOS, and C diets, respectively. CY varied between 75.4 and 69.7%. The highest value (p=0.05) was observed for DAV birds while intermediary values (71.3%) were observed for the DMOS groups of birds. It should be possible to improve average daily gain and carcass yield by incorporating AV in broiler diets and that MOS might substitute AV.

Key Words: Bacillus subtilis C-3102, broiler breeders, CALSPORIN

48 Responses to lysine levels in broiler chickens fed mannan oligosaccharide and yeast as an alternative to antibiotic growth promoters. S. Gomez* and M. L. Angeles, National Center for Research in Animal Physiology - INIFAP, Ajuchitlan, Queretaro, Mexico.

An experiment was done to evaluate the productivity, carcass yield and nutrient balance in broiler chicks fed two levels of lysine (LYS) with and without the provision of mannan oligosaccharide from *Saccharomyces cerevisiae* combined with dried yeast (MOS+YE) and with or without flavomycin and monensin (F+M). One hundred and thirty two Ross B300 males from 35 to 49 days of age were assigned to individual holding crates in a complete block design to eight treatments in a factorial arrangement of 2 F+M levels (0,0 and 50,500 ppm/ton of feed) x 2 MOS+YE levels (0 and 1 kg/ton of feed of yeast hydrolyzed fermentation solubles and hydrolyzed brewers dry yeast) x 2 digestive LYS levels (.85 and .95%). With F+M, weight gain (77.0 vs 81.0 g/d, SEM=2.590; P<.05), feed efficiency (.418 vs .446, SEM=.0068; P<.01), and ashes excretion were higher (2.9 g/d, SEM=.073; P<.05) and the ashes retention was lower (77.4 vs 74.8 %, SEM=.907; P<.05). With MOS+YE, body weight gain (76.3 vs 81.6 g/d, SEM=1.576; P<.05), weight and yield of carcass (1099.1 vs 1190.2 g, SEM=23.987; P<.01 and 42.9 to 46.4 %, SEM=.450; P<.01), weight and yield of thighs (328.7 vs 349.9 g, SEM=7.445; P<.05 and 12.8 vs 13.6 %, SEM=.291; P<.01), weight and yield of drumsticks (204.7 vs 220.6 g, SEM=4.124; P<.01 and 8.0 vs 8.6 %, SEM=.161; P<.01), retention of dry matter (89.8 %, SEM=.353; P<.05), organic matter (89.8 vs 90.7 %, SEM=.316; P<.05) and ashes (75.0 vs 77.2 %, SEM=.893; P<.05) were improved. At a dietary LYS level of .95, feed efficiency was improved (.421 vs .441, SEM=.0068; P<.05). In summary, broiler chickens fed F+M or MOS+YEA did not respond to the supplementary provision of LYS; chicks fed MOS+YE showed the greatest benefits on growth, carcass yield and nutrient retention and could be an alternative to antibiotic growth promoters.

Key Words: broiler, antibiotic, *Saccharomyces cerevisiae* cell wall
Poultry embryos depend on lipid-based energy metabolism (MT) during most of their development, but must shift to a carbohydrate-based MT dependant on glycogen reserves likely when hatching and pulmonary respiration begins. For glycogen reserves to accumulate and fuel hatching activity, gluconeogenic MT must be expressed. Our objective was to survey the time course and degree of expression among 90 genes associated with lipid and carbohydrate (CHO) MT at 20, 22, 24, 26, and 28 d of incubation (E) of turkeys, using microarrays (MA). At each time point, liver samples were collected, from 25 Nichols turkey embryos, to extract RNA to produce fluorescently labeled cDNAs for MA hybridization. MA were printed with specific 70 bp oligonucleotides designed for each of the 90 genes. Six genes that code for key enzymes of metabolic regulation were selected: enoyl-CoA hydratase/3-hydroxyacyl-CoA dehydrogenase (EHD), glucokinase (GK), phosphoenolpyruvate carboxykinase (PEPCK), citrate synthase (CS), glycogen synthase (GS) and glycogen phosphorylase (GP). Gene expression (GE) data for each time point were interpreted relative to E28 GE levels (set to 100%). Lipid MT was apparently reduced at E22, indicated by change in EHD GE of 20% above E28 levels at E20 (p<0.0001) to 9% below at E22 (p<0.05). Glycogenesis was apparently down regulated at E24 and E26, as GK GE decreased 10 and 13%, respectively (p<0.05). Gluconeogenesis was apparently down regulated only at E22, when PEPCK GE was suppressed by 15% (p<0.0001). Glycogen synthesis and breakdown GE increased transiently from E20 to peak at E26, as GS and GP changed from 20% below to 20% and 30% above E28 GE, respectively (p<0.0001). Likewise, CS GE, the key enzyme to control TCA cycle activity and energy usage, increased transiently from 30% below E28 GE (p<0.0001) at E20 to 20% above E28 at E26 (p<0.0001). Evidently, the shift from lipid to CHO MT initiates at E22, but storage and usage of CHO seems to gradually increase until E26, which corresponds to the time of internal pipping.

Key Words: turkeys, energy metabolism, microarrays

Lipid yolk utilization of late term broiler embryos.
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Yolk biochemical analysis during last period of incubation revealed changes in the protein; lipid weight ratio from 1.2 on day 17 E to 4.3 on day of hatch. This indicate intensive uptake of yolk lipid fraction and imply preferential use of the lipid, rather than the protein fraction of the yolk, in the late term embryo. In order to determine which portion of the yolk lipid fractions is required by the embryo, fatty acids profile and cholesterol concentration within the yolk were examined during the pre-hatch period in Ross embryos. The results indicated decreased cholesterol concentration toward hatch; differential uptake of the different fatty acids in the yolk as poly-unsaturated fatty acids (PUFA) concentration decreased from 23% of total fatty acids at day 17 of incubation, to 19% at hatch (P<0.05) and saturated (SAT) fatty acids concentration increased from 30% to 34% of total fatty acids at hatch (P<0.05). The results imply existence of a specific mechanism which enables the yolk sac membrane to transfer specific lipid fractions. Therefore, our further studies were focused on examining the mRNA expression of 1) lipoprotein lipase (LPL), which enables fatty acids utilization, and 2) low density lipoprotein receptor (LDLr) which enables lipoprotein uptake (by endocytosis) from the yolk to the yolk sac membrane.

Results showed that LPL mRNA expression decreased in 20 E and remained low at hatch, in comparison to its expression levels at 17 E, 18 E and 19 E (P<0.05). However, an increase was found in the LDLr mRNA expression levels by approximately 3 folds in 20 E, in comparison to 17 E, 18 E and 19E (P<0.05). These differences in mRNA expression patterns of LPL and LDLr, implies that the dominant pathway by which lipid fraction are utilized by the yolk sac membrane is turning from individual fatty acid transport, as facilitated by LDLr, to whole lipoprotein uptake, by LDLr. Additional identification of the genes enabling lipid utilization, and characterization of the lipid fractions utilized by the embryonic throughout the late embryonic period will clarify the embryonic needs at the pre-hatch period and the possible interaction with conditions in the hatchery.

Key Words: hatchery feeding, amino acid, broiler

51 Hatchery feeding of starter diets to broiler chicks.
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Research reports concerned with amino acid density and in ovo feeding have delineated the importance of early nutrition of broilers. Eggs from a Cobb x Cobb 500 slow-feathering cross were set in a common incubator and hatched. Chicks were feather-sexed, placed in 36 chick trays (25 chicks of each sex), and weighed by tray. One of four dietary treatments were administered (454g/tray) in crumble form: 1) no feed; 2) feed containing 1.24% digestible (d) Lys, 0.84% d TSAA, 0.80% d Thr, 23.2% CP, and 3,080 kcal/kg ME; 3) feed containing 1.45% d Lys, 0.94% d TSAA, 0.84% d Thr, 26.0% CP, and 3,080 kcal/kg ME; 4) as 3 plus 100 mL of potable water added to the crumbles five min before administration in the trays. Chicks received feed treatments in trays until placement (5 h total tray feeding). Chicks were placed in floor pens in a curtain-sided, tunnel-ventilated house by trays (50 chicks/pen) containing one tube feeder, nipple drinkers, and built-up litter (average litter temperature of 51 C under the brooder at d 1). All birds received common diets in pens from 1 to 17 d in crumble form, and 18 to 28 and 29 to 37 d in pellet form. BW by pen was measured on d 7, 17, and 37, and feed intake on d 1 to 17 and 1 to 37 for live performance measurements. Three birds from each sex per pen were chosen randomly for processing at d 37. Bird measurements at 37 and 38 d consisted of duodenum and jejunum wet weight, processing weight, foot paw score, carcass weight, abdominal fat weight, breast weight (fillets and tenders), wing weight, thigh weight, and drumstick weight. Pen was used as the experimental unit for all statistical analyses. Chicks receiving treatment 4 (140 g/bird) hatchery feed had higher d 7 (P = 0.02) BW gain than chicks receiving treatment 2 (137 g/bird) or 1 (136 g/bird). But chicks receiving treatments 2 and 3 had similar (P > 0.05) d 7 BW gain. Additional parameters measured did not differ (P > 0.05). Results indicate that pre-placement feeding for 5 h of the crumbled starter diets presented herein (as-is or wet) does not result in benefits for Cobb 500 broilers grown to 2.1 kg (straight-run average BW).

Key Words: hatchery feeding, amino acid, broiler
52 Effect of dietary gelatin supplementation on early intestinal development and performance of broiler chicks. Y. O. Fasina¹, E. T. Moran¹, C. M. Ashwell², D. E. Conner¹, and S. R. McKey¹, ¹Auburn University, Auburn, Alabama, ²North Carolina State University, Raleigh.

The intestine of poultry is not fully developed at hatch. One way to induce early intestinal development and digestive function in young poultry is through the inclusion of feed ingredients that can increase ribosomal capacity for translating amino acid to protein (protein:RNA) and the expression genes coding for brush border enzymes involved in membrane digestion of nutrients. Gelatin is an ingredient that contains a high level of protein (about 80%). Therefore, supplementing gelatin at 2% level of broiler chick starter diet may induce early intestinal development. A 14-day experiment was conducted using 144 day-old chicks obtained from a commercial hatchery. Chicks were randomly allocated to 2 treatments; treatment 1 (SB) in which chicks were fed a gelatin-free corn-soybean meal (SBM) diet, and treatment 2 (SBG) in which chicks were fed a gelatin-supplemented corn-SBM diet. Each treatment consisted of 4 replicate pens, with each pen containing 18 chicks. On day 7 of experiment, performance parameters of chicks (weight gain and feed conversion (FC)) were recorded. Also, intestinal tissue samples were collected (from jejunum) and analyzed for protein:RNA. The expression level of selected brush border enzymes (leucine aminopeptidase (LAP) and sucrase isomaltase (SIM)) in the jejunal tissues was also evaluated using the Reverse Transcriptase-Polymerase Chain Reaction (RT-PCR) procedure in which the expression of each gene was determined relative to that of a housekeeping gene (GAPDH or β actin). On day 14, only weight gain and feed intake was evaluated. Results showed that during the first week, the FC of chicks in the SBG treatment (1.12) was superior (p < 0.05) to the FC of chicks in the SB treatment (1.26). However, by day 14, chicks in both treatments had similar FC values. Protein:RNA ratio was also superior (p < 0.05) for chicks in the SBG compared to chicks in the SB, but there was no difference in the expression of LAP and SIM genes. It was concluded that supplementing broiler chick starter diets with 2% gelatin induced early intestinal development and enhanced FC during the first week of life.

Key Words: gelatin, broiler chicks, gene expression

53 The effect of varying period and severity of early food restriction on performance and carcass quality of two broiler strains. M. R. Bakhtiari, K. Nazer Adl, and H. Jannmohammadi*, University of Tabriz, Tabriz, East Azarjan, Iran.

Effect of two periods of early food restriction (7 or 14 days) and four level of food restriction severity (0, 30, 40, and 50 percentage of voluntary feed intake of control group) on weight gain, feed conversion ratio, dressing percentage and abdominal fat in two mixed-sex of Ross and Arian broiler strains were studied in completely randomized design as factorial method analysis. Food restriction regimes were started from 7- days of age. Main effects of period of food restriction was significant (P<0.05) on body weight gain (BWG) in week 3, but BWG, feed conversion ratio (FCR), dressing percentage and abdominal fat were similar in two period of food restriction (7 or 14 day) in 8-56 days of age. With increasing of severity of food restriction from 0 to 50 percentage, BWG decreased significantly (P<0.05) from 135 to 83.5 gm in week 3. In period of 8-56 days of age, the highest value of BWG was resulted with 30 percentage of food restriction severity. FCR and carcass qualities were not affected by food restriction severity treatments. The interaction between food restriction severity and broiler strains was significant (P<0.05) on BWG and FCR in 8-56 days of age. BWG and FCR values were better in Arian broilers than those in Ross ones. BWG and FCR were similar in all food restriction severity treatments for Arian broilers, but the highest value of BWG and the lowest value of FCR were obtained with 30 percentage of food restriction severity for Ross broilers in 8-56 day of age. The interaction between period of food restriction and broiler strains was significant (P<0.05) on BWG and FCR in 8-56 days of age. The period of food restriction had more negative effects on BWG and FCR of Ross broilers in comparisons to Arian ones. The best value of FCR was resulted in period of 14 days for Arian broilers.

Key Words: early food restriction, broiler strains, performance

54 A new natural feed additive for broiler chickens. F. Saleh*¹, M. Yamamoto¹, M. Tahir², A. Ohutsuka², and K. Hayashi², ¹Biogenkaji Research Institute, Kirishima city, Mizuho, Japan, ²Kagoshima University, Biochemical Science and Technology, Kagoshima city, Korimoto, Japan.

Supplementing exogenous enzymes, growth promoters or microbiorganisms to the broiler diet is widely used to improve broiler performance. In the present study, an experiment was conducted to study the effect of a new commercial feed additive Tomoko® on performance in broilers. Tomoko® is a feed additive produced by fermentation using Koji (Aspergillus awamori), containing enzymes and active Aspergillus awamori mycelium. Male broiler chicks (Cobb strain) were raised under 25 °C in wire bottom cages for 12 days from 15 days of age. Chicks were divided at 15 days of age into control (C), 0.05 % Tomoko® (T) and 0.05 % heated (85 °C, 1 min) Tomoko® (HT) groups with 7 replicates. The basal diet (CP 21.1%, ME 3000 Kcal/kg) was made mainly from corn and soybean meal and Tomoko® was mixed into the basal diet. Feed and water were offered ad libitum. Body weight was recorded every 3 days and feed intake recorded daily. At 27 days of age, all the birds were killed by decapitation and dissected to measure carcass yield. The data were analyzed through the analysis of variance (ANOVA), using a general linear model procedure of the statistical analysis system with Duncan’s multiple range test. The result showed no significant effect of T and HT on body weight gain. However, birds receiving diets supplemented with Tomoko® significantly consumed less feed compared to C group (C:1123g, T:1004g, HT:1044g) and feed conversion ratio was significantly decreased by Tomoko® (C:1.60, T:1.39, HT:1.49). Also, Tomoko® showed significant improvement in carcass yield (g/100g BW) (C:68.6, T: 70.0, HT:70.4). Interestingly, no significant differences were observed between T and HT groups in performance and carcass yield. It is concluded that Tomoko® is effective to improve the performance of broiler when fed corn soybean meal diet and the effectiveness was not affected by the heat treatment.

Key Words: broiler, performance, Tomoko
The objective of the study was to investigate the relationship between health and production traits in chickens. The data were obtained from a closed, fully pedigreed, commercial broiler line. Records included measurements of body weight (BW), residual feed intake (RFI), percent breast meat (PBM), and two health traits (H1 and H2) from 13,665 birds and 1,524 hens with progeny records. Production traits were recorded as continuous and health traits were recorded as binary (1 or 0). After data editing, 13,632 records remained for analysis. For the health traits there were no extreme case problems observed in the 28 contemporary groups. Two analyses were conducted: 1) a threshold-linear mixed model for the joint analysis of BW, RFI, PBM, and H1; and 1) a threshold mixed model for analysis of H2. The mixed model included fixed effects of contemporary group (flock-week of hatch-parent’s flock) and sex (not included in the model for H2); and random additive effects of bird and residual. A separate analysis for H2 was required since BW, RFI, PBM, and H1 were considered missing for these birds. In analysis 1, each bird had a valid observation for BW and H1, however, a bird which had RFI did not have PBM and vice versa. Thus a large number of birds had at least one missing observation in the first analysis and missing records for RFI and PBM were predicted based on the model parameters. Heritability estimates obtained for BW, PBM, RFI, H1, and H2 were 0.38, 0.55, 0.30, 0.14, and 0.12, respectively. Genetic correlations obtained from analysis 1 for BW with PBM, RFI and H1 were 0.08, 0.14 and -0.20, respectively; PBM with RFI and H1 was 0.38 and 0.08, respectively; and RFI with H1 was 0.03. The results suggest that as RFI is increased, BW and PBM were also increased. However, it would appear that as BW is increased, the health of the bird is decreased for H1. Residual correlations around -0.20 were reported between H1 with PBM and BW with RFI and 0.57 between BW with PBM. Given that H2 was analyzed separately, breeding values for birds in both analyses were correlated in order to obtain an approximation of the genetic correlation between BW, RFI, PBM, and H1 with H2. Correlations between H2 with BW, RFI, and RFI ranged from -0.03 to -0.04. A positive correlation of 0.05 was obtained for H2 with H1. The correlations were close to zero indicating that no definitive conclusions could be drawn for the relationship of H2 with the other traits using breeding values. In conclusion, the heritability estimates for the health and production traits of interest suggest that genetic improvement could be made. However, the relationship between these traits varies with the health traits having little to no relationship with the production traits. The fluctuation in these relationships could be due to the large number of missing records for PBM and RFI.

Key Words: body weight, breast meat, feed conversion

**56 Effects of the Rfp-Y gene complex on the development of rous sarcoma tumors in the arkansas progressor and regressor chicken lines.** M. V. Spanakos*1, H. O. Pavlidis1, S. M. Sullivan1, L. K. Stamps1, R. Kopulos2, G. F. Erf3, and N. B. Anthony1, 1University of Arkansas, Fayetteville, 2Northern Illinois University, Dekalb.

The Arkansas Progressor (AP) and Regressor (AR) lines of chickens have been developed based on their respective ability to cope with a tumor induced at the site of Rous sarcoma virus (RSV) injection (wing web). It has been demonstrated that RSV regression or progression can be influenced by the MHC; specifically the Bcomplex. Another locus, the Rfp-Y also contains MHC genes in the chicken. The objective of this study was to characterize AP and AR chicken lines for Rfp-Y haplotype, and to determine whether the Rfp-Y significantly influences the development of RSV-induced tumors in the pure lines and respective crosses between them. Also, complementation between the Y types and the B types was evaluated. The AP is fixed for the B13 haplotype while the AR has both the B13 and B221. Nine Rfp-Y haplotypes, defined for class I MHC-like loci, were identified between the three pure sublines (AP 13, AR 13, and AR 221) and the three crosses from these sublines. Only three Y haplotypes (Y1Y1, Y5Y5, and Y5Y5) out of those identified were used in this study due to those haplotypes having high enough frequencies for analysis, and being present in all sublines and crosses for comparison. Pattern of tumor response to the tumor was evaluated using tumor score, tumor profile index, and mortality. Regardless of B background it was determined that the Y1Y5 haplotype was less efficient in tumor regression than the other two Rfp-Y haplotypes studied. When examined on a common B background, the Y1Y5 haplotype was less effective in regressing tumors only in the AP 13 subline, and AP 13/AR 13 cross. The four other B backgrounds resulted in no significant differences in tumor development based on Y type. Data were generated that indicate interactions between MHC and non-MHC loci for tumor regression.

Key Words: MHC, Rfp-Y, rous sarcoma

**57 Growth performance and immune response of naked neck and normally feathered genotypes of chicken.** M. M. Fathi*, A. H. El-Attar, and A. Nazmi, Ain Sham University, Cairo, Egypt.

The favorable effect of naked neck (Na) gene on productive performance under high ambient temperatures has been documented by numerous researchers. While the immunocompetence measurements for naked neck birds are still under investigation. In this concern, an experiment was undertaken to evaluate the effect of Na gene in a single or double state on the growth performance and immune response in chickens. Two hundred and twenty (NaNa, Nana and nana) one day old chicks was used in this study. They were reared under similar environmental, managerial and hygienic conditions from hatching to 16 weeks of age. The current results revealed that the Nana genotype had significantly heavier body weight compared to nana one. However, there was no significant difference between NaNa and nana genotypes for body weight. The presence of Na gene in a single or double state significantly improved feed conversion ratio compared to nana sibs. With respect to cutaneous basophil hypersensitivity (CBH) response, the NaNa genotype significantly increased toe-web swelling at 48 and 72 hrs after PHA-P injection compared to Nana and nana genotypes. There were no significant differences among genotypes for relative weight of both spleen and thymus. However, the Nana genotype significantly increased relative bursa weight compared to both NaNa and nana genotypes. Also, the Nana genotype significantly increased hematocrit level compared to nana and NaNa genotypes. Concerning the phagocytic activity, the Nana genotype had significantly lower levels of carbon in their circulation as compared to nana genotype. The homozygous (NaNa) birds recorded a significantly higher H/L ratio compared to the other two genotypes. The presence of Na gene either in a single or in a double manner (NaNa, Nana) increased...
total antibody level for sheep red blood cells compared to normal case (nana).

We concluded that the homozygous (NaNa) genotype had a better cell-mediated immunity, while the heterozygous (Nana) genotype had better phagocytic ability and H/L ratio compared to normal (nana) genotype.

**Key Words:** immunocompetence, naked neck, growth performance

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**58 Use of real-time reverse transcriptase polymerase chain reaction assay for surveillance of influenza viruses in wild waterfowl populations.** T. Dormitorio*, J. Giambrane, and K. Guo, Auburn University, Auburn, Alabama.

Wild aquatic birds are considered the natural reservoirs of Influenza A, from which viruses can be transmitted to domestic poultry, pigs and other animals including humans. Through surveillance of wild birds, prevalence of avian influenza viruses (AIVs) can be monitored and the pathogenic and antigenic properties of the circulating viruses can be determined.

Real-time reverse transcriptase polymerase chain reaction (RRT-PCR) assay developed by the Southeast Poultry Research Laboratory in Georgia was optimized with modifications and used to detect AIVs from cloacal swabs of wild ducks from Southeastern United States. Viral RNA was extracted using a commercial kit and used as template in a one step protocol with specific primers and hydrolysis probes. The Roche LightCycler® instrument and software were used to run and analyze the test. In vitro-transcribed matrix, H5 or H7 gene RNA and live virus A/turkey/W/68 (H5N9) were used as positive controls.

alone of the swab samples tested to date, including those that agglutinated red blood cells was positive by RRT-PCR. Further testing is being conducted on allantoic fluid collected from embryonated chicken eggs inoculated with swab samples. The RRT-PCR test is a more sensitive, cost-effective and rapid assay compared to the standard virus isolation in embryonating eggs procedure.

**Key Words:** Avian Influenza, real-time RT-PCR, virus isolation

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**59 Over-supplementation of vitamin D and the risk of sudden death syndrome in fast growing commercial broilers.** S. Nain*, B. Larveld, and A. A. Olkowski, University of Saskatchewan, Saskatoon, SK, Canada.

Broiler diets are frequently fortified with Vitamin D (D3) above the recommended levels in an attempt to prevent commonly occurring leg problems. Since the basal levels of dietary D3 are rarely known, there is a risk of over-supplementation. Excessive intake of D3 has been shown to have detrimental effects on the heart. In order to evaluate the risk associated with D3 oversupplementation on cardiac health in fast growing broilers, we evaluated the effects of excess dietary D3 in commercial male broilers. The birds were randomly divided into two dietary groups, control and treatment. Respective groups were offered either commercial diet or commercial diet fortified with D3 at a level 16x NRC recommendation. The birds were housed in pens with raised perforated floors in an environmentally controlled room. During the first 7 days the temperature was maintained at 34°C followed by a gradual decrease to a level approximately 30% lower than that set for normo-thermal brooding. Feed and water were provided ad-lib. All birds were monitored several times a day for overt signs of disease and periodically electrocardiographic measurements were obtained.

Morbidity and mortality data were collected daily. The risk of sudden death (SDS) was approximately 2.5 fold higher (P<0.05) in birds fed a D3 enriched diet. The incidence of SDS mortality in the control group was 5.3 %, whereas 13.5% of broilers fed D3 fortified diet succumbed to SDS. Electrocardiographic examination showed a significantly higher (P<0.01) rate of cardiac arrhythmia in birds fed the D3 enriched diet (46.4%), in comparison to those fed the control diet (17.7%). The present findings indicate that over-supplementation of vitamin D may increase the risk of SDS in broilers.

**Key Words:** broiler, SDS, vitamin D

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**60 Effects of egg antibody to phospholipase A2 (aPLA2) on preventing coccidia induced growth depression.** M. Schwartz*, M. Yang, and M. Cook, University of Wisconsin, Madison.

Reduced animal performance of conventionally raised animals as compared to animals raised in germ-free environments has mainly been associated with immune induced growth suppression. Models for systemic immune regulation of growth involving injected lipopolysaccharide are well described however models where inflammation is localized in the gut are not well studied. Previous work has shown that egg yolk antibody to phospholipase A2 (aPLA2) improved the growth rate and feed efficiency of healthy broilers. Since fed antibodies have their effects at the gut lumen/mucosal interface, it was hypothesized that improved growth from aPLA2 feeding was due to anti-inflammatory effects in the gut. The objective of these experiments was to determine if aPLA2 improves growth and feed efficiency during coccidia induced gastrointestinal inflammation. In two experiments, 5 pens of 5 broiler chicks were assigned to 4 dietary treatments with or without immune stimulation in a 2x4 factorial design. Birds received either water or a 10X dose of a commercial coccidiosis vaccine by oral gavage on days 0, 7, and 14. The dietary treatments consisted of egg yolk containing aPLA2 (0.5 g/kg diet, exp 1 and 0.5, 1.0, or 1.5 g/kg diet, exp 2) or normal egg yolk (0.5 or 1.5 g/kg diet for respective exp controls). Immune stimulation decreased body weight gain 15.8% exp 1 (p<0.001) to 8.4% exp 2 (ns). Intestinal weight (g/kg body weight) was increased by 14.7% exp 1 (p<0.001) to 12.2% exp 2 (p<0.01). Immune induced growth suppression and intestinal weight increase was not consistently affected by dietary aPLA2. This model fails to explain the mechanism by which feeding aPLA2 improved broiler performance.

**Key Words:** gastrointestinal inflammation, egg yolk antibodies, coccidia

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**61 Use of a lactobacillus-based probiotic culture to reduce Salmonella in day of hatch broilers.** J. P. Higgins1, S. E. Higgins1, A. Torres-Rodriguez1, V. Salvador1, S. N. Henderson1, A. D. Woffenden1, C. M. Pixley1, A. M. Donoghue2, G. Tellez1, W. G. Bottje1, and B. M. Hargis1, 1University of Arkansas, Fayetteville, 2PP&PSRU, ARS, USDA, Fayetteville, Arkansas.

A commercially available Lactobacillus probiotic (FM-B11™ Ivesco LLC) (B11) significantly reduced Salmonella recovery from day-of-hatch chicks in several studies. For all experiments, day-of-hatch male broiler chicks (n=40 per pen) were challenged with approximately 10⁴ cfu per chick of Salmonella enteritidis (SE) or Salmonella typhimurium (ST) and 1 h later treated (as below). Cecal tonsils or cecae were harvested for Salmonella detection 24 h following treatment. In
experiment 1, oral administration of $10^5$ or $10^8$ cfu per chick of B11 significantly reduced SE recovery by 82% (p<0.05) as compared to untreated controls whereas $10^9$ cfu of B11 had no effect. In experiment 2, oral administration of B11 killed with penicillin or heat caused no reduction in SE recovery. In experiments 3, 4 and 5, B11 significantly reduced SE or ST recovery as compared to controls. Additionally, there was a 3 log$_{10}$ reduction in cfu of SE recovered from the cece of B11 treated chicks as compared to controls in all three experiments.

In experiments 6 & 7, the recovery of SE from the control and treated groups at 6 and 12 h following B11 treatment was not different, but at 24 h B11 a significant reduction in SE was observed as compared to controls. In experiment 8, again at 6 and 12 h following B11 treatment, SE recovered from the control and treated groups were similar, but at 12 h B11 caused a significant 1 log$_{10}$ reduction in cfu of SE from the cece as compared to controls. This difference continued to increase over time as significant 1.5 and 2.5 log$_{10}$ reductions were observed at 19 and 24 h respectively. Sufficient concentrations of live B11 significantly reduce Salmonella recovery in day-of-hatch chicks.

Key Words: probiotic, Salmonella

62 Characterization of avian pathogenic E. coli in a layer production facility. T. Baltzley* and T. Rehberger, Agtech Products, Inc.

Avian pathogenic Escherichia coli (APEC) include a subset of pathogenic E. coli that are linked to extraintestinal diseases in poultry. The objective of this study was to gain a thorough understanding of the diversity of APEC isolates present in pullets and layer hens from several production sites within one company. Two thousand seven hundred twenty three isolates were collected for this study. Of the isolates collected, 1,920 were from the gastrointestinal tract, 517 from ceca, ovaries, oviducts, tracheas, air sacs, and 286 from air and manure. Multiplex PCR was used to identify APEC isolates based on the presence of four virulence genes iss, tsh, iucC, and cvaC. Isolates were considered to be APEC only if they contained at least two of the genes. Of the four virulence-associated genes, the cvaC gene was the most prevalent detected in 75% of the isolates. The iss gene was the next most prevalent at 57%, and the tsh gene was detected 39% of the time. Only 12% of the isolates had none of the four genes present. The combination of the iss/cvaC genes was the most prevalent pathotype found 28% of the time. Iss/tsh/cvaC was the next most common pathotype occurring 11% of the time. RAPD PCR analysis grouped the APEC isolates into 197 clusters with a coefficient of similarity of greater than 80%. The largest cluster consisted of 207 members and was 12% of the APEC population. Thirty five of the families contained ten or more isolates and made up 72% of the population. Forty five clusters contained only one member and constituted 2.7% of the population. The location of the farm, age, health or organ of the bird did not appear to have an impact on clustering pattern of isolates collected from layer hens. The isolates collected from pullets did appear to cluster more closely and were only related to a small percentage of isolates collected from the layer hens. A better understanding of the diversity of APEC isolates in a production system is a prerequisite for a more efficacious and less costly treatment for APEC related diseases.

Key Words: E.coli, APEC, multiplex

63 Additional studies on idiopathic hepatic and splenic necrosis associated with vaccine administration in White Leghorn pullets. R. Porter*1,3, E. Gingerich2, K. Toohey-Kurth1,3, C. Radi1, and D. Zoromski1, 1Wisconsin Veterinary Diagnostic Laboratory, Madison, Wisconsin, 2University of Pennsylvania School of Veterinary Medicine, Kennett Square, Pennsylvania, 3University of Wisconsin School of Veterinary Medicine, Madison.

Two companies (A and B) in different states reported mortality in 14 to 15-week-old pullets at approximately 28 days after the birds had received an inactivated Salmonella/Newcastle/Infectious bronchitis vaccine (0.5 ml, intramuscular injection). The mortality comprised 1-3% over 2 weeks. Gross lesions in both flocks consisted of mild subcutaneous edema, occasional intracoelomic hemorrhage originating from hepatic subcapsular hematomas, free blood in the small intestines (primarily duodenum and jejunum), enlarged, friable livers, and enlarged, pale and friable spleens. Histopathological lesions consisted of hepatocellular necrosis with accumulation of fibrin or blood in the sinusoids and space of Disse. There was coagulative necrosis of the spleen and variable mucosal and luminal hemorrhage in the small intestine. Marked lymphoid depletion was observed in the bursa of Fabricius. Electron microscopy also revealed necrosis in liver and spleen with no observable viruses. Liver and spleen were negative for avian hepatitis E virus by PCR. There were no significant bacteriology and virology findings. Comparisons between two trivalent vaccines (1 and 2) used by Company A linked the hepatopathy to a specific vaccine 1. Endotoxin activity was greater in vaccine 2 (176,300 EU/ml) compared to vaccine 1 (2446.41 EU/ml) as measured by limulus amebocyte lysate assay. Mass spectroscopy revealed no potentially toxic compounds in vaccines 1 and 2.

The gross lesions are similar to hepatitis-splenomegaly syndrome described in adult laying hens infected with avian hepatitis E virus. In the case presented here no virus has been identified and an immune-mediated process is suspected. There is one previous report of hepatitis-splenomegaly occurring in layer flocks receiving repeated administration of oil emulsion vaccines.

Key Words: hepatic necrosis, splenic necrosis, vaccine administration

64 Comparison of S. enterica serovar Enteritidis levels in crops of fed or fasted infected hens. P. S. Holt*, L. E. Vaughn, R. W. Moore, and R. K. Gast, USDA/ARS Egg Safety & Quality Research Unit, Athens, Georgia.

Long term feed withdrawal has been shown to increase ileocecal intestinal colonization and fecal shedding of S. enterica serovar Enteritidis (SE) in challenged hens. Less information is available regarding effects of fasting on crop colonization. Two trials were conducted to compare effects of 14-day feed withdrawal vs full feed on crop colonization in hens challenged with SE. The levels of SE in the crop of fasted hens were significantly higher than in nonfasted hens on days 3 and 10 and days 3, 9 and 16 post-infection (PI) in trials 1 and 2, respectively. Fecal shedding of SE was significantly increased in the fasted hens on day 10 PI in trial 1. Analysis of crop IgA anti-SE lipopolysaccharide levels in crop lavage samples of hens in trial 1 revealed a humoral response post-infection in both treatment groups with no significant differences, although peak response for fasted hens occurred one week later. Histologic evaluation of H&E crop sections from trial 1 birds revealed mild to moderate heterophilic infiltration within the crop LP or LP and epithelium of nonfasted infected hens at 24 and 96 hours PI. In comparison, heterophils in crops of fasted

Key Words: S. Enteritidis, IgA, immune response
hens infected at this time point were sparse, indicating a possible diminished heterophil response in the fasted birds. Multifocal areas of tissue inflammation, as indicated by marked heterophil infiltration, with necrosis and sloughing of epithelium, were observed in crops from fasted hens at day 11 PI (14th day of feed withdrawal) but not in the fed groups. This severe heterophilic inflammation was observed in both challenged and non-challenged fasted hens, suggesting some factor other than SE was responsible. These results indicate that feed withdrawal can have a dramatic effect on the integrity of the crop and its ultimate response to infection.

Key Words: fasting, induced molt, Salmonella

65 Effects of F-strain Mycoplasma gallisepticum inoculation at twelve or twenty weeks of age and diet supplementation on the digestive and reproductive organ characteristics of commercial egg laying hens housed in a caged layer facility. S. W. Park1, E. D. Peebles*1, S. L. Branton2, M. T. Kidd1, S. K. Whitmarsh1, and P. D. Gerard1, 1Mississippi State University, Mississippi State, 2USDA, ARS, Poultry Research Unit, Mississippi State, Mississippi.

Dietary poultry fat (PF), phytase, and 1, 25 dihydroxycholecalciferol may be reported to alleviate decreases in egg production in Mycoplasma gallisepticum (MG)-infected laying hens. Also, layers inoculated with F-strain MG (FMG) have been shown to perform less adequately when housed in a commercial caged facility rather than in biological isolation units, and compared to 22 wk FMG inoculations, 12 wk inoculations have affected egg size and reduced pre- and post-peak egg production. The effects of FMG inoculation at 12 and 22 wk of age and various dietary supplementations on the digestive and reproductive organ characteristics of commercial layers housed in a caged layer facility were investigated. The following isocaloric diets were provided to birds at 20 wk: 1) Control basal (CB) formulated to contain 0.50 % PF; 2) CB formulated to contain 1.25 % PF; 3) CB formulated to contain 2.00 % PF; 4) CB formulated to contain 2.00 % PF, 0.013 % phytase, and 0.025 % 25-hydroxycholecalciferol (25-D3). Parameters assessed at 58 wk of age were liver weight, liver moisture and lipid concentration, incidence of fatty liver hemorrhagic syndrome, ovary weight, ovarian mature follicle numbers, weights and lengths of the oviduct and oviductal regions, and weights and lengths of the small intestine and small intestinal regions. In birds inoculated with FMG (12 or 22 wk), decreases in liver moisture and lipid content occurred in response to diets containing 2.00 % and 1.25 % PF, respectively. Furthermore, in FMG-infected birds (12 or 22 wk), the PF, phytase, and 25-D3 supplemented diet increased jejunum weight as a percentage of total small intestinal weight, whereas in birds inoculated with FMG at 12 wk, the 2.00 % PF diet led to an increase in the percentage of birds possessing 3 mature ovarian follicles. The potentiation of performance in FMG-infected layers by diets containing PF (2.00 %) may be mediated through metabolic effects in the liver and ovary. Supplemental phytase and 25-D3 may also exert effects in the digestive system during FMG infection.

Key Words: layer, Mycoplasma gallisepticum, poultry fat

66 Effects of pre-lay 6/85 strain Mycoplasma gallisepticum inoculation on the digestive and reproductive organ characteristics of commercial laying hens when given alone or in conjunction with F-strain Mycoplasma gallisepticum inoculations during lay. K. A. Viscione*1, E. D. Peebles1, S. L. Branton2, A. M. Vance2, S. K. Whitmarsh1, R. W. Keirs1, and P. D. Gerard1, 1Mississippi State University, Mississippi State, 2USDA, ARS, Poultry Research Unit, Mississippi State, Mississippi.

Performance in layers has been shown not to be adversely affected by a pre-lay 6/85-strain of Mycoplasma gallisepticum inoculation when given alone or in conjunction with subsequent overlay inoculations of F-strain of Mycoplasma gallisepticum (FMG) during lay. However, other reports have demonstrated that the reproductive tract of layers infected by MG and maintained under ideal conditions can be altered without any subsequent affects on overall performance. Two trials were conducted in this study, using layers housed in isolation units under controlled conditions, to compare the effects of the following inoculation treatments on their digestive and reproductive organ characteristics: sham inoculation at 10 wk of age, 6/85MG at 10 wk of age, 6/85MG at 10 wk overlaid by a subsequent FMG inoculation at 22 wk, and 6/85MG at 10 wk overlaid by a subsequent FMG inoculation at 45 wk. Parameters assessed in each trial at necropsy were body, liver, ovary, oviduct and small intestine weight; oviduct and small intestine length; regional lengths and weights of the oviduct and small intestine; liver moisture and lipid contents; incidence of fatty liver hemorrhagic syndrome; and follicular hierarchy. Total and regional organ weights were expressed as percentages of total organ and BW. There were no significant inoculation treatment effects on any of the parameters examined except for liver moisture content. The moisture content of livers from birds inoculated at 10 wk with 6/85MG or inoculated with 6/85MG at 10 wk followed by an overlay inoculation of FMG at 45 wk was higher compared to livers from birds that were sham inoculated at 10 wk or inoculated with 6/85MG at 10 wk with an FMG inoculation overlay at 22 wk. Pre-lay 6/85MG inoculations either alone or in conjunction with subsequent overlay inoculations of FMG during lay have no adverse impact on reproductive organ characteristics as well as the subsequent performance of commercial laying hens. The inoculation regimens used in this study may be effective for the protection of commercial layer flocks from field strain MG infections.

Key Words: layer, Mycoplasma gallisepticum, reproductive organ

67 Natural history of lesions development in chickens succumbing to necrotic enteritis. A. Olkowski*, C. Wojnarowicz, C. Chirino-Trejo, and B. Laarveld, University of Saskatchewan, Saskatoon, SK, Canada.

The objectives of this work were to investigate the natural history of lesions development in broilers succumbing to necrotic enteritis (NE). The experimental approach was based on evaluation of morphological changes in the intestinal tissue of broiler chickens diagnosed with NE and in chickens challenged with C. perfringens freshly isolated from field cases of NE. Microscopic examination of sections representing various levels of pathological changes in clinical cases of NE revealed progressive features of lesions development. The pathogens were seen in large numbers in the lumen (tissue debris), but were not found to be attached to the mucosal epithelial cells, and never penetrated the epithelium even in the areas showing clear evidence of advanced necrosis. Overall, the evolution of the pathological process appears
to follow morphologically distinctive initial phases affecting first the connective tissue underlying the epithelium, then progressively invading the inner structures of the lamina propria. These initial changes are followed by the pathological process spreading throughout the entire lamina propria, as well as the adjacent epithelial cells, which showed all features of necrotic cell death. Upon electron microscopic examination of the mucosal epithelium, significant ultra-structural changes were apparent at a level of the connective tissue at the interface of lamina propria and mucosal epithelium, and in the lateral domain of enterocytes, but the overall structure of the apical domain of these cells (plasma membrane and microvilli) appeared intact, even in enterocytes that showed clear signs of advanced necrotic process. The birds challenged with C. perfringens experimentally showed histological and ultra-structural changes similar to those seen in NE specimens, but of lesser magnitude. Our findings suggest that, in addition to alpha toxin, other factors may be involved in the initiation of necrotic enteritis.

**Key Words:** clostridium perfringens, necrotic enteritis, morphological changes

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**68 Automatic counting with differential and selective media.**

Z. Williams and Y. Vizzier-Thaxton*, Mississippi State University, Mississippi State.

The need to estimate bacterial diversity and identify certain organisms led to the development of chromatogenic media. These media are expensive and only effective with certain groups of organisms. In order to determine if utilization of a computer-operated color colony counter could be “trained” to do the same thing using common differential and selective media, a series of tests were run. The primary focus was on coliform bacteria of concern in poultry production. The Spiral Biotechnology Color Q was used for the counts and the media selected included eosin methylene blue, brilliant green, McConkey, *Salmonella*-Shigella, Hektoen Enteric and Rambach. First the counter was “trained” using known cultures on the various media to establish the color for each genus. Organisms chosen represented the target group as well as others. These included *Enterobacter aerogenes*, *Salmonella typhimurium*, Streptococcus pneumoniae, *Enterococcus faecalis*, Proteus mirabilis and Escherichia coli. Next mixed known cultures were inoculated on the various media and the system was allowed to do all counts according to the colors established in the training session. The system is capable of differentiating among the colonies and thus speeding both the counting process and the selection of colonies for further testing resulting in significant savings of time, labor and expendables.

**Key Words:** bacteria, automatic counting, chromatogenic medium

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**Physiology, Endocrinology, and Reproduction: Endocrinology**

**69 Evaluation of the serotonin receptor blockers ketanserin and methiothepin on the pulmonary hypertensive responses of broilers to intravenously infused serotonin.** M. E. Chapman* and R. F. Wideman, University of Arkansas, Fayetteville.

The pathogenesis of pulmonary hypertension remains incompletely understood. Many factors have been implicated, however there has been great interest in the potent pulmonary vasoconstrictor serotonin (5-HT) due to episodes of primary pulmonary hypertension in humans triggered by serotoninergic appetite suppressant drugs. Pulmonary hypertensive patients have elevated blood 5-HT levels, and pulmonary vasoconstriction induced by 5-HT is believed to be mediated through 5-HT1B/1D and 5-HT2A receptors expressed by pulmonary smooth muscle cells. The vascular remodeling associated with pulmonary hypertension also appears to require the serotonin transporter (5-HTT). We investigated the roles of 5-HT receptor blockers on the development of pulmonary hypertension induced by infusing 5-HT i.v. in broilers. For this purpose, we treated broilers with the selective 5-HT2A receptor antagonist ketanserin (5 mg/Kg BW) or with the nonselective 5-HT1/2 receptor antagonist methiothepin (3 mg/Kg BW). Receptor blockade was followed by infusion of 5-HT while recording pulmonary arterial pressure and pulmonary arterial blood flow. The results demonstrate that methiothepin but not ketanserin eliminated the 5-HT-induced pulmonary hypertensive responses in broilers. The 5-HT2A receptor does not, therefore, appear to play a roll in the 5-HT-induced pulmonary hypertensive responses in broilers. Methiothepin did not inhibit pulmonary vascular contractility per se, as the pulmonary hypertensive response to the thromboxane A2 mimetic U44069 remained intact in methiothepin-treated broilers. Methiothepin will be a useful tool for evaluating the role of 5-HT in the pathogenesis of pulmonary hypertension syndrome (PHS, ascites) as well as the onset of pulmonary hypertension triggered by inflammatory stimuli such as bacterial lipopolysaccharide.

**Key Words:** hypertension, ketanserin, methiothepin

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**70 Evaluation of the serotonin receptor blocker methiothepin in broilers injected intravenously lipopolysaccharide and microparticles.** M. E. Chapman* and R. F. Wideman, University of Arkansas, Fayetteville.

There has been considerable interest in the role of serotonin (5-hydroxytryptamine, 5-HT) in the pathogenesis of pulmonary hypertension due to episodes of primary pulmonary hypertension (PPH) in humans linked to serotoninergic appetite suppressant drugs. In this study, we investigated the impact of serotonin on the development of pulmonary hypertension induced by injecting bacterial lipopolysaccharide (LPS, endotoxin) and cellulose micro-particles intravenously using the non-selective 5-HT1/2 receptor antagonist methiothepin. In experiment 1 broilers selected for ascites susceptibility or resistance under conditions of hypobaric hypoxia were treated with methiothepin or saline followed by injection of LPS while recording PAP. In experiment 2 ascites-susceptible broilers were treated with methiothepin or saline followed by injection of cellulose micro-

Gonadotropin inhibitory hormone (GnIH) has been found to inhibit gonadotropin secretion in several avian species. We recently cloned the complementary DNA encoding a G-protein coupled receptor that binds to GnIH (GnIHR). In the present study, we hypothesized that GnIH mRNA is expressed in the Leghorn chicken diencephalon and pituitary gland, and that its expression will be affected by estradiol and/or progesterone treatment. By RT-PCR, we detected GnIHR mRNA in the chicken diencephalon, anterior pituitary gland, total ovary, and ovarian granulosa cells but not in the liver. Using real-time quantitative PCR assays, we found that the quantity of GnIHR mRNA was the greatest in the diencephalon compared to that of the anterior pituitary gland and ovary. A polyclonal antiserum raised against chicken GnIH synthetic peptide detected GnIHR-immunoreactive cells in the anterior pituitary gland and in the granulosa cell layer of ovarian follicles. GnIHR mRNA quantity in total ovary was significantly greater in sexually immature chicken versus sexually mature hen (P<0.05; n=6). Sexually immature Leghorn chickens (16 wk old; n=8) were injected with estradiol (E2) and/or progesterone (P4) to determine the influence of gonadal steroids on GnIHR mRNA quantity in the diencephalon, pituitary gland and total ovary. We found that GnIHR mRNA expression was significantly lower in total ovaries and pituitary glands of chickens treated with E2 or E2+P4 (P<0.05) but E2 and/or P4 treatment did not alter GnIHR mRNA quantity in the diencephalon. We also found that GnIHR mRNA quantity was significantly lower in the total ovary of chickens treated with P4 alone (P<0.05). We conclude that ovarian steroids influence GnIHR mRNA expression in the chicken anterior pituitary gland and ovary. GnIHR expressed in the chicken pituitary gland and ovary may possibly be involved in gonadotropin secretion and steroidogenesis, respectively.

Key Words: GnIH, ovarian steroids, chicken


Calciitonin is primarily produced by the thyroid C cells in mammals or by the ultimobrachial gland in chickens. However, calcitonin has been found to be expressed by the rat pituitary gland, where it functions as a paracrine factor causing decreased lactotroph proliferation and prolactin secretion. Calcitonin is derived from its precursor protein, procalcitonin. Procalcitonin gene expression in the avian pituitary gland has not been previously reported. We tested the hypotheses that procalcitonin mRNA is expressed in the chicken pituitary gland, and that this expression will vary based on the reproductive status or in response to ovarian steroid administration. By RT-PCR, we detected robust expression of procalcitonin mRNA in the chicken pituitary gland. Pituitary-derived chicken procalcitonin mRNA sequence was identical to that expressed in the ultimobrachial gland. Quantitative real-time PCR assays revealed that sexually mature chicken pituitary glands contained less procalcitonin mRNA and greater prolactin mRNA quantities when compared with sexually immature chicken pituitary glands (P<0.05). To determine the influence of ovarian steroids on procalcitonin mRNA expression, sexually immature Leghorn chickens (16 weeks old; n=8) were injected with estradiol and/or progesterone. Estradiol treatment of sexually immature chickens led to a significant decrease in pituitary procalcitonin mRNA quantity (P<0.05), while progesterone alone or in combination with estradiol did not change pituitary procalcitonin mRNA quantity relative to vehicle-treated chickens (P>0.05). Our results suggest that pituitary procalcitonin mRNA expression is restored by progesterone from the suppressive effects of estradiol treatment. Further studies are required to elucidate the function of pituitary calcitonin on the secretion of pituitary hormones.

Key Words: procalcitonin, chicken, pituitary

73 Expression of 5-HT1A and 5-HT2C receptors in the hypothalamus during the turkey reproductive cycle: Colocalization with tyrosine hydroxylase. T. Bakken*, 1 S. W. Kang1, A. Thayananuphat,1 J. A. Proudman2, and M. E. El Halawani1, 1University of Minnesota, St. Paul, 2USDA, Beltsville, Maryland.

Serotonin (5-HT) acts through dopamine (DA) and vasoactive intestinal peptide (VIP) to stimulate prolactin (PRL) release when infused into the third ventricle of the turkey brain. Dopamine also inhibits PRL release by antagonizing the stimulatory effect of VIP at the pituitary level. Recent studies have shown that a 5-HT2A/2C receptor agonist stimulates and a 5-HT1A receptor agonist inhibits PRL secretion. The stimulatory effect of 5-HT2A/2C receptor agonist appears to be mediated via DA cells in the nucleus preamellaris (PMN) and nucleus mamillaris lateralis (ML). The site of the inhibitory action of the 5-HT1A receptor agonist needs to be clarified. To clarify the involvement of 5-HT1A and 5-HT2C receptors in PRL regulation, in situ hybridization experiments were performed on tissue sections from the turkey hypothalamus. The nucleus preopticus medialis (POM), ML and PMN showed strong expression of 5-HT1A receptors, while 5-HT2C receptors were concentrated in the nucleus paraventricularis hypothalami (PVN), PMN and ML. The relative density of receptor expression in each hypothalamic region was compared between birds from different reproductive stages. A significant difference in 5-HT1A

Key Words: GnIH, ovarian steroids, chicken
receptor expression was seen in the ML, PMN, and POM in birds of different stages, with photorefractory birds showing the highest and incubating birds the lowest expression. In the ML, 5-HT2C receptors density was significantly higher in incubating birds than short day birds. In the ML and PMN, 5-HT1A receptors were colocalized with tyrosine hydroxylase (TH) immunoreactive cells. The data presented, taken together with our previous findings showing that the two receptor subtypes are antagonistic to each other supports the notion that 5-HT, like DA, can both stimulate and inhibit PRL secretion, depending on the relative abundance of the two receptor subtypes.

**Key Words:** prolactin, 5-HT1A receptor, 5-HT2C receptor

### 74 Characterization of the serotonergic system in the brainstem during the turkey reproductive cycle

S. W. Kang*, T Bakken, and M. E. El Halawani, University of Minnesota, St. Paul.

The serotonergic (5-HTergic) system is an important regulator of the avian reproductive cycle. Our earlier studies indicated that serotonin (5-HT) played a pivotal role in the regulation of prolactin secretion. This regulatory effect of 5-HT was mediated via the DAergic system which expressed 5-HT receptors and with which 5-HT immunoreactive fibers were intermingled. However, little is known about the 5-HTergic system neuroanatomical distribution and its neuronal activity across the turkey reproductive cycle. These were investigated in the present study utilizing the expression of tryptophan hydroxylase 2 (TPH2) mRNA, the rate limiting enzyme in the 5-HT biosynthesis. We identified three 5-HTergic groups in the brainstem of the turkey using in situ hybridization technique for TPH2 expression including: (1) A ventro-rostral mesencephalic group located in the area ventralis of Tsai (AVT), dorsal to the nucleus interpeduncularis (IP). (2) A dorsal mesencephalo-pontine group located in the dorsal and ventral to the nucleus linearis caudalis (LC), and (3) A ventro-caudal ponto-medullary group, occupying the raphe nucleus (R). Significant differences in TPH2 expression across reproductive states were observed within the ventro-rostral mesencephalic and dorsal mesencephalo-pontine groups. TPH2 expression was markedly less in reproductively quiescent non photostimulated hens as compared with laying and incubating hens. Photorefractory hens displayed intermediate TPH2 expression. However, 5-HT neurons of raphe nucleus group in the ventro-caudal ponto-medullary region did not show significant alterations in TPH2 expression during the turkey reproductive cycle. These findings indicate that the variations in reproductive hormones expression and secretion observed across the turkey reproductive cycle may be explained, in part, by changes in neuronal serotonergic activity in the turkey brainstem. This is the first study to show alterations in neuronal 5-HT synthesis and the 5-HT neuronal group involved during the different reproductive stages in avian species.

**Key Words:** tryptophan hydroxylase 2 mRNA, serotonin, turkey brainstem

### 75 Dopamine and gonadotrophin releasing hormone-I neuronal activation following photostimulation in the turkey

A. Thayananuphat*, S. W. Kang†, T. Bakken‡, J. R. Millam*, and M. E. El Halawani†, University of Minnesota, St Paul, University of California, Davis.

Photoperiod plays a critical role in the regulation of turkey reproduction, but the precise neural pathways through which day length is detected, measured, and transduced into a reproductive neuroendocrine response have yet to be elucidated. Dopamine (DA) has been shown to play a regulatory role in prolactin (PRL) and luteinizing hormone-follicle stimulating hormone (LH-FSH) secretion. However the neuro-anatomical interrelationship between DA and Gonadotrophin Releasing Hormone-I (GnRH-I)-LH/FSH and vasotocinergic intestinal peptide (VIP)-PRL systems in avian species is still unclear. In the present study, we used the photo-induced activation of c-fos mRNA expression and double in situ hybridization/immunocytochemistry (ISH/ICC) to identify the DAergic neural group or subgroup that became active following photostimulation. In order to establish reproductive neuroendocrine system activation, double ISH/ICC was also conducted on c-fos-GnRH-I and c-fos-VIP. In addition, we investigated the optimal length of light required to induce c-fos mRNA expression. C-fos mRNA expression was observed in DA neurons within the nucleus premamillaris (PMN) and in GnRH-I neurons in nucleus commissurae pallii (nCPA), and nucleus preopticus medialis (POm), and nucleus paraventricularis hypothalami (PVN) of short day birds exposed to a 30 minute of light period at 14 hours after first light. No c-fos expression was observed in nucleus infundibularis (IN) where VIP neurons secreting the PRL-releasing factor are located. c-fos mRNA expression in the PMN was higher in hens exposed to a 30 min light period at 14 or 16 hours after first light than at 8 and 20 hours, or in short day non-treated controls. The results revealed several brain areas which were activated by light and suggested that DA neurons in the PMN might contribute to the initiation of avian sexual reproduction.

**Key Words:** dopamine, GnRH-I, photostimulation

### 76 Deiodinase II and the immediate early gene product c-fos in the hypothalamus of photostimulated turkey hens

J. R. Millam*, E. K. Hoye†, and T. D. Siopes‡, University of California, Davis, North Carolina State University, Raleigh.

Photo-induced expression of an immediate early gene product, c-fos, in photosensitive but not photorefractory turkey hens implicates cells in the tuberal hypothalamus in the development of photorefractoriness. Up-regulation of hypothalamic deiodinase II (Dio II) is one of the earliest steps in photosexual stimulation of Japanese quail; Dio II activation leads to retraction of glial end-feet thus giving GnRH terminals access to the portal vasculature. We therefore asked whether c-fos expression, as a measure of neuronal activity, might be co-localized with Dio II in photostimulated turkey hens. Nicholas breeding hens were held on 8L:16D until 30 wk of age to assure a photosensitive condition, then photostimulated by exposure to 16L:8D for 2 d before sacrifice. Brains were briefly perfused, fixed overnight, cryoprotected, frozen, cryostat-sliced, and mounted on slides for staining. Immunohistochemical (IHC) expression of c-fos protein (rabbit polyclonal antibody, Santa Cruz #SC253) and in situ hybridization (ISH) expression of Dio II mRNA were prominent throughout the tuberal hypothalamus and in the ependymal layer surrounding the third ventricle. In double-label experiments, cells in the ependymal layer often appeared to contain both c-fos and Dio II. IHC staining of Dio II using a rabbit anti-human antibody, differing from chicken by one amino acid over a twenty amino acid sequence, labelled cells throughout the tuberal hypothalamus but not in the ependymal area. In contrast, photorefractory hens (ceasing egg-laying after extended exposure to 16L:8D) and held on 8L:16D for 2 wk – an insufficient time to reverse photorefractoriness – then sacrificed after 48 h of photostimulation, showed very sparse c-fos expression, though Dio
II staining was not appreciably different from photostimulated, photosensitive hens. While expression of Dio II either by IHC or ISH does not accurately estimate biologic activity, these results support a role for Dio II in photosexual stimulation of turkeys, but leave open the question of whether photorefractoriness might involve failure of Dio II activity.

Key Words: photostimulation, deiodinase, immediate early gene

77 The efficacy of intracerebroventricular injections of arginine vasotocin (AVT) and corticotropin releasing hormone (CRH) on plasma corticosterone levels in male and female broilers (Gallus gallus) and their respective distribution of AVT and CRH neurons. F. N. Madison*, A. Jurkevich, and W. J. Kuenzel, University of Arkansas, Fayetteville.

Stress is a common factor faced by birds in the poultry industry and it has been demonstrated that male birds seem more susceptible to stress than females. Little, however, is known about sex-related differences in the neuroendocrine control of the hypothalamo-pituitary adrenal axis (HPA) during the stress response in broilers. There is evidence showing that in addition to the well-known role of CRH, another hypothalamic neuropeptide, AVT stimulates the HPA in birds. The purpose of this study was to determine the efficacy of AVT and CRH administered intracerebroventricularly for releasing corticosterone (CORT) in undisturbed birds. Broiler chickens were fitted with a chronic cannula surgically placed in the lateral ventricle. Birds were housed individually in cages behind a one-way glass partition and unnecessary noise was avoided during the sampling period. Each bird in the study received a single 5.0 ml intracerebroventricular injection of either saline (SAL), AVT (100 pM), or CRH (100 pM). Blood was sampled remotely every 15 min for 2 h beginning from time of injection via a catheter implanted in the jugular vein and plasma CORT was determined by radioimmunoassay. Female birds injected with SAL had significantly higher plasma CORT levels than males injected with SAL 15 min post injection and maintained higher plasma CORT levels throughout the sampling period. Male birds injected with AVT had higher plasma CORT release than females injected with AVT, and levels were significantly higher at 1 h and 1 h 15 min post injection. Male birds injected with CRH had a significantly higher plasma CORT release 15 min post injection, which continued higher throughout the entire sampling period. Our lab is currently utilizing immunocytochemical techniques to quantitate AVT and CRH cells within the hypothalamus.

Key Words: oviduct, phytoestrogen, development


Developmentally inappropriate exposures to estrogenic compounds are known to alter morphology and function of the reproductive tract in various species. Chickens are continually exposed to the relatively potent estrogenic soy isoflavones through the diet. Previous experiments in this laboratory have demonstrated that the primary soy isoflavone genistein induces proliferation of the chick oviduct. However, information is lacking as to specific reproductive tract developmental effects of genistein exposure in chicks. Experiments were done to compare specific oviduct morphological and functional responses to genistein exposure with responses elicited by a classical estrogen, diethylstilbestrol (DES). To avoid the effects of dietary soy isoflavones, the experimental diets were formulated with dried egg white, rather than the usual soybean meal, as a protein source. Day old female chicks were assigned to treatments: egg white based diet with daily oral gavage of corn oil vehicle (CV); 1mg diethylstilbestrol (DES); 2.0mg genistein (G2); 20mg genistein (G20); or 40mg genistein (G40). At 15 d of age, half the birds from each treatment received a single injection of 2mg progesterone in a corn oil vehicle to induce ovalbumin synthesis in the oviduct. The classical oviduct responses to estrogen, induction of progesterone receptor and initiation of ovalbumin synthesis, were examined by immunohistochemistry. At 16 d of age, DES treatments increased oviduct weight and percentage of final body weight as compared to all other treatments (P<0.05). Immunohistochemistry of formalin fixed oviduct samples revealed that the DES, G20, and G40 treatments induced progesterone receptor and ovalbumin in the chick. A direct ELISA was performed to determine the amount of vitellogenin in plasma samples from the birds. There were no significant treatment effects on plasma vitellogenin. It was concluded that genistein, at the concentrations tested, acts as a weak estrogen in the chick oviduct.

Key Words: sex differences, vasopressin, stress

79 Effect of sulfamethazine and photostimulation on gene expression of vasoactive intestinal polypeptide (VIP) and phosphodiesterase in the lateral septal organ (LSO) and pituitary gonadotropin content in the chick. H. Li*, J. A. Proudman1, and W. J. Kuenzel1, 1University of Arkansas, Fayetteville, 2USDA/ARS/GBPL, Beltsville, Maryland.

Most birds living in the temperate zone use seasonal changes in day length as predictive environmental cues to initiate and terminate breeding. Long day illumination induces rapid gonadal development and stimulates gonadotropin-releasing hormone (GnRH), follicle stimulating hormone (FSH), luteinizing hormone (LH), and testosterone secretion in avian species. A group of non-photostimulated, non-photurnal encephalic photoreceptors (EPRs) were hypothesized some time ago to sense external photoperiodic change. Two sites located in deep brain were suggested to house the potential EPRs, the LSO and the medial basal hypothalamus. Molecules identified in the putative EPRs of the LSO and considered as critical components in the possible phototransduction pathway included rhodopsin, rod-type cGMP-phosphodiesterase β-subunit, and VIP. Of interest is that the combination treatment of sulfamethazine (SMZ), a compound that stimulates gonadal development, together with long day exposure significantly increased plasma LH within 48 h. To elucidate whether and how SMZ and/or long day illumination affect the neuroendocrine system, a 2X2 factorial study was conducted in non-photostimulated or photostimulated and SMZ-fed or control diet-fed chickens. Pituitary content of prolactin (PRL) and gonadotropin were assayed and gene expression and SMZ-fed or control diet-fed chickens. Pituitary content of prolactin (PRL) and gonadotropin were assayed and gene expression of rhodopsin, phosphodiesterase, and VIP in the LSO, as well as FSH and LH in the pituitary gland were quantitated using real time-PCR. SMZ treatment significantly increased pituitary content of LH at 16h, and decreased PRL at 12h (n=5, p<0.05). Peak of LH and FSH mRNA level occurred as early as 6 h in pituitary, while at the level of brain, VIP and phosphodiesterase increased in the LSO following SMZ feeding at 4h and 6 h, respectively. The current study indicated that SMZ functions at a level higher than the pituitary gland in the photoneuroendocrine system, and it might affect the phototransduction cascade in the EPRs.

Key Words: encephalic photoreceptors, photoneuroendocrine system, real time PCR
80 Immunohistochemical localization of dopamine neurons in the brain of the native Thai chicken (Gallus domesticus). N. Sartssoongnoen*1, S. Kosonsiriluk1, N. Prakobsaeng1, A. Thayanuphat2, T. Songserm3, M. E. El Halawani2, and Y. Chaiseha1, 1Saranaree University of Technology, Thailand, 2University of Minnesota, St. Paul, 3Kasetsart University, Thailand.

Avian prolactin (PRL) secretion is regulated by vasoactive intestinal peptide (VIP). Dopamine (DA) acts centrally through D1 DA receptors to stimulate PRL secretion via an intact VIPergic system and activates D2 DA receptors and subsequently prevents VIP from stimulating the PRL release at the pituitary. The present study was aimed to characterize the distribution of the DAergic system in the native Thai chicken, a non-seasonally breeding tropical species, with paucity of information about its reproductive neuroendocrine regulation. An immunohistochemical method to localize tyrosine hydroxylase (TH) as a marker of the DAergic neuronal system was elucidated in the brain of laying hens. The results revealed that TH immunoreactive (TH-ir) cells and/or fibers were found throughout the brain and predominantly located within the diencephalon; nucleus preopticus medialis, nucleus paraventricularis magnocellularis, nucleus intramedialis, nucleus mammillaris medialis (MM), nucleus mammillaris lateralis (ML), and area ventralis (AVT). The greatest density was found within MM, ML, and AVT. The staining of TH-ir cells and fibers was also observed within nucleus accumbens, nucleus septalis lateralis, nucleus suprachiasmaticus, pars medialis, regio lateralis hypothalami, nucleus commissurae pallii, median eminence, etc. The distributions pattern of TH-ir observed in the present study is consistent with that reported previously in several avian species. It is suggested that DA may play a pivotal role in the regulation of reproduction activity in tropical species as in the case of temperate zone birds.

Key Words: bird, dopamine, immunohistochemistry

81 Distribution of cGnRH-I immunoreactive neurons and fibers in the brain of native Thai chicken (Gallus domesticus). N. Sartssoongnoen1, S. Kosonsiriluk1, S. W. Kang2, J. R. Millam3, M. E. El Halawani2, and Y. Chaiseha*1, 1Saranaree University of Technology, Thailand, 2University of Minnesota, St. Paul, 3University of California, Davis.

Avian reproduction is primarily regulated by gonadotropin releasing hormone-I (GnRH-I) which is synthesized by neurosecretory cells in the hypothalamus. This decanpeptide stimulates the synthesis and release of pituitary gonadotropins. However, the data of the neuroendocrine regulation of native Thai chicken, a non-seasonally breeding tropical species are limited. The distribution of GnRH-I neurons has been reported in many temperate zone species. The GnRH-I neuronal system needs to be clarified in the native Thai chicken. The distribution of GnRH-I neurons of native Thai chicken brain was elucidated utilizing immunohistochemical technique. The results revealed that cGnRH-I-immunoreactive (cGnRH-I-ir)-cells and fibers were found mainly in the hypothalamus; nucleus preopticus medialis (POM), nucleus septalis lateralis, nucleus septalis medialis, nucleus accumbens, nucleus paraventricularis magnocellularis, nucleus periventricularis hypothalami, nucleus suprachiasmaticus, pars medialis, regio lateralis hypothalami, nucleus commissurae pallii (nCPa), nucleus habenularis medialis, nucleus habenularis lateralis, nucleus subhabenularis lateralis, and nucleus mesencephalicus nervi trigemini. The most abundance of cGnRH-I-ir neurons was found within the POM and nCPa. cGnRH-I-ir-fibers were mainly bilaterally located along the third ventricle with more abundance around the organum vasculosum lamina terminalis and very dense fibers were observed in the external layer of the median eminence as has been reported for other avian species. This present study confirms a pivotal role in the control of avian reproduction of non-seasonally breeding tropical species.

Key Words: bird, cGnRH, immunohistochemistry

82 Distribution of vasoactive intestinal peptide-expressing neurons in the brain of the native Thai chicken (Gallus domesticus). S. Kosonsiriluk*1, N. Sartssoongnoen1, N. Prakobsaeng1, T. Bakken2, T. Songserm3, M. E. El Halawani2, and Y. Chaiseha1, 1Saranaree University of Technology, Thailand, 2University of Minnesota, St. Paul, 3Kasetsart University, Thailand.

Avian prolactin (PRL) secretion is under stimulatory control by vasoactive intestinal peptide (VIP), the PRL-releasing factor, residing in nucleus infundibuli hypothalami (IN). The release and expression of VIP/PRL system is photo-periodically regulated by gonad stimulatory photoperiod in temperate zone birds. The distribution of VIP-immunoreactivity (VIP-ir) in several brain areas of these species has been reported. This study was designed to characterize the distribution of VIP system in the native Thai chicken brain, a non-photorperiodic species. The differential VIP expression may give us insight into the mechanism(s) underlying the regulation of the reproductive cycle in this species. Immunohistochemistry technique with quantitative analysis was performed throughout the brain of laying hens. The results revealed that VIP-ir cells and fibers were found throughout the brain and predominantly located within the diencephalon; nucleus preopticus medialis, nucleus anterior medialis hypothalami, regio lateralis hypothalami, nucleus paraventricularis magnocellularis, nucleus ventromedialis hypothalami, IN, and median eminence. The greatest staining was found within the IN. VIP-ir neurons were also observed within nucleus accumbens, cerebellum, nucleus septalis lateralis, nucleus commissurae pallii, etc. The pattern of VIP-ir distributions in this study is similar to that reported previously in several avian species. The abundance of VIP neuronal network in hypothalamus of the native Thai chicken suggests of its importance in the regulation of reproductive behavior in equatorial birds.

Key Words: bird, immunohistochemistry, VIP
83 Holistic vs. traditional teaching of complex aspects of avian physiology in a laboratory setting. S. Burgos*, North Carolina State University, Raleigh.

Biological concepts often carry a high degree of complexity, which increases explanatory difficulty. Although most students have previously encountered mammalian biology, an avian physiology course must ensure that, irrespective of their backgrounds, students develop a clear understanding of unique aspects of birds' body functions, and how these differ from their mammalian counterparts. The fact that many students have not previously been exposed to euthanasia and tissue dissection, adds to the challenge. The objective of this study was to compare the implementation of concrete multifaceted techniques for teaching complex aspects in avian physiology (PO-405), a North Carolina State University 4 credit-hour undergraduate course with a weekly 3h experimental laboratory. Forty-two students were registered for the course for fall semester 2005. Faced with an influx of students from diverse disciplines, limited laboratory equipment and space to house them, they were randomly distributed into two groups of twenty-one students as Group B and Group S. While both groups received the usual printed lab handouts and a short introductory explanation, Group S participants also received a comprehensive teaching model consisting of a short computer animated video of the metabolic process studied, a visual demonstration of the pertinent procedure, a printed sheet delineating each step to follow, an optional plastic chicken with its organs for orientation, and finally, a holistic explanation of how the laboratory session relates to the overall understanding of the course. After lab completion, identical assessments were placed, collected and graded by the instructor. Data was analyzed using proc GLM of the SAS Institute. Final laboratory scores were significantly higher (p<0.05) for holistically engaged students in Group S compared to Group B. Our simple comparative study suggests that comprehensive teaching with an emphasis on various learning styles results in better grades, probably leading to better understanding, and a more meaningful laboratory experience.

Key Words: teaching, avian, physiology

84 Monitoring the health status of California game fowl flocks. B. A. McCrea* and F. A. Bradley, University of California, Davis.

The Game Fowl Health Assurance (GFHA) Program was developed in 2003. Participating California game fowl producers voluntarily test their flocks for Avian Influenza (AI) and Exotic Newcastle Disease (END). Producers are sent swab kits and they collect pharyngeal and cloacal swabs from specified numbers of birds. Additionally, birds are periodically submitted to the California Animal Health and Food Safety (CAHFS) labs for testing. Swab kit results have been retained and reviewed since the inception of the program. CAHFS bird submission reports have yielded information on the prevalence of different disease-causing organisms in game fowl flocks throughout the state. Flock sizes ranged from 6 to 1000 birds, with an average flock size of 100 birds. A total of 31 counties was represented in the program. From October 2003 to March 2006, 25.0% (n=26) of swab kits were tested for END and 75.0% (n=78) were tested for both AI and END. The majority of swab kits (65.4%) have been submitted by producers from southern California. Swab kit testing was performed on 4,565 birds. No flocks in the program have tested positive for END or AI using pharyngeal or cloacal swabs as analyzed by PCR and confirmatory virus isolation. From October 2003 to March 2006, 95 birds were submitted to CAHFS as part of whole bird submissions. The majority (83.2%) of submissions occurred in 2004. A variety of disease-causing organisms have been recovered in birds submitted to CAHFS including Mycoplasma sp., roundworms, tapeworms, Eimeria spp., Marek's Disease Virus, trichomonads, Fowl Pox Virus, Gallibacterium anatis, and lice. All whole bird submissions were negative for END and AI. Serological titers for Newcastle Disease Virus, Infectious Bronchitis Virus, Infectious Bursal Disease Virus, Mycoplasma synoviae and Mycoplasma gallisepticum were common. As part of this game fowl health promotion program, owners have been provided with flock health status information. Program organizers have used these results to develop future educational programs for this clientele group.

Key Words: game fowl, Exotic Newcastle Disease, Avian Influenza

85 Mississippi poultry nutrient management educational programming. J. Oldham and T. Chamblee*, Mississippi State University, Mississippi State.

Poultry production, the largest grossing agricultural enterprise in Mississippi, is concentrated in the south central region of the state. The location of the Mississippi poultry industry provided the impetus for educational programming detailing the management of non-point source nutrients and water resource quality in the region. In recent years, Mississippi State University Extension Service (MSU-ES) and Mississippi Agricultural and Forestry Experiment Station personnel have worked closely with all segments of the industry and other agencies to expand the research base and to provide training in nutrient management. Reorganization of MSU-ES in 2002 addressed the need for more non-traditional education programs in environmental issues in general, and nutrient management in particular. Facilitated discussions among attendees of the 2003 Mississippi Nutrient Management Symposium focused on the perceived strengths and weaknesses of the effort, and offered suggestions for improvement. The MSU-ES Environment/Nutrient Management Program Priority Group was organized to plan and implement programming efforts using multiple disciplines and university units. Recent changes in state CAFO permit requirements (2004) further increased the educational needs of poultry producers in nutrient management, record keeping, and other management skills. Mississippi requires annual continuing education for animal waste permit holders. MSU-ES, in conjunction with other agencies, facilitates and conducts continuing education programming for poultry producers.

Key Words: nutrient management

86 Poultry grower education program on current and future issues effecting the poultry industry. A. J. Pescatore1, M. G. Miller2, K. D. Casey3, R. S. Gates4, and D. G. Overhults4. 1University of Kentucky, Lexington, 2Kentucky Poultry Federation/ Kentucky Egg Council, Lexington, Kentucky, 3Texas Agricultural Experiment Station, Texas A&M University, Amarillo, 4Department of Biosystems and Agricultural Engineering, Lexington, Kentucky.

Numerous issues including biosecurity, avian influenza, air emission regulations, animal welfare and water quality have the potential to impact the profitability and sustainability of the commercial poultry
industry. Poultry growers hear or read conflicting sound bites and stories on these issues. An educational program was conducted to provide factual information on these topics to poultry producers. Ten local educational sessions were conducted for poultry producers and company support personnel from seven different poultry companies. In-depth discussions on the topics listed above were presented. Over five hundred producers have attended these programs. The attendees indicated that these programs improved their understanding of these issues. As a follow-up, a statewide one-day educational program for poultry growers was held that provided additional information on these issues. Funding for these educational efforts was provided by the Kentucky Department of Agriculture and the Kentucky Poultry Federation.

**Key Words:** grower education, issues education

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### Immunology


In order to strengthen the youth programs in poultry a training workshop and resource manual was developed for teachers and extension agents. A focus group of six people that were representative of our target audience were invited to participate in an all day discussion on educational materials and activities. From this discussion a resource manual and program was developed. This program used the egg as the basis for providing information on nutrition, food safety, meal planning, science and agriculture. Educational resources and worksheets were developed. The workshops were designed to include a mixture of lectures, activities and hands-on demonstrations. The resource materials were distributed to 180 educators and extension professionals. The training was well received and the program has been implemented in numerous schools and county programs across the state. This program was developed in cooperation with the Kentucky Poultry Federation/Kentucky Egg Council with funding provided by a grant from the US Poultry and Egg Association.

**Key Words:** youth programs, 4-H, resource manual

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Chicken major histocompatibility complex (MHC) genes include B-F, MHC class I; B-L, MHC class II; and B-G, MHC class IV. The genes are closely linked on chromosome 16 in the chicken genome. Recombinants between the MHC B-F and B-G regions have been useful to define genetic control of immune responses more precisely. Inbred Line UCD 003, (B17B17) is the genetic base for six congenic lines each containing a single unique MHC recombinant. These congenic lines have undergone ten backcrosses to Line UCD 003 and thus have 99.9% genetic uniformity. A new recombinant, designated R13 (BF17-BG23), was found in a single male from the tenth BC generation for R1 (BF24-BG23). The number of R13 birds was increased through an additional backcross to Line UCD 003 and thus have 99.9% genetic uniformity. A new recombinant, designated R13 (BF17-BG23), was found in a single male from the tenth BC generation for R1 (BF24-BG23). The number of R13 birds was increased through an additional backcross to Line UCD 003 and thus have 99.9% genetic uniformity. A new recombinant, designated R13 (BF17-BG23), was found in a single male from the tenth BC generation for R1 (BF24-BG23).

89 **Identification and characterization of thymosin β4 in chicken macrophages.** L. Kannan*1,2, R. Liyanage1, J. Lay1, and N. Rath2, 1University of Arkansas, Fayetteville, 2USDA-ARS, Poultry Production and Product Safety Research Unit, Fayetteville, Arkansas.

Molecular markers are important to understand the developmental, physiological, metabolic, and pathology-related changes in the cells and tissues. Low molecular weight proteins and peptides play pivotal roles in signal transduction and cellular regulation. To prospect for such markers we compared the differences between monocytes and granulocytes isolated from chicken peripheral blood. Using whole cell MALDI/TOF mass spectrometry in the mass range of 1-20 kDa, the results showed association of several minor and few major peaks with each population of cells. One major peak corresponding to mass 4963 was uniquely associated with monocytes but not with the granulocytes. To characterize 4963 we developed a purification procedure using reverse phase liquid chromatography and electrospray ionization mass spectrometry. We purified this peptide from the lysates of two transformed macrophage cell lines HD11 and HTC. Attempts to sequence this peptide by Edman degradation showed it to be N-terminally blocked. Tryptsinization and peptide mass fingerprinting followed by MASCOT database search yielded it to be N-acetylated thymosin β4 (Tβ4). It was further confirmed by collision-induced dissociation. RT-PCR also showed the expression of Tβ4 mRNA by the macrophages. Though originally discovered in thymus gland, Tβ4...
appears to be present in many different cells and sequesters G-actin, a cytoskeletal protein. Many mammalian studies have reported Tβ4 to promote wound healing and angiogenesis. We hypothesize that the release of Tβ4 in macrophages may be crucial to post inflammatory tissue repair and resolution of inflammation. Our future research will focus on the modes and modulations of Tβ4 secretion by macrophages.

**Key Words:** macrophage, mass spectrometry, thymosin β4

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Nitric oxide (NO) is a potent vasodilator synthesized from L-arginine by nitric oxide synthase (NOS). Constitutive nitric oxide synthase in endothelial cells (eNOS) produces transient bursts of NO in low but physiologically effective levels. Activated monocytes/macrophages express inducible nitric oxide synthase (iNOS) which produces copious quantities of NO. Previous studies showed that NO attenuates pulmonary hypertensive responses induced by i.v. injections of lipopolysaccharide (LPS) or cellulose microparticles (MP). The present study was designed to determine whether changes in plasma NO concentrations can be used to assess the time course of iNOS expression and NO production in response to LPS or MP injections. Broilers (120 per group) were injected i.v. with 1 mL of PBS (control), 1 mL of LPS (1 mg/mL), or 0.4 mL of MPs (0.02 g/mL). Plasma samples were collected from 10 broilers per group at 15, 30, 45 and 60 min, and at 2, 3, 4, 5, 6, 8, 10 and 12 h post-injection. Total plasma NO concentrations were analyzed by nitrate + nitrite assay. After PBS or MP injection plasma NO did not change throughout the 12 h period. In LPS-injected broilers plasma NO increased from non-detectable levels at 15 min to 26.3 ± 4.0 µM by 3 h post-injection, reached peak levels of 85.1 ± 10.6 µM at 5 h, and returned to baseline levels similar to MP- and PBS-injected broilers by 12 h post-injection. We conclude that LPS triggered widespread iNOS expression by circulating monocytes/macrophages, resulting in copious NO production as reflected by significant increases in total plasma NO. Proportionally few monocytes/macrophages responded to MP-entrapped in pulmonary arterioles, consequently the quantities of NO produced by iNOS in these activated leukocytes or by eNOS in the pulmonary vasculature had a minimal impact on total plasma NO concentrations. Total plasma NO levels in broilers did reflect the time course of massive iNOS activation in response to LPS, but biologically relevant quantities of NO produced by iNOS and eNOS in response to entrapped MPs were too low to affect total plasma NO.

**Key Words:** nitric oxide, lipopolysaccharide, broiler

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Injection of microparticles (MP) has been used to select broilers with sufficiently robust pulmonary vascular capacity to resist onset of pulmonary hypertension (PH). Injected MP (i.v.) become lodged in the pulmonary vasculature where they increase the resistance to blood flow and trigger PH. MP lodged in vessels initiate aggregation of mononuclear leukocytes within the surrounding lung parenchyma. Activated avian macrophages express inducible nitric oxide synthase (iNOS), which produces large quantities of nitric oxide (NO). NO attenuates PH through its role as a vasodilator and its ability to modulate the release of key vasoconstrictors. The objective of this study was to establish the time-course over which i.v. MP injections induce the responding macrophages to express iNOS. Broilers from Control (C), PHS-Resistant (R), and PHS-Susceptible (S) lines were injected with MP (10 birds/line/time point) and their left lung was collected at 0 h (no MP) and 2, 24 and 48 h post-injection. The lungs were snap frozen and stored at -80°C for gene expression and immunohistochemical studies. iNOS expression was studied by quantitative real time 2-step RT-PCR (Taqman) and was quantified by relative standard curve method and expressed as fold change in iNOS mRNA levels. At 2 h, there was no line difference in the iNOS expression (P = 0.190). At 24 h, iNOS expression in line R (15.8 ± 6.4) was higher (P = 0.074) compared to lines C (5.4 ± 1.0) and S (2.4 ± 0.6). At 48 h, lines R (24.9 ± 6.4) and S (26.2 ± 4.4) had higher (P = 0.014) iNOS expression than line C (5.4 ± 1.3). Immuno- and NADPH-diaphorase histochemical staining revealed the presence of macrophages (KUL01 mAb) and NO, respectively, in the large mononuclear aggregates that had formed around the MP-occluded vessels by 24 h onwards. These observations suggest that the macrophages recruited to the site of entrapped MP were activated and expressed iNOS to attenuate the MP-induced PH via NO production.

**Key Words:** iNOS, macrophage, broiler lung

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**92 Enumeration of macrophages in the cecae following challenge with Salmonella enteritidis and treatment with a probiotic culture.** S. E. Higgins*, J. P. Higgins, G. F. Erf, A. D. Wolfenden, S. N. Henderson, G. Tellez, and B. M. Hargis, University of Arkansas, Fayetteville.

During previous studies with neonatal chicks, we found consistent reduction of Salmonella enteritidis (SE) within 24 h of infection when a probiotic culture (FM-B11™, Ivesco LLC) was administered one hour after challenge. Two studies were performed to determine whether the observed reduction in SE could be associated with the numbers of macrophages present in cecal tissue. Briefly, 100 day of hatch chicks were randomly assigned to four groups. Two groups were challenged by oral gavage with approximately 10⁸ cfu of SE, and two groups received sterile saline by oral gavage (n = 25 per group). One hour later, one challenged and one un-challenged group were treated by oral gavage with approximately 10⁸ cfu of FM-B11. The other two groups received the vehicle, skim milk. Twenty-four hours after treatment, the birds were humanely killed, and the cecal tonsils removed aseptically and enriched for detection of SE. Also, one cecum was removed and snap-frozen in liquid nitrogen. The frozen ceca were embedded in OCT medium and cut into 8µm thick sections. Immunohistochemistry was performed on these tissues using a monoclonal antibody specific for chicken monocytes and macrophages (KUL01). In both experiments there was a significant reduction of SE in challenged chicks receiving probiotic treatment compared to untreated controls (Exp 1, 67% reduction; Exp 2, 59% reduction). Enumeration of macrophages in cecal tissue in experiment one showed an increase (p<0.02) in macrophages in the cecae of chicks receiving only probiotic treatment compared to chicks receiving neither treatment nor challenge (3.32 cells/10,000 um² and 3.66 cells/10,000 um²). However, in experiment two, there were no significant differences in the numbers of macrophages between any groups. These data do not suggest that
there is a biologically meaningful relationship between the number of macrophages in the ceca of chicks and reduction of SE due to probiotic treatment.

Key Words: probiotic, Salmonella, macrophage

93 Lycopene and α-tocopherol incorporation into egg yolks and their effects on laying hen immune function. J. Olson* and E. Koutsos, California Polytechnic State University, San Luis Obispo.

Lycopene is a carotenoid that has several biological functions associated with decreased cancer risk. The purpose of these trials was to examine the ability of the laying hen (Hyline W36) to deposit dietary lycopene and/or α-tocopherol into the egg yolk and to investigate their effects on immune function. All birds were housed in commercial cages, had ad libitum access to water, and were fed fed 100 g/bird*day for 15 days in trial 1 and 17 days in trial 2. Trial 1 consisted of four dietary levels of lycopene (0, 65, 257, 650 mg lycopene/kg diet). HPLC analysis revealed that dietary lycopene was incorporated into egg yolks (p<0.01 versus 0 mg lycopene). Regression analysis shows that maximum incorporation of lycopene into egg yolk occurs at 420 mg lycopene/kg diet resulting in 0.09 mg lycopene per egg yolk. Trial 2 was designed as a 3 x factorial, with three levels of lycopene (0, 420, 840 mg lycopene/kg diet), and two levels of α-tocopherol (0, 200mg α-tocopherol/kg diet). Inflammatory response was measured following LPS administration (subcutaneously at 1 mg LPS/kg BW). LPS increased liver and spleen weights for all diets (p<0.01), although body weight was not affected by LPS (p=0.82). There was an interaction between α-tocopherol and lycopene (p<0.01); at 24 h post-LPS, birds fed 200 mg α-tocopherol had greater liver weights compared to control diets. LPS also increased plasma haptoglobin (p<0.01), but neither lycopene nor α-tocopherol affected haptoglobin concentrations (p>0.39 for each). Cutaneous basophil hypersensitivity was measured following PHA administration (injected in the toe web at 0.2 mg/bird). Toe web swelling was increased by PHA (p<0.01) and birds fed diets with 420 mg lycopene/kg had greater swelling at six hours compared to the control diets (p<0.01). These data indicate that lycopene can be incorporated into egg yolks and that α-tocopherol and lycopene may not have beneficial effects to the laying hen’s immune system at some dietary levels.

Key Words: lycopene, α-tocopherol, laying hen

94 A novel formula for predicting infectious bursal disease vaccination time on chick weight rather than age. A. Vaziry*1, D. Venne2, D. Frenette1, and A. Silim1, 1Faculté de Médecine Vétérinaire, Université de Montréal, St. Hyacinthe, QB, Canada, 2Couvoir Scott, Scott Junction, QB, Canada.

Growth rate in broiler birds has increased substantially in the last decade due to improvement in genetics, feed formulation, cleaner environment and bio-security. As a result, it has become necessary to review and revise prediction method for vaccination in chicks. This study was undertaken to determine the possible use of weight-gain rate rather than age in predicting vaccination time. Two groups of one day-old broilers originating from old and young breeders respectively and with different levels of maternal antibodies against infectious bursal disease virus (IBDV) were used in this study. Both groups were divided into 2 sub-groups and subjected to two feed regimens: groups Ia and Ila were fed broiler feed for normal growth rate and groups Ib and IIb were fed breeder feed for slower growth rate. At 1, 4, 8, 12, 16, 22, 29 and 36 days of age, 22 chicks in each group were weighed and blood samples collected. Serum samples were tested for antibodies against IBDV by ELISA (Symbiotics Corporation) and virus neutralization test (VNT). The maternal antibody decline curves for each group were plotted out according to chick age and chick weight. Fast-growing birds in groups Ia and Ila showed a faster rate of antibody decline whereas slow-growing birds in groups Ib and IIb had a slower rate of antibody decline. No difference in antibody decline rate was observed between chicks from younger versus older breeders. Based on the effect of weight-gain on maternal antibody decline, a new way of predicting vaccination time for IBDV based on measuring maternal antibody titers at 4 days of age was proposed and tested. The predicted antibody decline was shown to correspond to the real ELISA titers measured in our experiments (R2 = 0.9812) whereas a lower correlation (R2 = 0.5853) between real ELISA titers and the titers predicted by current method using age-based Deventer formula was observed.

Key Words: maternal antibody, vaccination formula, infectious bursal disease

95 Evaluation of Coccivac-B® or Bio-Cox® (salinomycin) for control of field strain Eimeria in broilers on two different feeding programs. J. T. Lee*1, C. Broussard2, S. Fitz-Coy2, P. Burke2, N. Eckett1, S. Stevens1, P. Anderson1, and D. J. Caldwell1, 1Texas A&M University, College Station, 2Schering-Plough Animal Health, Union, New Jersey.

The objective of this study was to compare Coccivac-B® or Bio-Cox® (salinomycin) for controlling field strain Eimeria in broilers reared on two different dietary rations varying mostly in protein concentration. Each treatment included 10 replicate pens for a total of 40 pens with 43 broilers placed per pen. Broilers were reared to 50 days on a four-phase feeding program: starter (Day 1-14), grower (Day 15-29), and withdrawal (Day 41-50). Both diets evaluated in this study, Diet A (control) or Diet B (test diet), were formulated to simulate a local commercial integrator’s diets by season. The dietary protein profile for Diet A was 21.5% (starter), 20% (grower), 16.5% (finisher), and 15.75% (withdrawal), and Diet B was 22% (starter), 19.6% (finisher), 17.8% (finisher), and 17.5% (withdrawal). On day 14 of grow-out, Eimeria collected from commercial broiler farms in Texas were spray applied to the litter in all pens. Broilers reared on Diet B were heavier (P<0.05) at Day 40 while body weights at day 50 were similar (P>0.05) for all groups. Broilers fed Diet B had lower (P<0.05) mortality corrected feed conversions ratios (FCR) during the starter and finisher diets. Broilers fed salinomycin had lower (P<0.05) mortality corrected FCR for the starter and grower diets while vaccinated broilers had lower (P<0.05) mortality corrected FCR during the withdrawal period. Cumulative FCR for the entire grow out period were similar (P>0.05) for all groups. The results of this investigation suggest that feeding an appropriately formulated diet while vaccinating broilers with Coccivac-B® as an alternative to the use of salinomycin yields at least equivalent if not elevated performance in the presence of field-strain Eimeria during grow-out.

Key Words: dietary protein, vaccination, Eimeria
Currently in the U.S., feed deprivation is used to induce molting and stimulate multiple egg-laying cycles in laying hens for commercial egg production. Previous reports show that alfalfa is effective in inducing a molt as well as producing protection against Salmonella enteritidis (SE) organ invasion. Our laboratory has also shown that immune function is significantly reduced during molting. The present investigation was performed to evaluate heterophil function during an induced molt in hens fed alfalfa. Two replicate experiments utilized hens over 65 wk of age that were divided into 6 groups of 12 hens each and placed in individual laying cages. Two wk prior to dietary changes, hens were placed on an 8-h light and 16 h-dark photoperiod that continued for the 12-day experiment. Blood samples were taken from the hens during three sampling periods, 1-2d, 5-6d, and 11-12d. Treatments groups consisted of non-fed hens (NF), full-fed hens (FF) and alfalfa-fed hens (AF). Heterophil function was measured using several in vitro assays. To evaluate the oxidative burst of heterophils, phorbol 12-myristate acetate was used to stimulate collected cells from each treatment group. Both the FF and AF birds oxidative response was significantly (P < 0.05) higher than the NF birds for all three sampling periods. During the degranulation assay heterophils were stimulated with opsonized SE for one hour. Results showed a significant (P < 0.05) increase in degranulation during all three sampling periods when the AF birds were compared to the NF controls. These results confirm that heterophil function is significantly reduced in NF birds during an induced molt. More importantly AF birds showed an increased immune response during a 12d molting period. The commercial layer industry should consider using alfalfa as a diet when developing commercial molting programs.

Key Words: chicken, heterophil, molting

98 Developing chicken lymphocytes increase glucose metabolism after hatch. S. Rudrappa and B. Humphrey*, University of Maryland, College Park.

Coordinated regulation of energy metabolism in lymphocytes is vital for their development. Three experiments examined glucose, glutamine and fatty acid metabolism in developing lymphocytes from broiler chickens during embryogenesis (e) and posthatch (d). In experiment one, bursacytes and thymocytes were sampled (n = 5) on e17, e20, d1, d7 and d14. Thymocyte glucose transporter-3 (Glut-3) and hexokinase (HK) mRNA abundance increased 10-fold from e17 to d14 (P < 0.05) and Glut-1 mRNA abundance increased 3-fold from e17 to d14 (P < 0.05). Bursacyte Glut-3 mRNA abundance increased 2.5-fold from e17 to d14 while Glut-1 mRNA abundance decreased 2.5-fold from e17 to d14 (P < 0.05). Bursacyte HK mRNA abundance increased 2.5-fold from e17 to e20 (P < 0.05). Thymocyte glutamine transporter (SNAT-1), SNAT-2 and glutaminase (GA) mRNA abundance increased at least 5-fold from e17 to d7 (P < 0.05). Bursacyte SNAT-1 and GA mRNA abundance increased 3-fold from e17 to d7 (P < 0.05). Carnitine palmitoyl transferase-1 (CPT-1) mRNA abundance decreased 5-fold from e17 to e20 in bursacytes and increased 5-fold from e17 to d1 in thymocytes (P < 0.05). In experiment two, bursacytes, thymocytes and serum were sampled (n = 6) on e20, d1, d3 and d7. HK enzyme activity increased to maximum levels between e20 to d3 in bursacytes and d3 to d7 in thymocytes (P < 0.05). GA enzyme activity increased from e20 to d7 in bursacytes (P < 0.05) and did not change in thymocytes (P > 0.05). CPT enzyme activity did not change over time in either cell population (P > 0.05). In experiment three, bursacytes and thymocytes were sampled (n = 6) on d1, d7 and d14. Fluorescent D-glucose uptake by bursacytes and thymocytes was greater on d14 compared to d1 and d7 (P < 0.05). Results indicate that (a) developing B and T lymphocytes increase glucose metabolism with no change in fatty acid metabolism during the first two weeks after hatch; (b) developing B lymphocytes and not T lymphocytes increase glutamine metabolism after hatch.

Key Words: lymphocyte, glucose, glutamine
Metabolism and Nutrition: Nutrition - Feeds and Manufacturing

99  Effects of marker selection and mix time on coefficient of variation in the mixing process.  P. M. Clark* and K. C. Behnke, Kansas State University, Manhattan.

An experiment was conducted to evaluate marker selection and mix time on mix uniformity in the feed manufacturing process as determined by percent coefficient of variation (% CV). A corn-soybean meal based diet was formulated for broiler chicks from d 0 to 17. Dietary nutrients or tracers evaluated included: 1) salt (chloride ion); 2) phosphorus; 3) manganese; 4) iron particles (Micro Tracer™ Red #40 by count)(MTC); 5) iron particles (Micro Tracer™ Red #40 by absorbance)(MTA); 6) iron particles (Micro Tracer™ RF Blue Lake)(MTB); 7) roxarsone; 8) semduramicin; 9) DL-Methionine; 10) HCl-Lysine; and 11) crude protein. Diets were mixed with a double ribbon mixer for three different mix times (0.5, 2.5, and 5.0 min). Ingredients were weighed separately and added in the same location for all treatments. Following the mix cycle, feed was conveyed to a sacking bin by a discharge screw and bucket elevator. Samples (5 kg) were collected from 10 sacks (i.e. 1.3,5, etc.) for % CV calculation. Within each sample, all markers were analyzed for that particular batch. With the exception of protein and MTA, all marker data reported a considerable reduction in % CV as a percent, ranging from 17.3% (roxarsone) to 52.9% (phosphorus) from 0.5 to 2.5 minute mix time. From 2.5 to 5.0 minutes, salt, roxarsone, and MTC, % CV increased, while all other markers continued to reduce in % CV. Overall, from 0.5 to 5.0 minutes all markers showed a reduction in % CV however, crude protein should not be considered as a marker due to all major components contribute some level of protein and can be difficult to determine if the batch has been mixed adequately.

Table 1. Effect of marker selection and mix time on diet uniformity

<table>
<thead>
<tr>
<th>Item, % CV</th>
<th>Mix time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Salt (chloride ion)</td>
<td>20.3</td>
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<tr>
<td>Phosphorus</td>
<td>13.7</td>
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<tr>
<td>Manganese</td>
<td>36.3</td>
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<tr>
<td>Micro Tracer™ Red #40 (count)</td>
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<td>HCl-Lysine</td>
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<tr>
<td>Crude Protein</td>
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</tr>
</tbody>
</table>

Key Words: mixer analysis, diet uniformity

100  The effects of cellulose and soy protein isolate on pellet manufacture variables and quality.  N. P. Buchanan*, J. M. Hott, S. E. Cutlip, and J. S. Moritz, West Virginia University, Morgantown.

The majority of broiler feed is in pelleted form. Feeding pelleted diets results in an increase in weight gain and feed efficiency compared to feeding mash diets. Improvements in performance are contingent upon pellet quality. Past research has focused on methods to improve pellet quality without negatively affecting processing variables and performance. However, data are limited. Pellet quality is measured using the Pellet Durability Index (PDI), Modified Pellet Durability Index (MPDI), and calculating the percentage of fine particles present after pelleting. Improvement in pellet quality may be achieved through thermal alterations of starch, fiber, and protein. The objective of the current study was to evaluate the effects of cellulose and soy protein isolate inclusion on pellet manufacture variables and quality in a corn-soybean based broiler diet. Cellulose or soy protein isolate was included at 5% into a corn-soybean based diet at the expense of corn. A control (CON), a cellulose (CELL), and a soy protein isolate (SPI) diet were manufactured in a Latin Square Design over a three-day period. All feed was conditioned at 82.2°C using a steam pressure of 262kPa. The mean ambient temperature during processing was –0.63°C. Production rate, percentage of fines, and bulk density did not differ between treatment (P=0.5366, 0.1700, and 0.1778, respectively). Relative to the control diet, cellulose or soy protein isolate inclusion improved PDI by 8.19 and 7.50% (P=0.0450) and MPDI by 13.44 and 11.67%, respectively (P=0.0527). Pelleting resulted in the addition of 3.34, 4.11, and 3.70% moisture for CON, CELL, and SPI, respectively (P=0.2834). Pellet moisture loss following three-day storage at 11.7°C averaged 3.48% and did not differ between treatment (P=0.9415). These results demonstrate that the addition of cellulose or soy protein isolate to a corn-soybean based broiler diet may improve pellet quality without negatively affecting processing variables.

Key Words: soy protein isolate, cellulose, pellet quality

101  Effect of steam conditioning practices on pellet quality and growing broiler nutritional value.  S. Cutlip*, J. Hott, N. Buchanan, and J. Moritz, West Virginia University, Morgantown.

Feed incurs 60-65% of broiler production cost. Research demonstrates that feeding pellets opposed to mash improves broiler performance. However, pellet quality and subsequent beneficial effects vary based on means of feed processing. Optimization of pellet quality through precision thermo-mechanical processing may decrease broiler production cost. This study evaluates the effect of steam conditioning practice on pellet quality and growing broiler nutritional value. A Latin Square Design was implemented to measure interactions among conditioning temperature and steam pressure. Corn-soybean meal based diets were processed with one of four temperature x steam pressure combinations: 82.2°C at 138 kPa, 93.3°C at 138 kPa, 82.2°C at 552 kPa or 93.3°C at 552 kPa. Three additional diets were prepared: unprocessed mash, the 93.3°C/552 kPa diet reground to mash, and a 50:50 combination of pellets and reground mash produced from the 93.3°C/552 kPa treatment to simulate a high fines percentage diet. Pelleted diets were tested for quality through calculations of pellet durability index (PDI), modified pellet durability index (MPDI) and percentage of fines. Each of the seven treatments was fed to eight replicate pens of 16 straight-run Cobb X Cobb broilers during the 21-to-39 day growing period. Pellet durability index and MPDI improved as temperature was increased (P=0.0001 and 0.0001 respectively). Higher processing temperatures also reduced percentage of fines (P=0.0397). Feed conversion ratio and live weight gain (LWG) improved with increasing processing temperature (P=0.0321 and 0.0001 respectively). Higher steam pressure improved MPDI (P=0.0299); however, higher steam pressure did not improve broiler
performance. Broilers fed the additional three diets had lower feed intake and lower LWG (P<0.05). Elevated thermo-mechanical processing produced better quality pellets subsequently leading to improved broiler performance. These effects may be attributed to the physiochemical changes induced by pelleting at the above normal conditions of 93.3°C and 552 kPa.

**Key Words:** steam conditioning, pelleting, broilers

### 102 Effect of moisture addition with a mold inhibitor on feed manufacture, pellet quality and broiler performance.

J. M. Hott*, N. P. Buchanan, S. E. Cutlip, and J. S. Moritz, West Virginia University, Morgantown.

Pelleting broiler diets improves feed efficiency and increases live weight gain. The addition of moisture at the mixer to corn-soybean based diets has been shown to improve pellet durability, increase pellet throughput and decrease pellet mill energy consumption. However, moisture addition may dilute feed nutrients and negatively impact broiler performance. In addition, feeds with high moisture levels may be susceptible to mold spore germination and growth. To prevent mold proliferation, commercial inhibitors are available for diet inclusion. The objective of this study was to evaluate the effects of top-dress moisture addition plus a mold inhibitor on feed manufacture, pellet quality, and broiler performance. Two experiments were conducted. In experiment one, the following three diets were manufactured at the WVU pilot feed mill: control (CON), control + 1% addition of water: Mold inhibitor (95:5), and control + 2% addition of water: Mold inhibitor (95:5). Manufacturing was replicated three times using a Latin Square Design. Bulk density, production rate, pellet durability index (PDI), fines percentage, electrical energy usage, and starch gelatinization were measured. In experiment two, day-old, straight-run, Cobb 500 broiler chicks were divided into 30 pens of 16 each. Dietary treatments of experiment one were randomly assigned to 10 replicate pens. Performance variables included live weight gain, feed intake and feed conversion.

**Key Words:** mold inhibitor, moisture, feed manufacture

### 103 The effects of whole grains on growth performance, nutrient digestibilities, and cecal short-chain fatty acid production in young chicks.


Five experiments were conducted to evaluate whole wheat, whole sorghum, or whole barley in ground corn-soybean meal diets fed to young chicks. The first four studies utilized New Hampshire x Columbian male chicks and the fifth study used Ross X Ross commercial male chicks. In the first experiment, feeding 5, 10, 15, or 20% whole wheat had no effect on growth at 21 days when compared with chicks fed the control diet. In the second experiment, feeding 10 or 20% whole wheat from 0 to 21 days or from 8 to 21 days had no significant effect on growth performance. The third experiment tested 20, 35, and 50% whole wheat fed from 0 to 21 days of age and showed that a 50% whole wheat diet decreased (P<0.05) 21-day growth and feed efficiency when compared to chicks fed the control diet. In Experiment 4, 10 and 20% whole sorghum caused a reduction (P<0.05) in growth at 21 days while chicks fed 10 and 20% whole barley had similar weight gains to chicks fed a corn-soybean meal diet. The fifth study with commercial broiler chicks evaluated 10 and 20% whole sorghum or whole barley and 20 and 35% whole wheat. Growth at 21 days was unaffected by any dietary treatment. Feed efficiency was decreased (P<0.05) at 21 days with 20% whole wheat and improved (P<0.05) with 10% whole barley. Feeding whole grains to chicks caused an increase in relative gizzard weight, even as early as 7 days, in all experiments. The greatest increase in relative gizzard weights occurred with 20% whole barley and 20 and 35% whole wheat. Chicks fed diets containing 10 to 20% whole wheat generally had increased MEn values at 3-4, 7, 14, and 21 days and also had slight increases in amino acid digestibility at 21 days in one experiment. At 21 days, cecal pH and short-chain fatty acid concentrations in all experiments were unaffected by feeding whole grains to chicks. The results of this study indicated the feeding whole wheat, sorghum, or barley increases gizzard weight and feeding 10 to 20% whole wheat may increase MEn and amino acid digestibility.

**Key Words:** whole wheat, whole sorghum, whole barley

### 104 Increasing the number of phases fed to broiler chickens by blending diets.

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Increasing metabolizable energy and decreasing protein levels in broiler chicken diets is the traditional phase feeding concept intended to approximate the requirements of the bird to avoid wastage of nutrients and reduce feed costs. Commercial feed weighers are capable of blending several feeds prior to delivery to feeders and therefore, provide the opportunity to increase the number of phases administered to a broiler flock without formulating additional rations. The objective of this project was to determine the value of feeding an additional two phases as 50/50 blends of starter and grower and grower and finisher in a broiler chicken feeding regime. 912 male broiler chickens were randomly assigned to one of 24 pens (38 birds/pen). There were 12 replications of either a standard three phase diet or 5 phase diet. The control birds were fed starter (23% crude protein (CP), 3050 Kcal of ME/kg) until 35 days of age at which point the birds were shipped. The treatment birds were fed starter the first week, a 50/50 blend of starter and grower the second week, grower the third week, a 50/50 blend of grower and finisher the fourth week and finisher the last week. All birds were weighed on days 7, 14, 21, 28, and 35 and feed consumed was monitored. Pen means were analyzed using the proc mixed function of SAS with repeated measures. The body weight of birds was unaffected by the feed treatments for all dates measured with the birds reaching 1993g by day 35. Overall growth the birds on the starter/grower 50/50 blend (FE=1.62). Results indicated the use of a feed weigher to blend feed phases could provide an economic benefit to producers since birds performance is not reduced but feed costs would be since the earlier phase feeds are more expensive.

**Key Words:** broiler chicken, phase feeding, growth performance
105 Phosphorus bioavailability, TME, and amino acid digestibilities of high protein corn distillers dried grains with solubles and dehydrated corn germ meal. E. J. Kim*, P. L. Utterback, and C. M. Parsons, University of Illinois, Urbana.

There is currently much ongoing research and interest for developing new processing technologies to produce corn distillers dried grains with solubles (DDGS). The current study evaluated a high protein (HP) DDGS and a dehydrated corn germ meal which are the products that can be produced by a modified dry milling process. To evaluate the nutritional characteristics of these products, a chick experiment was conducted to determine the phosphorus (P) bioavailability based on tibia ash. In addition, precision-fed rooster assays were conducted to determine TMEp and amino acid digestibility. For the chick assay, a P-deficient cornstarch-dextrose-soybean meal basal diet containing 0.10% non-phytate P was supplemented with 0.0, 0.05 and 0.10% P from KH2PO4 or 7 and 14% conventional DDGS, HP DDGS, and corn germ meal. New Hampshire x Columbian female chicks were fed the experimental diets from day 9-23 days post hatch and bioavailability of P was estimated using the slope-ratio method where tibia ash was regressed on P intake. The total P content (90% DM basis) of the conventional DDGS, HP DDGS, and corn germ meal were 0.76, 0.33, and 1.22%, respectively. Bioavailability of the P in conventional DDGS, HP DDGS, and corn germ were found to be 60%, 58%, and 25%, respectively. The TMEp in conventional roosters was found to be significantly increased for the corn germ meal when compared to the HP DDGS. The protein content (90% DM basis) of the HP DDGS and corn germ meal was 33% and 14%, respectively, and the total lysine as a % of CP was approximately two times greater for the corn germ meal than for the HP DDGS. Amino acid digestibilities in cecectomized roosters were consistently higher for the corn germ meal than in the HP DDGS.

Key Words: distillers dried grains with solubles, corn germ meal, phosphorus


The low biodegradability of waste products generated from the Atlantic Shellfish Industry has raised concerns over disposal practices and their impact on the environment. Processing of shellfish by-products isolates valuable compounds and provides protein rich feed ingredients for poultry. A 34 wk production study would be conducted to evaluate the effects of supplementing laying hen diets with crab meal (CM) and lobster meal (LM). Four hundred and thirty-two Shaver White Leghorn pullets (34 wks of age) will be randomly allocated to 1 of 6 diets (Control, 2.5% CM, 2.5% LM, 5% CM, 5% LM, 2.5% CM + 2.5% LM). Feed consumption, egg weight, egg specific gravity, albumen height, and egg yolk parameters will be evaluated monthly for 34 wks. Egg production will be monitored daily. Calcium (Ca) retention will be determined at early (34 wks), mid (54 wks) and late (68 wks) production by analyses of dietary treatment, egg shell and excreta Ca content. Wing bones collected at 36 wks (10 birds), 54 wks (36 birds) and 68 wks (36 birds) will be analyzed for bone density, bone breaking strength and Ca content. An in vitro solubility trial will be conducted to examine the potential of mollusc shells, CM and LM as dietary Ca sources. Preliminary results on egg yolk parameters showed that there was an increase in red pigmentation on d28 and d56 from treatments supplemented with CM and LM when compared to control (p<0.05). This suggests that the laying hen is capable of depositing dietary carotenoids in the egg yolk, which could benefit in producing eggs with elevated antioxidant content.

Key Words: laying hen, crab and lobster meal, egg yolk pigmentation


Variation in corn kernel physical and chemical traits among corn hybrids may affect broiler chicken growth performance. Six commercial Golden Harvest brand corn hybrids (A, B, C, D, E, F) were added to a soybean meal–based basal diet and formulated for 0–2 wk of age (Phase [Ph] 1; 0.77% TSAA, 1.06% Lys), 2–4 wk (Ph 2; 0.71% TSAA, 0.98% Lys), and 4–6 wk (Ph 3; 0.61% TSAA, 0.85% Lys). All diets contained 3.2 Mcal/kg MEa. A total of 720 male 1-d-old Ross-308 broiler chicks were allotted to floor pens (10 chicks/pen) in a randomized complete block design (12 blocks). Feed intake and BW were recorded every 2 wk and flock uniformity (pen CV) was determined at 6 wk of age. Data were analyzed using ANOVA, and hybrids compared by using Fisher’s least significant difference (P < 0.1 considered significant). In Ph 1, the average daily gain (ADG) of chicks fed Hybrid F was 4.4% greater than that of those fed E (P < 0.1). Feeding Hybrids A, C, or F improved the feed utilization (gain-to-feed ratio; GF) by up to 5.3% compared with D or E (P < 0.1). Over the 6-wk period, chickens fed Hybrid E had up to a 4.4% higher GF compared with F or A (P < 0.1), but no differences (P > 0.1) were observed for ADG (55.5 g/d) or final BW (2.37 kg). The flock uniformity of chickens fed Hybrid C (10%) was better than when E (14.1%) or F (14.0%) was fed (P < 0.1). During Ph 1, the improved ADG and GF of broilers fed Hybrid F correlated with smallest kernel size, second highest seed density, highest oil content, and midrange Lys and TSAA contents. In both cases, corn kernel fiber content did not correlate with growth performance. These results show that corn kernel physical and chemical traits can affect broiler growth performance and flock uniformity. In addition, growth performance improvements resulting from different corn hybrids are dependent on the age of the chickens.

Key Words: broiler, growth performance, corn hybrid

108 Corn hybrid kernel trait variation affects laying-hen egg production. S. Moore*, D. Beitz†, C. Stalder, W. Fithian†, and K. Bregendahl†, 1Iowa State University, Ames, 2Golden Harvest Seeds, Inc., Waterloo, Nebraska.

Variation in corn kernel physical and chemical traits among corn hybrids may affect laying-hen egg-production performance. Six commercially available Golden Harvest corn hybrids (A, B, C, D, E, F) were added to a soybean meal–based basal diet to contain 85% of NRC (1994) nutrient recommendations (0.55% TSAA, 0.65% Lys). All diets contained at least 100% of NRC-recommended MEn (2.87 Mcal/kg), Ca (4.2%), and nonphytate P (0.33%). A total of 240 52-wk-old Hy-Line W-36 laying hens were allotted to cages (2 hens/cage) in a randomized complete block design (20 blocks). Egg production was recorded daily during the 14-wk-long study. Feed intake...
of these 9 hens, 1 produced only black chicks originating from the Rock roosters to determine the gametic origin of the offspring. Of the transplanted tissue were inseminated with semen from Barred Plymouth immunosuppressant (100mg/kg CellCept®) were surgically transplanted with fresh ovarian tissue from day-old to be demonstrated. Twenty one day-old White Leghorn chicks function and the production of donor-derived offspring remained could attach and undergo development in the host. Normal ovarian surgical technique for orthotopic transplantation of ovarian tissue techniques have not been available for birds. We recently developed a method for conserving the female germline in rodents, but comparable Cryopreservation and transplantation of ovarian tissue is an effective and total tract apparent retention (TTAR) of nutrients in broilers. One-d-old male chicks (Cobb-500) were randomly allotted to 36 cages (18 birds/cage) and six cages were assigned to each treatment. The control diets (VO or YG without fiber inclusion) contained 1.5% crude fiber and were based on rice, soy protein concentrate, fish meal, fat (5%), and sepiolite (3%). In the remaining diets the fiber source was included at the expenses of sepiolite (wt/wt). Average daily gain (ADG) and feed conversion ratio (F:G) were measured from 1 to 15 d of age. Also, AID of DM, CP, and starch (ST), TTAR of nitrogen (NR) and ether extract (EE), and AMEn of the diets were measured at 15 d of age using 2% celite as an indigestible marker. Fecal retention of N (70.9% vs. 68.8%, P < 0.05) and of EE (91.6% vs. 87.4%, P < 0.001), and AMEn (3,237 vs. 3,178 kcal/kg, P < 0.001) were higher for VO-than for YG-based diets. However, type of fat did not affect AID of nutrients and had little effect on productive performance of broilers. The inclusion of a fiber source, either OH or SBP, tended to increase ADG (25.3 vs. 24.5 g/d, for the fiber diets and control diet, respectively; P = 0.07) and improved F:G (1.245 vs. 1.308; P < 0.001), TTAR of EE (P < 0.05), and AMEn (P < 0.05). Inclusion of SBP reduced AID of DM, CP, ST, and NR (P < 0.05) whereas the OH inclusion did not affect AID of nutrients. An interaction type of fat x inclusion of fiber was observed; the beneficial effects of fiber on AMEn were more noticeable with YG than with VO (P < 0.05). The results indicate that type of fat and nature of the fiber influence nutrient utilization and that young broilers have a minimum requirement of insoluble fiber in the diet.

Key Words: nutrient digestibility, fat, crude fiber


We studied the effects of type of fat [vegetable oil mixture (VO) vs. yellow grease (YG)] and source of fiber in the diet [none vs. oat hulls (OH) vs. sugar beet pulp (SBP)] on apparent ileal digestibility (AID) and that young broilers have a minimum requirement of insoluble fiber in the diet.

Key Words: laying hen, corn hybrid, egg-production performance

110 Transplantation of chicken ovaries: A breakthrough for germplasm conservation. Y. Song* and F. G. Silversides, Agriculture and Agri-Food Canada, Agassiz, BC, Canada.

Cryopreservation and transplantation of ovarian tissue is an effective method for conserving the female germ line in rodents, but comparable techniques have not been available for birds. We recently developed a surgical technique for orthotopic transplantation of ovarian tissue in newly hatched chickens and demonstrated that the grafted tissue could attach and undergo development in the host. Normal ovarian function and the production of donor-derived offspring remained to be demonstrated. Twenty one day-old White Leghorn chicks were surgically transplanted with fresh ovarian tissue from day-old Barred Plymouth Rock chicks. Nine chicks were administered an immunosuppressant (100mg/kg CellCept®) after the surgery. All transplanted birds grew to sexual maturity but two of the immuno-suppressed chicks underwent sex-reversal. Hens that had received the transplanted tissue were inseminated with semen from Barred Plymouth Rock roosters to determine the gametic origin of the offspring. Of the 12 hens in the non-immunosuppressed group, 9 have produced eggs. Of these 9 hens, 1 produced only black chicks originating from the transplanted ovaries, 4 produced only white chicks from regenerated host ovaries, and one produced a mixture of black and white chicks. Eggs from the other 3 hens were fertile but all embryos died before pigment deposition. Six of the 7 hens in the immunosuppressed treatment produced eggs. Of the 6 hens, 1 produced only black chicks, 3 produced only white chicks, and 2 produced only embryos that died early in incubation. These results demonstrated that transplanted ovaries could produce normal eggs and give rise to donor-derived offspring, and provide a new approach to developing protocols for the cryopreservation of poultry stocks.

Key Words: chicken, ovary transplantation, germplasm conservation

111 Storage of turkey semen at 4°C for 24h alters the sperm glycocalyx. J. Peláez and J. Long*, Beltsville Agricultural Research Center, Beltsville, Maryland.

The glycocalyx, a carbohydrate-rich zone on the surface of all eukaryotic cells, represents the primary interface between the male gamete and its environment and is known to be involved with immunoprotection in the
female genital tract and early gamete interactions. We recently have characterized the types and distribution of sugar residues comprising the glyocalyx of poultry sperm. Our objective here was to determine the effects of semen storage on the turkey sperm glyocalyx from both high and low sperm mobility toms. Semen was collected from 3 high and 3 low mobility toms, pooled within mobility group and extended 1:1 with BPSE. Extended semen was maintained at 4°C with constant agitation for 24 h. At 0, 2, 4, 8, 12 and 24 h, semen aliquots were centrifuged (400g; 5min) to remove seminal plasma. Isolated sperm were either immediately stained with 1 of 14 FITC-conjugated lectins (100 µg/mL; 30min; 25°C; 100x10^6 cells/mL; non-treated), or were neuraminidase-treated (30min; 37°C; 1 IU/10^6 cells; n’as-treated) followed by lectin staining. Samples were counterstained with propidium iodide and assessed by flow cytometry (n=6). For each lectin, differences in Mean Fluorescence Intensity (MnFI) of live cells were studied over time between mobility groups and sperm treatments. In non-treated sperm, the MnFI for 8/14 lectins increased (P<0.05) between 8 and 24 h of semen storage compared to 0h (8h: Con A, GS-I, jacalin, RCA, sWGA; 12h: GNA; 24h: PNA, lotus). The MnFI for WFA, ECA and GS-II were constant (P>0.05) over time in non-treated samples; however, in n’as-treated sperm, MnFI increased after 8 h. The MnFI for SBA and PSA remained constant during semen storage, regardless of treatment (P>0.05). Sialic acid residues increased during storage suggesting that free sialic acid in the seminal plasma can be incorporated into the glyocalyx. Only 3 lectins (Con A, SBA and PSA) exhibited differential binding between mobility groups, with MnFI consistently higher (P<0.05) for low mobility sperm. These data demonstrate that the glyocalyx of turkey sperm is modified during storage and suggest that alterations in surface carbohydrates may adversely impact sperm function.

Key Words: turkey, sperm, glyocalyx


Calcitonin, a hormone primarily known for its role in calcium homeostasis, has recently been linked to reproduction, specifically as a marker for embryonic implantation in mammals. Furthermore, ovarian steroid hormones have been shown to alter the expression and secretion of calcitonin in both mammalian and non-mammalian species. However, production of calcitonin in the ovary has yet to be elucidated in any vertebrate species. The objective of the present study therefore was to determine if procalcitonin mRNA is present in the avian ovary, and if so, to ascertain how the expression may change with follicular maturation or steroid influences. We hypothesized that procalcitonin mRNA is expressed by the ovarian granulosa cells, and its expression will be altered by follicular maturation, as well as treatment with estradiol and/or progesterone. Using RT-PCR, we detected procalcitonin mRNA in the total ovary, specifically in the granulosa cells of the F1 and F2-4 follicles. Further analysis with real-time quantitative PCR revealed that the F1 follicle had a significantly greater amount of procalcitonin mRNA (P<0.05) compared with F2-F6 follicles and total ovary. To determine the influence of ovarian steroids on procalcitonin mRNA expression, sexually immature Leghorn chickens (16 wk old; n=8) were injected with estradiol (E2) and/or progesterone (P4). Quantification of total ovarian procalcitonin mRNA revealed a significantly greater expression with P4 treatment (P<0.05), while E2 and E2+P4 treatments decreased mRNA levels (P<0.05) compared to vehicle treated control chickens. Collectively, these findings indicate that follicular maturation and ovarian steroids influence procalcitonin gene expression in the granulosa cells of the chicken ovary. We thereby speculate that progesterone, secreted by the F1 follicle, is responsible for the increased procalcitonin mRNA levels.

Key Words: procalcitonin, ovary, chicken

113 Spontaneously occurring fibroid tumors of the laying hen oviduct. A. L. Doernte*1, M. G. Conner2, M. N. Barnes2, S. H. Oates1, and W. D. Berry1, 1Auburn University, Auburn, Alabama, 2The University of Alabama, Birmingham.

Spontaneously occurring benign uterine leiomyomas (fibroids) are the most common tumors of reproductive age women. It is estimated that more than 70% of all women have uterine fibroids and the presence of these tumors is a primary cause of hysterectomies. Research into the causes and treatment of uterine fibroids is hampered by a lack of reliable animal models for the disease. Leiomyomas that appear to be outwardly similar to human uterine fibroid tumors are known to occur on the oviducts of laying hens over two years of age. The objective was to characterize these tumors and compare them to human uterine fibroids for the purpose of determining the suitability of the aging hen as a model system for the study of the disease. In this study, hens at 5 years of age were examined for the presence of oviduct associated fibroid tumors. Tumors were found attached to the internal surface of the oviduct, embedded in the oviduct wall, or attached to the exterior of the magnum and isthmus. Tumor and normal oviduct samples were frozen or fixed in formalin for histological analysis including immunohistochemistry for a qualitative analysis of estrogen and progesterone receptors, PCNA, Bcl-2, TGF-β3, IGFBP-5, and IGF-2. Human uterine fibroid samples were acquired and evaluated as a comparison to hen oviduct fibroids. The results demonstrated that laying hen fibroid tumors are similar to human fibroid tumors with respect to estrogen and progesterone receptors, localized cellular proliferation, and expression of the latter proteins.

Key Words: fibroid, avian model, immunohistochemistry

114 The effect of dietary supplementation of L-carnitine on reproductive traits of White Leghorns. W. Zhai*1, S. L. Neuman2, M. A. Latour1, and P. Y. Hester1, 1Purdue University, West Lafayette, Indiana, 2Guidant Corporation, St. Paul, Minnesota.

Previous work in our lab has shown that the inclusion of 125 ppm of carnitine into diets of roosters increased sperm concentration. The objective of the current experiment was to determine if the increase in sperm concentration observed in roosters consuming carnitine would culminate in improved hatch rates. Diets formulated to contain 0 and 125 ppm of carnitine were fed to male and female birds beginning at hatch until 37 wk of age. Feed analysis showed carnitine levels at hatch until 37 wk of age. Feed analysis showed carnitine levels at 1 and 143 ppm for control and supplemented diets, respectively. Eighty-four roosters were used with the semen of 2 roosters comprising an experimental unit. Using a 2 x 2 factorial arrangement, pools of semen from either control or carnitine supplemented roosters were artificially inseminated to each of 288 hens with 23.5 µL of semen weekly resulting in a mean insemination dose of 1.2 and 1.1 x 10^8 sperm/hen for carnitine and control hens, respectively. Data were analyzed using ANOVA with repeated measurements using the mixed
model procedure of SAS. Dietary carnitine as compared to control diets improved sperm concentration (5.3 and 4.8 × 10^6 sperm/mL, SEM = 0.1, P = 0.002), increased egg yolk carnitine concentration (16.3 and 12.7 nanomoles, SEM = 0.3, P = 0.001), decreased yolk weights (3.2 and 3.7 g, SEM = 0.1, P = 0.0001) at hatch, but had no effect on semen volume (0.49 and 0.50 mL SEM = 0.02, P = 0.87), and hatch of fertile (90% and 91%, SEM = 1, P = 0.47), respectively. It is concluded that supplementation of diets with L-carnitine improved the yolk carnitine concentration, decreased the yolk weight and improved sperm concentration, but did not result in a subsequent improvement in hatch rate most likely due to the high numbers of sperm that were inseminated in both the control and carnitine fed hens.

Key Words: carnitine, semen, hatch

115 Broiler parent flock age influences embryonic metabolism.

This study examined the effect of broiler genetic strain (Ross 308 (R); Cobb 500 (C)) and parent flock age on eggshell conductance (G), and embryonic metabolism. The G on thirty hatching eggs from young (Y) (R and C=29 wk), peak (P) (R=34 wk; C=36 wk), and post-peak (PP) (R=40 wk; C=40 wk) flocks were calculated, then these eggs broken open to establish wet (W) and dry (D) yolk, albumen and shell content. Twenty eggs from the same flocks were weighed then incubated for 21.5 d in individual metabolic chambers. During incubation, O_2 consumption, CO_2 output and eggshell temperature were measured. Metabolic heat production (H) was calculated. Hatched chicks were euthanized, yolk sacs removed, and wet and dry yolk sac and carcass weights recorded. The data were analyzed using SAS® GLM with P≤0.05. Strain and flock age did not affect G. Wet and dry yolk, albumen, and eggshell percentages were not affected by strain. Wet and dry yolk fraction were higher in P (90.9±0.4%; D=15.5±0.3%) and PP (W=30.9±0.4%; D=15.5±0.3%) than Y eggs (W=25.8±0.4%; D=14.2±0.3%). But wet and dry shell contents were higher in PP (W=9.0±0.1%; D=8.9±0.1%) versus Y (W=8.7±0.1%; D=8.6±0.1%) and P (8.7±0.1%; D=8.5±0.1%) while wet albumen content was higher in Y (61.7±0.4%) than P (56.5±0.5%) and PP (55.4±0.4%) eggs. Strain did not affect O_2 consumption CO_2 output, eggshell temperature or heat output. Embryos from Y produced more heat (88.3±1.9mW) and consumed more O_2 (915.6±19.4ppm) than embryos from P (H=74.4±2.1mW; O_2=818.5±20.7ppm) or PP (H=75.9±1.7mW; O_2=769.5±18.3ppm). Output of CO_2 was higher in Y (529.5±12.2ppm) or P (561.7±12.6ppm) embryos than PP (522.3±11.9ppm) embryos but Y and PP were not different. Chick weights were heavier in R (48.4±0.2g) than C (47.2±0.2g). Wet and dry yolk sacs were heavier in PP (W=8.7±0.2g; D=4.8±0.1g) than Y (W=8.1±0.2g; D=4.1±0.1g) or P (W=8.3±0.2g; D=4.4±0.1g) chicks but Y and P wet yolk sacs did not differ. These results show that embryonic metabolism was affected by flock age but not strain. Future trials should be aimed at examining embryos from older flocks and different breeder strains.

Key Words: broiler genetic strain incubation, eggshell conductance, embryo metabolism

116 Expression of the mRNA for zona pellucida proteins A, B2, and X in two genetic lines of turkey hens that differ in fertility.
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The freshly ovulated ovum in avian species is surrounded by a protein layer called the inner perivitelline layer (IPVL), which is equivalent to the zona pellucida in mammals. For successful fertilization, sperm must attach to and penetrate the IPVL. The IPVL contains the zona pellucida family of proteins and members of this family have been shown to possess sperm binding activity and to stimulate sperm penetration of the zona pellucida. In the domestic chicken six distinct zona pellucida genes have been characterized (ZPA, ZPB1, ZPB2, ZPC, ZPD and ZPX). Previously our laboratory characterized the mRNA expression of ZPB1, ZPC, and ZPD by Northern blot analysis in two lines of turkey hens selected for over 40 generations for either increased egg production (E) or increased body weight (F). In the present research, the expression of the mRNA for ZPA, ZPB2, and ZPX was investigated in these two lines of turkey hens.

Individual granulosa layers were isolated from the F₁ to F₄ follicles of 64-8 wk old hens from each genetic line. In addition, a 1 cm² section of the granulosa layer around the germinal disc (GD) and a nongermineral disc (NGD) area of the F₁ and F₂ follicles was isolated from 12 hens from each line. Total RNA was extracted and DNase treated for two step real-time PCR analyses of ZPA, ZPB2, and ZPX. Taqman minor groove-binding probes and primers for detecting ZPA, ZPB2, ZPX, and GAPDH (endogenous control) were designed with Primer Express based on turkey cDNA sequences for these 4 genes. Expression of ZPA, ZPB2, and ZPX was detected in all follicle sizes. No significant differences in ZPA and ZPX mRNA expression were detected between the GD and NGD areas. However, the expression of the mRNA for ZPB2 was significantly greater in the GD area when compared to the NGD area in F₁ and F₂ follicles from both E line and F line hens. The results suggest that higher expression of ZPB2 in the germinal disc area may be important for the preferential binding of sperm to this region of the IPVL.

Key Words: zona pellucida proteins, turkeys, fertility

117 Effect of season, hatch time, and post-hatch holding on glycogen status of turkey poults.
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Post-hatch survival and development of poults is dependent upon their glycogen reserves. The effects of season and hatch time on the glycogen status of neonatal turkey poults and subsequent recovery of glycogen reserves were studied in three commercial North Carolina hatcheries. During summer (September) and the following winter (February), poults were identified by color marker on their heads as hatched at 636, 648, 660, and 672 h of incubation. At 672 h (hatch pull), fifteen poults from each hatch time were randomly selected, euthanized by CO₂ and chilled on ice. Tissue (whole breast muscle, pipping muscle and liver) was collected and frozen for later analysis. Another 15 poult sample hatched at the aforementioned times was processed and held for 24 h prior to similar tissue sampling. Ten embryos from each hatchery were also sampled at 600 h of incubation.
to serve as a reference point for this study. All tissue samples were weighed and sub-sampled for glycogen analysis. Liver glycogen (3.1 mg/g liver or 2.8 mg total) and breast glycogen (2.3 mg/g, 3.7 mg total) were 2 and 1.2 times higher, respectively, in the winter than in the summer (P<0.0001). Only during the winter did hatch time affect glycogen status. Total glycogen levels in liver and breast were 3.4 and 1.3 times higher, respectively, among poult's hatched at 648 h than those hatched at 636, 660 or 672 h. Post-hatch holding played a significant role in the recovery of glycogen in breast muscle in winter and in liver glycogen in summer, however total breast glycogen decreased 1.35 fold during the holding period in the summer. These results demonstrate that hatch time and season influence glycogen reserves, possibly affecting early poult survival.

Key Words: turkeys, hatch time, glycogen

118 Incubation temperature and eggshell conductance effects on the intestinal maturation and thyroid function in commercial turkey poult's hatching from a first cycle flock. S. L. Funderburk*, V. L. Christensen1, G. G. Campbell2, M. J. Wineland1, J. L. Grimes1, K. M. Mann1, E. R. Neely1, D. T. Ort1, D. V. Rives2, and J. P. McMurtry3, 1North Carolina State University, Raleigh, 2North Carolina State University, Raleigh, 3USDA-ARS, Beltsville, Maryland.

Eggshell conductance (G) and egg weight (EW) affect poult viability. Poor livability may be related to intestinal maturation and thyroid function of the neonate. The objectives of this study were to test if incubator temperature and G determine poult maturity among egg from a young turkey flock. Maturation was assessed by measuring body weight (BW), feed per gain, jejunal maltase (M) and alkaline phosphatase (ALP) activities and thyroid function of commercial turkey poult's. Eggs from a first cycle flock (new), mean EW 83.47 g, were weighed, numbered, set and incubated under standard operating procedures in a commercial turkey hatchery. Eggs were incubated under a high temperature profile (HP) and under a low temperature profile (LP). All eggs were reweighed at 25 d and G was calculated. The eggs were then sorted into three groups: high, average, and low G. At hatch poult's were identified by G group and incubation profile. Poult's from each experimental group were placed in battery brooders and grown for 7 d and BW and feed consumption were measured at days 1, 3, and 7. At days 1 and 3 posthatching blood and intestinal samples were taken from each G group and incubation profile. Data were analyzed using the GLM procedure of SAS. Poult's incubated under the HP showed increased jejuna weight, M, ALP and T3 compared to LP poult's. High and average G poult's showed greater jejuna ALP, BW gain and decreased feed per gain compared to low G poult's. Males incubated at HP with high G had higher M than average and low G males at HP. Females incubated at HP with an average and low G had greater M than high G females at HP. The greatest BW can be seen among HP males with average G and HP females with high G. Incubation profile interacted with G to affect weight, ALP and thyroid activities among poult's from a recycled flock. Thus, incubation profile and G may be managed to improve poult maturity.

Key Words: conductance, maltase, thyroid

119 Incubation temperature and eggshell conductance effects on gastrointestinal and thyroid function in commercial turkey poult's hatching from an induced molted flock. S. L. Funderburk*, V. L. Christensen1, G. G. Campbell2, M. J. Wineland1, J. L. Grimes1, K. M. Mann1, E. R. Neely1, D. T. Ort1, D. V. Rives2, and J. P. McMurtry3, 1North Carolina State University, Raleigh, 2Prestage Farms, Clinton, North Carolina, 3USDA-ARS, Beltsville, Maryland.

Eggshell conductance (G) and egg weight (EW) affect poult livability. Poor viability may be related to intestinal maturation and thyroid function of the neonate. The objectives of this study were to test if incubator temperature and G determine poult maturity. Maturation was assessed by measuring body weight (BW), feed per gain, jejunal maltase (M) and alkaline phosphatase (ALP) and thyroid function of commercial turkey poult's. Eggs from an induced molted flock (recycled), mean EW of 92.55 g, were weighed, numbered, set and incubated under standard operating procedures in a commercial turkey hatchery. Eggs were incubated using a high temperature profile (HP) and a low temperature profile (LP). All eggs were reweighed at 25 d and G was calculated. The eggs were then sorted into three groups: high, average, and low G. At hatch poult's were identified by G group and incubation profile. Poult's from each experimental group were placed in battery brooders and grown for 7 d and BW and feed consumption were measured at days 1, 3, and 7. At days 1 and 3 posthatching blood and intestinal samples were taken from each G group and incubation profile. Data were analyzed using the GLM procedure of SAS. Poult's incubated under the HP showed increased jejuna weight, M, ALP and T3 compared to LP poult's. High and average G poult's showed greater jejuna ALP, BW gain and decreased feed per gain compared to low G poult's. Males incubated at HP with high G had higher M than average and low G males at HP. Females incubated at HP with an average and low G had greater M than high G females at HP. The greatest BW can be seen among HP males with average G and HP females with high G. Incubation profile interacted with G to affect weight, ALP and thyroid activities among poult's from a recycled flock. Thus, incubation profile and G may be managed to improve poult maturity.

Key Words: conductance, maltase, thyroid


Broiler growth modeling is usually done using average body weight data over certain periods of time for specific strain of birds under given management conditions. Such growth curve data are then analyzed for its underlying distribution and for predictions either with mathematical models, like Gompertz or nonlinear statistical models that fits the data best. Constant selection in genetic pool, nutritional factors and environmental concerns however, make such models limited in their utility due to difficulty in fitting the growth curve across time, bird-strain and other determining variables. Moreover, generating data for every strain of birds under continually changing variables is not a feasible approach. The current model addresses two objectives: using simulation techniques to generate growth data, using published literature, on broilers for different growth periods; and use of artificial intelligence techniques rather mathematical-statistical approaches
Alternatives to electrical stunning of broilers before slaughter by exsanguination are being studied. Inhalation of inert gases has been proposed as a humane stunning method. High levels of carbon dioxide (CO2) with or without argon rendered birds unconscious, as evidenced by suppressed electroencephalograms (EEG), within 20-40 sec after onset of exposure. This method is proposed as an effective and humane method of stunning poultry. The present report is focused on evaluation of low atmospheric pressure as a method of slaughter of poultry. Market aged broilers (59 d) included in several experiments were fitted with electrodes which insured continuous monitoring of both EEG and electrocardiograms (ECG). Birds were placed in an air-tight decompression chamber (volume =83.3L) and pressures of 0.70 to 0.20 atmospheres (-228 to -608 mmHg vacuum) were achieved using a rotary vane vacuum pump with a flow rate of 16.9 m³/h. A PC-based data acquisition and control system was used to monitor tank pressure, control pump action, and receive telemeterized EEG and ECG signals. A signal decrease in EEG and ECG to at least 10% of peak signal voltage, and recumbency once the desired pressure within decompression chamber was reached was determined on each bird. The average times for these events were 32, 35 and 37 sec, respectively. All birds were maintained in the decompression chamber for 2 min. Immediately thereafter they were decapitated and a sample of blood was collected into a clean test tube. Blood clotting time was determined to be approximately 60 sec longer in birds killed by low pressure, as compared to those killed by cervical dislocation.

Key Words: electroencephalogram, electrocardiogram, stunning/ killing

123 Impact of age and time of portioning on tenderness of slittered broiler breast fillets. C. M. Owens*, A. Saha, V. S. Perumalla, and J.-F. C. Meullenet, University of Arkansas, Fayetteville.

Boneless breast fillets are often portioned into smaller pieces in order to create highly uniform products for foodservice operations and to maximize usage of breast fillets. Larger birds (>3.2 kg) are often used in this deboning market. The purpose of this study was to evaluate the effect of age on tenderness of slittered (horizontally cut) breast meat and the effect of time of portioning on tenderness. Two hundred forty broilers either 6 or 8 week of age (n=120 each) were slaughtered in an in-line system using a two stage chilling system, and carcasses were deboned at either 2 or 4 h postmortem. Boneless breast fillets were then horizontally cut (slittered) at either time of deboning or at 24 h postmortem to evaluate the effect of portioning time on tenderness. Whole and slittered fillets (top piece) were weighed. Tenderness was assessed by cooking slittered fillets to an internal temperature of 76 C and shearing using the MORS method. Whole and slittered fillets from 8 wk old birds were significantly heavier (P<0.05) than fillets (whole and slittered) from 6 wk old birds. The difference between the treatments of the slittered fillets was approximately 40 g. After cooking, the fillet height of the two treatments differed by less 3 mm (19 vs. 16.7 mm). Deboning at 2 h postmortem reduced tenderness compared to deboning at 4 h as indicated by the 2 h fillets having a significantly higher (P<0.05) MORS total energy than the 4 h fillets. Age impacted tenderness as well. The slittered fillets from the 8 wk

Key Words: gas stunning, slaughter
broilers had significantly higher (P<0.05) MORS total energy (tougher) than the 6 wk broilers. The time of slitting did not further impact tenderness as indicated by no significant differences between total energy values of fillets slitted at time of deboning or at 24 h. The results of this study suggest that age of broilers can impact tenderness of slittered/portioned breast meat. In this study, the deboning process impacted tenderness more than the secondary process of portioning.

**Key Words:** tenderness, portioning, breast meat


Marination is an increasing popular trend in the meat industry for meat quality enhancement. The purpose of this study was to evaluate and compare the effects different levels of salt in marinated poultry breast meat. A total of 100 broiler carcasses were deboned at 4h postmortem and breast fillets were marinated with one of 4 concentrations of salt: 0.5%, 0.75%, 1%, and 1.25%. All marinated treatments had 0.45% phosphate concentration. A non-marinated control was also included. Sensory evaluations of left fillets for juiciness, tenderness, salt intensity, flavor intensity, and overall impression were obtained on all treatments using hedonic and just about right scales. Instrumental tenderness analysis was conducted on right fillets using MORS method. Using the hedonic scale, there was no significant difference in the marinated products (0.5% to 1.25% salt) for overall impression, flavor, and texture. However according to the JAR scale, as the percentage of salt in the formulation increased (0.5, 0.75, 1.0, 1.25%), the percentage of consumers who considered the product as not salty enough generally decreased. The products with the higher concentrations of salt (1.0 and 1.25%) resulted in high percentages of consumers who considered the product too salty. For juiciness and tenderness, a large percentage (>70%) of the consumers considered 0.5%, 0.75%, and 1.0% treatments to be just about right. Additionally, consumers rated samples with salt concentrations of 1% and above as being too strong for overall flavor. Using instrumental tenderness analysis, salt concentrations above 1.0 % were more tender than other treatments; however, all marinated treatments were significantly more tender than non-marinated controls. These results indicate that differences exist among products marinated with varying concentrations of salt and may impact consumer acceptability of products.

**Key Words:** salt, sensory, marination


The purpose of this study was to evaluate the effect of carcass chilling methods on marination properties and tenderness of broiler breast fillets. A total of 90 broilers were slaughtered at 6 wk of age. Carcasses were either water-chilled (2 stage pre-chill/chill system) (WC) or air-chilled (AC), and deboned at 3 hrs postmortem to allow sufficient chilling of the AC carcasses. Fillets were tumble marinated in a 15% solution (0.75% salt and 0.5% phosphate, final concentration) at 24 h postmortem for 30 min. Water uptake of the RTC, drip loss of the boneless fillets, marination pickup and retention, cook loss, muscle pH and total energy of shear (MORS method) were measured. During the chilling process, the WC birds had a significantly higher percentage water uptake in the RTC carcass (4.08%) than the AC birds (-2.12%). Although carcasses had weight changes due to chilling, drip loss of the boneless breasts was not affected by chilling method as indicated by no significant difference in drip loss of fillets. Additionally, the chilling treatments did not affect marination properties; there were no significant differences between treatments in marination pickup, marination retention, or cook loss of fillets. The pH values measured at both 3 h and 24h postmortem were similar in both the treatments. Tenderness was not affected by chilling method as indicated by no significant difference between WC and AC in the MORS total energy of the marinated fillets. In this study, air chilling did not affect marination or tenderness properties of broiler breast fillets, producing similar results as the water chilling method.

**Key Words:** marination, water chilling, air-chilling


A research study was conducted to evaluate the cooking performance within a KOCH One-Truck MarketMaster™ Smokehouse. Broilers (R X 708 Males) receiving common feed and management were conventionally processed (n=216) and were randomly divided into two treatments: Fresh kept at refrigeration (4 C) and Frozen kept in a freezer (-10 C) until completely frozen (24 hr). The frozen treatment was then thawed for 48 hr. All carcasses were weighed and drip loss was calculated. The carcasses were brined overnight using a common formulation and repetitively weighed again to measure progression in yield. Birds were randomized among 3 cooking cycles and each cycle had 3 vertical blocks (Top, Middle and Bottom), a left and right block and a front and back block. The oven was evaluated for cooking uniformity by cook-loss, cooked breast yield, skin color of the cooked product and the color of the breast meat. All color was evaluated using a Hunter L*a*b* color system measured with a Minolta Colorimeter standardized to a ‘pink’ color plate. There were no differences found in the left and right blocks or the front and back blocks. There were differences in cook loss, Skin L* value and Skin a* value for the vertical blocks. For cook loss, the trend was Top>Middle>Bottom at the bottom of the oven was warmer than the top. The Skin L* values were greatest in the top and middle tiers of the oven which is equivalent to a lighter product. The bottom Tier had the lowest L* value corresponding to a darker color. For the Skin a* values, the top and middle tiers had the lower values and bottom tier had the highest value indicating more red color. Between the 3 oven cycles there were differences in cook loss, cooked breast yield, Skin L*a*b* values and Meat L*a*b* values. Variation in product location within the smokehouse for heat, air and smoke distribution can contribute to variation in product quality and lack of uniformity. Blocking to accommodate these differences provides additional dimension to source birds and preceding treatments.

**Key Words:** smoked, chicken, product uniformity, cook loss
127 Cathepsin activity in two commercial broiler chicken strains fed supplementary tryptophan. M. MacKenzie*,1, J. MacIsaac2, and B. Rathgeber1, 1University of Alberta, Edmonton, AB, Canada, 2Atlantic Poultry Research Institute, Truro, NS, Canada, 3Agriculture & Agri-Food Canada, Truro, NS, Canada.

Reduced protein functionality in breast muscle tissue has been shown to be associated with increased proteolytic degradation of important structural proteins in skeletal muscle. The group of enzymes believed to be responsible for this degradation is the cathepsins. To study this relationship it would be beneficial to have a natural source of variation for activity of these enzymes. A study was conducted to examine the variability of cathepsin activity in both sexes of two strains of commercial broilers. Additionally, dietary tryptophan was administered in attempt to reduce bird stress levels and influence the rate of postmortem proteolytic activity. Two strains of sex-separated broiler chickens were randomly assigned to 16 pens of 38 birds each and fed diets formulated to contain 0g/kg or 6g/kg of tryptophan above commercial levels. Birds were raised to 38 days of age and breast samples from 4 birds per pen were collected at 15 m postmortem and frozen in liquid nitrogen at a commercial slaughter facility. Levels of cathepsins B and L were determined using fluorescent substrates incubated in a microtitre plate reader. Results indicated the two strains differed in cathepsin activity. Strain A had a higher cathepsin B activity than strain B (P<0.001). The opposite effect was observed for cathepsin B + L activity (P<0.022). Dietary tryptophan supplementation increased activity of cathepsin B + L for both strains (P<0.036). However, tryptophan was not consistent in its effect on each sex. Strain A males fed the control diet had a lower level of breast muscle cathepsin L activity than strain B males which was not different when tryptophan was fed. When strain A females consumed excess tryptophan the cathepsin L activity was reduced compared to strain B. These two commercial broiler strains appear to be good candidates for studying the effects of cathepsin activity on postmortem muscle changes. The influence of tryptophan may be a useful tool to augment the utilization of these strains for muscle quality research. Additional studies will focus on the impact of cathepsin activity in relation to protein functionality and poultry meat quality.

Key Words: broiler chicken, cathepsin, tryptophan

128 Apple by-products as poultry feed ingredients. C. Ronalds*1, H. P. V. Rupasinghe1, and B. Rathgeber2, 1Nova Scotia Agricultural College, Truro, NS, Canada, 2Agriculture & Agri-Food Canada, Truro, NS, Canada.

Each year, industrial processing of apples in Nova Scotia results in the production of over four million kilograms of waste by-product in the form of peels, core, and pomace. Both the cost of disposal and the waste of the valuable antioxidant present in by-products are of concern to the agricultural sector. The objective of this research project is to study the feasibility of developing value-added poultry feed ingredients from apple by-products by evaluating broiler growth response to elevated levels of dietary inclusion. The long term objectives are to investigate the bioavailability of key apple phenolics and their potential inhibition of lipid oxidation of processed breast and thigh meat. A floor trial was conducted involving 608 commercial male broilers. Birds were randomly assigned to one of 16 pens and raised until 25 days of age on standard corn and soybean based starter and grower diets. The pens were randomly assigned one of four treatment finisher diets with the inclusion of dehydrated apple skin powder at the following levels (0%, 5%, 10%, and 15% (w/w)). These diets were formulated to be isocaloric and isonitrogenous based on results of a broiler digestibility study previously conducted to determine broiler utilization of nutrients from similar apple by-product. The birds in this study were raised from 25 to 36 days of age on treatment diets at which time they were weighed to determine growth performance. Statistical analysis revealed that the inclusion of dehydrated apple skin powder up to 15% of a balanced diet does not significantly (P>0.05) influence the broilers’ growth or feed efficiency (FE) (1806g, 2.16 FE) compared to control birds (1839g, 1.96 FE). Future studies will include the evaluation of incorporation of apple phenolics in broiler tissues and the potential development of other feed ingredients rich in apple phenolics.

Key Words: broiler chicken, apple phenolics, growth performance

129 Influence of dietary organic and inorganic chromium supplementation on lipid peroxidation and proteolysis in meat of heat-stressed broiler chicks. M. Toghyani*,1, M. Shivazad2, A. Gheisari2, A. Khodami2, and R. Bahadoran1, 1Islamic Azad University, Khorasgan Branch, Esfahan, Iran, 2Islamic Azad University, Science and Research Branch, Tehran, Iran, 3Esfahan Agricultural Research Center, Esfahan, Iran, 4Islamic Azad University, Khorasgan Branch, Esfahan, Iran.

In this experiment four hundred and twenty five-day-old male broilers (Ross 308) in heat stress condition (33 ± 3°C) were allocated to seven treatments with four replicates in a completely randomized design. Treatments were supplemented with 0 (control), 500, 1000 or 1500 ppb Cr in the form of chromium nicotinate and chloride as organic and inorganic sources respectively. At 42 days of age three chicks were chosen randomly from each replicate, killed and carcass and abdominal fat pad were removed, weighed and expressed as a percentage of live body weight. During two and six days of refrigerated storage (4°C) malonaldehyde (TBARs) and tyrosine value of breast and thigh meat were measured as indicators of lipid peroxidation (oxidative stability) and proteolysis of meat respectively. Chromium supplementation increased carcass yield and decreased abdominal fat pad (P<0.01). Storage time significantly increased lipid peroxidation and proteolysis of thigh and breast meat (P<0.01). TBARs value (mg malonaldehyde/kg meat) of thigh muscle for each storage time was higher than breast muscle (P<0.01). It was also found that increasing dietary chromium supplementation, especially 1500 ppb Cr, significantly decreased lipid oxidation and TBARs value of thigh and breast meat for 2 days of storage (P<0.05). On the 6th day of storage, dietary Cr supplement did not significantly decrease lipid peroxidation of breast and thigh muscles (P>0.05). The results of this experiment show that in heat stress conditions, supplemental chromium especially 1500 ppb nicotinate (organic chromium) lead to an increase of carcass yield, a reduction in abdominal fat pad and also improved oxidative stability of thigh and breast meat but had no effect on proteolysis of meat during refrigerated storage.

Key Words: broiler, organic and inorganic chromium, lipid peroxidation and proteolysis
The effect of Tasker Blue on aerobic plate counts and Escherichia coli counts on fresh broiler chicken carcasses. S. M. Russell*, The University of Georgia, Athens.

A study was conducted to evaluate the effect of Tasker Blue (sulfuric acid, ammonium sulfate, and copper sulfate) on aerobic plate counts (APC) and *Escherichia coli* (*E. coli*) counts on fresh broiler chicken carcasses. Two 55 gallon drums were filled with scald water (S), 2 with water from chiller 1 (CH1), 2 with water from chiller 2 (CH2), 2 with water from chiller 3 (CH3), and 2 with tap water (DIP) after 5 h of run-time in a commercial poultry processing facility. One of each of these pairs of drums was used as a control (C) and one was dosed with Tasker Blue (TB) to a pH of 2.0 and copper content of 2.0 ppm, except chiller water was dosed to a pH of 3.2 and a copper content of 2.0 ppm. S, CH1, CH2, CH3, and DIP exposure times for C and TB were 2 min, 17 min, 15 min, 45 min, and 10 s, respectively. Five carcasses each were exposed to C DIP or TB DIP as a post-chill dip. Five carcasses each were exposed to C S or TB S and C DIP or TB DIP. Five carcasses each were exposed to C S, CH1, CH2, CH3 and DIP or TB S, CH1, CH2, CH3 and DIP. After treatment, the carcasses were allowed to drip for 1 min, individually placed into sterile bags, packed on ice in coolers, transported to the laboratory, and evaluated for APC and *E. coli* counts. Two replicate trials were conducted. Log10 APC results for DIP were 6.29 and 5.15 for C and 2.13 and 2.48 for TB for Reps 1 and 2, respectively. Log10 *E. coli* results for DIP were 3.93 and 4.14 for C and 0.34 and 0.91 for TB for Reps 1 and 2, respectively. Log10 APC results for S and DIP were 4.86 and 4.79 for C and 2.51 and 2.53 for TB for Reps 1 and 2, respectively. Log10 *E. coli* results for S and DIP were 2.97 and 3.14 for C and 1.77 and 1.67 for TB for Reps 1 and 2, respectively. Log10 APC results for S, CH1, CH2, CH3, and DIP were 4.73 and 3.62 for C and 0.67 and 0.60 for TB for Reps 1 and 2, respectively. Log10 *E. coli* results for S, CH1, CH2, CH3, and DIP were 2.63 and 2.71 for C and 0 and 0.20 for TB for Reps 1 and 2, respectively. Tasker Blue, applied at various locations throughout the processing operation, dramatically and significantly (P≤0.05) lowered APC and *E. coli* on broiler carcasses.

Key Words: *E. coli* count, Tasker Blue, chicken
**T1** In ovo feeding of glutamine to chicks. A. A. Pedroso*, V. T. Barbosa, I. B. Maciel, C. E. Barbosa, and K. L. Martins, University of Goias, Goiania, Goias, Brazil.

An experiment was carried using 650 fertilized eggs. The eggs were identified, weighed, and allocated into five incubators regulated at 65% RH and 37.5°C. At the 16th incubation day, eggshells were drilled at the air chamber region and test solution was injected manually with a sterile syringe. The experimental treatments were: 0, 10, 20 and 30 mg of glutamine and a control group represented by intact eggs. The glutamine was dissolved in 200 ml of saline solution (0.9%) and deposited into amniotic liquid. The experiment consisted of five treatments with 130 eggs used in each treatment. Each egg represented an experimental unit. After inoculation, the eggs were packed individually in tulle and relocated into the incubators until hatch. Glutamine levels did not improve hatchability, chick:egg, and chick weight. Glutamine levels did not affect embryonic mortality, but embryos supplemented with glutamine hatched faster.

**Key Words:** embryos, chicken, amino acid

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Two broiler trials were conducted to evaluate the effect of dietary Glutamine or Glutamic acid on the growth performance with or without antibiotics. In the initial trial (EXP 1), 900 broiler chicks (Arbor Acres) at 0 d were allocated to one of six treatments with six replicates (25 birds per pen). The experimental diets consisted of either 1.0% Glutamine, 1.0% Glutamic acid or 1.0% L-Ala (nitrogen source) supplementation with or without antibiotics (CP 22.5%). Chicks were fed each experimental diet from 0 to 21 days of age, with body weight and feed intake per pen measured at 7, 14 and 21 days of age. Without antibiotics, body weight and feed conversion ratio were significantly improved by supplementation of 1.0% Glutamine and 1.0% Glutamic acid (P<0.05). When feeding antibiotics, there was no additional benefit of supplementing Glutamine or Glutamic acid in regards to body weight and feed conversion ratio. In the subsequent trial, 480 broiler chicks (Arbor Acres) at 0 d were allocated to one of five treatments with six replicates (16 birds per pen). Similar diets as in EXP 1 were used with 1.0% Glutamine, 1.0% Glutamic acid or 1.0% L-Ala supplementation without antibiotics, while antibiotic fed groups were only supplemented with 1.0% Glutamine or 1.0% L-Ala. Phases of the trial were as follows: CP 22.5% starter: d0-d21; CP 20.0% grower: d21-d42; CP 18.9% finisher: d42-d56. Chickens were fed experimental diets from 0 to 56 days of age, and measuring body weight and feed intake per pen weekly. Glutamine and Glutamic acid could not show any improvement in starter and finisher, but in grower, Glutamine supplementation could show the significant improvement (P<0.05) and Glutamic acid supplementation could show the tendency of improvement (P<0.20) under the condition without antibiotics. Therefore, these results suggest that Gln and Glutamic acid supplementation have possibility to improve growth performances as replacement of antibiotics in broiler chickens.

**Key Words:** Glutamine, Glutamic acid, antibiotics

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**T3** Dried porcine solubles (DPS) and coccidiosis vaccines on morphometric parameters in lower intestine. P. H. D. Tomasi and J. L. Andriguetto*, Universidade Federal do Paraná, Curitiba, Paraná, Brazil.

The objectives were to compare the effectiveness of two different coccidiosis vaccines and their effect on the intestinal morphometry of broilers, and to evaluate the interaction of dried porcine solubles, a source of peptides, on the intestinal parameters of the vaccinated broilers. Vaccines against coccidiosis cause a reaction on the mucosa of the small intestine decreasing performance. A vaccine made of attenuated oocysts (Paracox® - Schering Plough) was given to 1-day old chicks (active immunity), and a vaccine based on antigens isolated from gametocytes of Eimeria (Coxabic® - Abic) was given to the breeders, and the chicks were used in the trials (passive immunity). DPS was supplied, for the first 21 days, in an attempt to reduce the deleterious effects of the vaccines, as a source of peptides rich in glutamine (6%), in a 2 x 2 factorial design: T1(Paracox/DPS; n=420), T2 (Paracox only; n=420), T3 (Coxabic/DPS; n=420), T4 (Coxabic only; n=420). Animals were fed equal levels of energy, protein, and amino acids. On day 7, there was an interaction between type of vaccine and DPS in the vilus height (VH) and in the relation between vilus height and crypt depth (V:C) in duodenum and V:C in ileum. In these interactions, the use of Paracox resulted in a lesser VH and V:C, if compared against Coxabic, but DPS improved these parameters (P < 0.05). DPS, on day 7, increased VH in ileum (P < 0.05). On day 14, Coxabic produced better parameters in VH and V:C of duodenum, VH, crypt depth (CD) and V:C of jejunum and CD and V:C of ileum (P < 0.05). The use of DPS produced a bigger V:C in duodenum and jejunum (P < 0.05). At 21 days of age, the analysis of interactions showed that the use of Paracox resulted in a worse CD and V:C in jejunum and a worse VH in ileum and, with DPS these parameters were improved to the level of Coxabic (P < 0.05). DPS improved VH and V:C of duodenum, VH of jejunum and V:C of ileum (P < 0.05). To conclude, Paracox produced bigger intestinal lesions than Coxabic, but the use of DPS significantly decreased such lesions.

**Key Words:** DPS, intestinal morphometry, coccidiosis vaccine
T4  Efficacy of probiotic supplementation in broiler diets. J. Sánchez¹, E. Esteve-Garcia², D. Diaz², J. I. Fernández², and J. Peinado¹, ¹Imasde Agropecuario S.L., Madrid, Spain, ²IRTA, Spain, ³Norel S.A., Madrid, Spain.

Two experiments were conducted to evaluate the efficacy of a bacillary probiotic feed additive (Ecobiol®) containing 1 x 10⁹ CFU/g of Bacillus coagulans CECT 5940 on performance of broiler chickens. A randomized complete block design was applied in each experiment. The experimental design was applied to 308 Ross male broilers in both the starter (0-21d) and the grower (22-42d) phases, from day-old to slaughter at 42 days of age. In experiment I, there were four treatments, a basal diet (control), and three levels of inclusion of the bacillary probiotic: 10, 100, and 1,000 mg/kg, applied to 12 cage-pens of 12 broilers each. Mortality was considered normal (mean 4.3%) and was not affected by treatment. During the grower phase, probiotic supplementation improved feed to gain ratio (1.99 vs 1.97, 1.96, and 1.96 g gain/g feed, for control vs 10, 100 and 1,000 mg/kg, respectively; P ≤ 0.05). Improvements were also observed over the global period, and broilers supplemented with the probiotic converted better than control birds (1.80, 1.79, 1.78, and 1.78 g feed/g gain; for control, 10, 100 and 1,000 mg/kg, respectively; P ≤ 0.05). No differences were observed among the different doses. In experiment II, two experimental treatments with 12 floor-pens of 60 broilers each were used: 1) basal diet (control), and 2) basal diet with 1,000 mg/kg of probiotic, the recommended commercial dose. Mortality was considered normal (mean 4.5%) and was not affected by treatment. During the grower phase, probiotic supplementation improved feed to gain ratio (1.91 vs 1.88 g gain/g feed; P ≤ 0.05). For the global period, broilers supplemented with the probiotic converted better (1.85 vs 1.80 g feed/g gain; P≤0.01) and tended to eat less feed (102.7 vs 100.2 g/d; P < 0.10) than control birds. In conclusion, the data from these studies provide evidence that bacillary probiotic supplementation improves performance in broilers.

Key Words: bacillus coagulans, probiotic, broilers


Numerous investigations performed in animal models have shown repeatedly that prebiotics, such as inulin, oligofructose, stimulate mineral absorption, mainly calcium. The objective of this study was to determine the effect of oligofructose and inulin intake on calcium and phosphorus content in tibia bone of broiler chickens in growing in a commercial farm. A total of 30,000 1-day old male Ross broiler chickens were randomly allocated into two groups. The birds were fed a control diet or a control diet supplemented with oligofructose 2% (Raftifeed® OPS) from the chicken reception to 7-days- old chicks and inulin (Raftifeed® IPS) 0.1% from 8-days-old chicks to 42-days-old chicken.

A random sample (10 birds per treatment) was taken and culled by cervical dislocation at 1, 7, 14, 21, 28, 35 and 42 days of age to evaluate calcium and phosphorus content in bone. The inclusion of oligofructose and inulin improved calcium content in tibia bone by 18% on day 14, 7.8% on day 21 and 42 and in 5.7% on day 28 (P < 0.05). No significant differences were observed in phosphorus content. However inulin and oligofructose inclusion improved the molar Ca:P ratio of bone on day 7,14,21,28 and 42 (P < 0.05). These results indicate the inclusion of oligofructose and inulin improve calcium concentration in bone from growing broiler chickens.

Key Words: inulin, bone, calcium

T7  Effect of mannan oligosaccharides and enzymes on antibody titers against Gumboro. M. C. Oliveira¹, D. F. Figueiredo², D. E. Faria Filho², L. C. Cancherini², R. A. Gravena², and V. M. B. Moraes*², ¹Universidade de Rio Verde, Rio Verde, GO, Brazil, ²Universidade Estadual Paulista, Jaboticabal, SP, Brazil.

This study evaluated the effect of including mannan oligosaccharides (MOS) and/or enzymes in broiler diets on antibody titers against Gumboro disease. A total of 750 one-day-old Cobb male chicks with initial weight 41.51±0.59 g were used in the trial. The birds were distributed into a completely randomized experimental design in a 2 x 2 + 1 factorial scheme with two levels of MOS (0 and 0.1% until 21 days and 0.05% from 22 to 42 days of age), two levels of enzymes (0 and 0.05%) and a positive control diet with 125 ppm of colistin sulfate and 10 ppm of virginamycin as growth promoters and 51 ppm of salinomycin as anticoccidial, totaling five treatments and five reps. Enzyme contained cellulase, protease and amylase. Birds were obtained from flocks vaccinated against Gumboro at 14, 25 and 36 days and 10, 15 and 22 weeks of age. All vaccines contained live virus. The birds were vaccinated against Gumboro at 7 (attenuated live virus, Lukert sample) and 21 days of age (live virus, strong sample, strain V877), through drinking water. For serum analyses, blood samples were collected weekly through jugular vein puncture in two birds per replicate. The first and last collections were done at 7 and 42 days of age, respectively. Blood samples were centrifuged and serum was analyzed for antibody titers. There was no significant interaction (P > 0.05) between antibiotic and factorial (MOS and/or enzymes) or MOS and enzymes on antibody titers. The inclusion of MOS resulted in increased antibody titers against Gumboro in the 4th (P < 0.03) and 5th (P < 0.02) weeks. The titers in broilers fed MOS were 23.71 and

Key Words: mineral chelator, laying hen, egg quality

T5  Evaluation of a mineral chelate for late-cyle laying hens. J. L. MacIsaac*¹, D. M. Anderson², S. J. Butt², and B. Rathgeber¹, ¹Atlantic Poultry Research Institute, Truro, NS, Canada, ²Nova Scotia Agricultural College, Truro, NS, Canada, ³Agriculture & Agri-Food Canada, Truro, NS, Canada.

To determine the effect of a commercial chelated mineral product (Bioplex Poultry®) on the egg quality of late-cycle laying hens, 360 55 week-old Babcock White Leghorns were fed either a control diet (C) or a supplemented diet containing Bioplex Poultry® (BP). The BP was added sequentially at 4 week intervals in a completely randomized design with dietary treatment (C, BP 55 weeks (BP55), BP 59 weeks (BP59), BP 63 weeks (BP63) and BP 67 weeks (BP67)) as the main factor. Feed consumption, body weights and hen-day production were measured monthly and egg quality data was measured bi-weekly. BP had no effect (P > 0.05) on feed consumption, body weights or hen-day production. Hen-day egg production was 82.5%, 82.2%, 84.4%, 84.9% and 79.1% for C, BP55, BP59, BP63 and BP67, respectively. BP had no effect (P > 0.05) on egg specific gravity, egg weight, albumin height or percent egg shell. Egg specific gravity was 1.080, 1.081, 1.081, 1.082 and 1.081, while percent egg shell was 8.8%, 8.7%, 8.3%, 8.7% and 8.7% for C, BP55, BP59, BP63 and BP67 respectively.

For the late-cycle laying hens in this trial BP did not improve the eggshell quality.

Key Words: mineral chelator, laying hen, egg quality

T4  Efficacy of probiotic supplementation in broiler diets. J. Sánchez¹, E. Esteve-Garcia², D. Diaz², J. I. Fernández², and J. Peinado¹, ¹Imasde Agropecuario S.L., Madrid, Spain, ²IRTA, Spain, ³Norel S.A., Madrid, Spain.
8.76% higher, respectively during the 4th and 5th weeks, compared with birds of the other treatments. These results demonstrate the positive influence of MOS on the immune system of birds. It can be concluded that MOS was effective in stimulating the immune response against Gumboro vaccine virus.

**Key Words:** additives, immune modulation, prebiotic

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**T8** *Availa*®*Zn and *Availa*®*Mn improve performance and intestinal strength of broilers fed plant-based diets. S. Davis*, T. Cheng*, and T. Ward1, 1Colorado Quality Research, Wellington, Colorado, 2Zinpro Corporation, Eden Prairie, Minnesota.

A total of 882 Ross x Cobb 500 chicks were randomly placed into 49 pens and fed only plant-based diets. The treatments consisted of (1) Sulfates [100 ppm Zn from ZnSO4 and 110 ppm Mn from MnSO4]; (2) ISO 40 Availa-Zn [Availa-Zn zinc amino acid complex replaced 40 ppm Zn from ZnSO4]; (3) ISO 80 Availa-Zn [Availa-Zn replaced 40 ppm Zn from ZnSO4]; (4) + 40 Availa-Zn [Availa-Zn provided 40 ppm Zn on top of ZnSO4]; (5) ISO 40 Availa-Mn [Availa-Mn manganese amino acid complex replaced 40 ppm Mn from MnSO4]; (6) ISO 80 Availa-Mn [Availa-Mn replaced 80 ppm Mn from MnSO4]; and (7) + 40 Availa-Mn [Availa-Mn provided 40 ppm Mn on top of MnSO4]. Broilers from the ISO 40 Availa-Zn treatment had numerically heavier 56-day body (3.84 vs. 3.74 kg) and breast meat (0.69 vs. 0.68 kg) weights whiles those from the + 40 Availa-Zn treatment showed significantly (P < 0.05) heavier 56-day body (3.94 vs. 3.74 kg) and breast meat (0.72 vs. 0.68 kg) weights when compared to the Sulfate control. All manganese treatments showed numerically heavier 56-day body (3.79, 3.75, 3.83 vs. 3.74 kg) and breast meat (0.69, 0.69, 0.69 vs. 0.67 kg) weights when compared to the Sulfate control. Intestinal strength was numerically higher for birds from the + 40 Availa-Zn treatment when compared to the Sulfate treatment (0.046 vs. 0.036 kg). Broilers fed plant-based diets can benefit from Availa-Zn and/or Availa-Mn supplementation.

**Key Words:** zinc, manganese, broilers

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An 8 week trial was designed to determine the influence of sodium chloride drinking water supplementation on Hy-Line laying hens performance, egg yields and eggshell quality. Two hundred 40-week-old laying hens were allotted one of four treatments (controls, 0.4, 0.8 and 1.2 g of NaCl/L in drinking water) in a completely randomized design with five replicates and 10 birds per replicate. Birds were reared in bird cages. Diets were formulated to meet or exceed NRC recommendations. Water and feed were provided for ad libitum. Feed consumption was measured weekly while feed efficiency was calculated. Egg production, egg weight, and egg mass were recorded daily from 40 to 48 weeks of age. Random samples of 8 eggs from each treatment were collected weekly to measure egg yields, haugh units and eggshell quality such as egg specific gravity, eggshell thickness, eggshell breaking strength. Production parameters such as feed intake, egg production, egg weight, feed efficiency, body weight variation, and egg mass were not affected (P > 0.05). Eggshell parameters: Eggshell breaking strength, shell weight, eggshell thickness, and yolk percentage were not affected (P > 0.05). Haugh units and specific gravity were affected by treatments (P < 0.01). The results indicated that the HyLine hens were relatively insensitive to intakes of NaCl from drinking water at concentrations of 1.2 g/L.

**Key Words:** drinking water, eggshell quality, sodium chloride

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We evaluated the inclusion of fiber in the diet on productive performance of Cobb 500 broilers fed low–fiber diets from 1 to 21 d of age. There were six treatments and five replicates (a cage with 14 chicks) per treatment. The control diet was based on rice, fish meal, soy protein concentrate, yellow grease, and 3% of sepiolite and contained 3,095 kcal ME/kg, 1.31% total lysine, and 1.53% crude fiber. Three additional diets were formulated to be similar to the control diet but the sepiolite was substituted (wt/wt) by either oat hulls (OH), sugar beet pulp (SBP), or microcrystalline cellulose (CEL). There were two extra diets that were identical to the OH– or SBP– containing diets but in which the fiber source was ground to pass through a 0.5–mm screen instead of a 2.0–mm screen. Particle size of the fiber source did not affect any of the productive traits studied and no interactions of fiber source × particle size were observed. From 1 to 21 d of age, the inclusion of additional fiber improved average daily gain (ADG) (31.4 vs. 29.3 g; P < 0.05) and feed to gain ratio (F:G) (1.299 vs. 1.362 g/g; P < 0.01). Broilers fed OH had better ADG than broilers fed SBP with broilers fed CEL showing an intermediate growth rate (P < 0.01). The inclusion of OH or CEL in the diet increased feed intake with respect to the inclusion of SBP (P < 0.05). Also, broilers fed OH had better F:G than broilers fed CEL with broilers fed SBP showing an intermediate value (P < 0.01). From 15 to 21 d of age, the inclusion of SBP in the diet tended to impair ADG (P = 0.06) and F:G (P = 0.06) with respect to the inclusion of OH. We hypothesize that fermentable fiber sources such as SBP might reduce feed intake and impair broiler performance late in the productive cycle but that insoluble fiber sources such as OH might be beneficial, especially during the first stages of life. Therefore, young broilers might have a requirement for a minimal amount of insoluble fiber in the diet.

**Key Words:** inclusion of fiber, particle size, broiler

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β-mannan is a non-starch polysaccharide found in soybean meal and may lower nutrient utilization in corn-soy diets fed to broiler chickens. The present study was conducted to evaluate the effects of 3 mannanase (MAN) products on the performance, N-corrected apparent metabolizable energy (AMEn) and excreta scores of broilers fed corn-soy diets that were marginal in metabolizable energy and amino acids. Each of the 3 MAN products was tested at 2 inclusion levels (MAN1, 100 and 1000 mg/kg; MAN2, 100 and 1000 mg/kg; MAN3, 20 and 1000 mg/kg) and compared with the unsupplemented...
diet. Each of the 7 dietary treatments was randomly assigned to 12 individually-caged birds and fed from d 7 to 28. Total excreta collection was carried out from d 24 to 27 for the determination of AME<sub>n</sub>, and excreta were scored daily during these 4 days for stickiness and wateriness on a scale of 1 to 5. MAN products had no effects (P > 0.05) on weight gain and feed intake, but significantly (P < 0.05) influenced feed/gain of broilers. Both inclusion levels of MAN1 and MAN2 caused improvements in feed/gain over the unsupplemented control, but the differences were significant (P < 0.05) only with MAN1 at 1000 mg/kg and MAN2 at 100 mg/kg. All 3 MAN products, irrespective of the inclusion level, increased (P < 0.05) the AME<sub>n</sub> values. Excreta scores of broilers tended (P < 0.10) to be lowered by supplemental mannanases. The present results suggest that b-mannanase supplementation may improve performance, energy utilization and manure quality of broilers fed corn-soy diets.

Key Words: β-mannanase, metabolizable energy, broilers


Thirty four week-old Cobb 500 females were fed 8 different diets for a 12 week period: basal (positive control), basal - B<sub>12</sub>, basal - riboflavin, basal - B<sub>12</sub>, basal - folic acid, basal - choline, basal - vitamin A; and basal without each of the test vitamins. The hatching eggs were collected after weekly AI with 50 million sperms. The isotopic tracers, [2,3,3-<sup>H</sup>]-L-serine, [2,3-<sup>H</sup>]-L-betaine and [L-<sup>13</sup>C]-L-methionine were administered as a single bolus dose by amnion routine injection into 18 day-old chick embryos from breeders after 12 weeks feeding with positive control, missing folic acid or B<sub>12</sub>-missing diets. Six chick embryos were killed at time 0, 30, 60, 120 min after injection, respectively. Hepatic amino acids concentrations and enrichments were investigated by using HPLC and HPLC/MS methods, respectively. The lack of B<sub>12</sub>, folic acid, B<sub>12</sub>, or riboflavin supplementation showed a significantly negative affect on hatchability (about 10% lower) within 1-4 weeks feeding prior to decreasing egg production about 10% in 5-8 weeks. Each of the test vitamins significantly increased egg weight with 1.5-2.0 gram, which was consistent with the previous observation that all nutrients tightly involved in methionine metabolism play a critical role in egg weight. About two fold elevation of hepatic homocysteine in chick embryos from breeders fed diets without added folic acid or B<sub>12</sub> indicated an impaired methionine metabolism. The peak area of M+0, M+1 and M+2 forms of free methionine significantly increased with time after isotopes were injected suggesting the chick embryos was killed at time 0, 30, 60, 120 min after injection, respectively. Hepatic amino acids concentrations and enrichments were investigated by using HPLC and HPLC/MS methods, respectively. The lack of B<sub>12</sub>, folic acid, B<sub>12</sub>, or riboflavin supplementation showed a significantly negative affect on hatchability (about 10% lower) within 1-4 weeks feeding prior to decreasing egg production about 10% in 5-8 weeks. Each of the test vitamins significantly increased egg weight with 1.5-2.0 gram, which was consistent with the previous observation that all nutrients tightly involved in methionine metabolism play a critical role in egg weight. About two fold elevation of hepatic homocysteine in chick embryos from breeders fed diets without added folic acid or B<sub>12</sub> indicated an impaired methionine metabolism. The peak area of M+0, M+1 and M+2 forms of free methionine significantly increased with time after isotopes were injected suggesting the chick embryo can absorb and utilize methionine provided by amnion routine injection. [2,3-<sup>H</sup>]-methionine was not detectable suggesting remethylation via MHMT is the primary pathway of the two remethylation reactions. The findings in the present study may indicate that methionine metabolism has a critical role in breeder performance and thereafter chick embryonic development. Supplying enough vitamins in broiler breeder diets is necessary for optimal breeder performance, hatchability, and chick quality.

Key Words: vitamins, broiler breeder, isotopes, methionine metabolism


Whole grains can be offered to poultry in either a mix feeding (MF) system where the whole grain is added substituting part of the ground grain in a complete, pelleted diet or a free choice feeding (FCF) system where the birds have the choice to select the whole grain or protein concentrate offered in separate feeders. The present study was conducted to investigate the effects of feeding whole-wheat through MF or FCF on the performance and gizzard development in broilers. The following 3 treatments were employed: GW, ground wheat diet with 60-69% wheat; MF, GW diet with 49-50% wheat and 10-20% whole wheat; and FCF, whole wheat and protein concentrate offered in separate feeders. The GW diets and the protein concentrate were offered as pellets. Each diet was fed to six pens of 36 birds each from day 7 to 35. On d 35, 24 birds from each treatment were killed to obtain gizzard weights. No differences (P > 0.05) were observed in the weight gain, feed intake and feed/gain of broilers on the GW and MF treatments. Birds on the FCF treatment had the lowest (P < 0.05) weight gain and feed intake, and the highest (P < 0.05) feed/gain. During week 1, the protein concentrate was consumed more than the whole-wheat (69 vs. 31%), which led to the amount of concentrate offered being restricted during subsequent weeks. Over the trial period, the average consumption of protein concentrate remained high (56% of the total intake). Both whole wheat treatments increased (P < 0.05) the relative gizzard weights. Factors that affect diet selection such as learning and previous experience, visual differences between the foods, texture and, flavor of the food and palatability may explain the lower whole-wheat intake in the FCF treatment. In this study, whole wheat was introduced only on d 7 and it is possible that the birds may have to be trained to experience choice feeding from the first week of life. However, the present results appear to suggest that FCF may not be an appropriate feeding system for fast-growing modern broilers.

Key Words: whole wheat, free choice feeding, broilers


Two trials were conducted to determine the effect of different levels of an evolved thermo-tolerant phytase (Q, Quantum Phytase) on performance, nutrient retention and bone mineralization, using male Ross 308 broiler chickens. Trial 1 consisted of a 10-d battery pen trial (1 to 10 d of age) using four pens/treatment (8 b/pen) to determine the impact of adding Q to tibia mineralization, Ca and P absorption and retention from diets formulated to be at NRC (1994) non-phytin P (nPP) recommendations or below. Tibia ash wt (dry-defatted basis) in broilers fed the control (C) diet (0.45%) was similar (P > 0.05) to that of broilers fed diets containing 250 and 2500 U Q/kg (was 1.59, 1.80 respectively). Broilers fed the diet containing 2500 U Q/kg had higher (P < 0.05) ash weight than those fed the diet containing the same level of nPP (0.45%) but no added phytase. Tibia ash wt increased from 1.34 to 1.66g when birds fed a low nPP diet (0.33%) were offered Q at 250 U/kg (P < 0.05), with this enzyme treatment returning tibia ash wt to that of the C diet (0.45% nPP). The equivalency as calculated against P from monocalcium phosphate, of 250 U/kg
was 0.127 % nPP. Trial 2 (H to 45 d) was done to determine pelleting survivability, performance and bone ash, of two phytases [Q and R (Ronozyme (P) CT®)] in a floor pen trial (8 pens/Trt, 59 b/pen). An industry level of nPP was used in the control diets (C). This level was reduced by 0.12% nPP with no added phytase (NC) or with 250, 500, 1000 and 2500U Q/kg or 250 and 500 U R/kg in pelleted (80 to 85C) diets. Over the 45 d of the trial, broilers fed the Q1000 diets had similar gain as those fed the C diets (2.89 and 2.88 kg) and had the same feed conversion (1.75). Broilers fed the R500 diets performed similarly to those fed the Q250 diets but not as well (P<0.05) as those fed the Q500 diets. Femur ash wt was similar in birds fed the Q250 and R500 diets and higher (P<0.01) for those fed the Q500, Q1000, and C diets. Average pelleting survivability was 62.5 and 24.9% for Q and R, respectively. This study demonstrates there are differences in phytase sources and response in the bird.

Key Words: phytase, pelleting, broiler chickens


The long term feeding of conjugated linoleic acid (CLA) and fish oil on egg quality characteristics, production performance, liver pathology, plasma prostaglandins, tissue and egg fatty acid content of laying hens is investigated. Single comb white leghorn hens (n=112; 22 weeks old) were kept in cages and randomly assigned to four diets (28 hens/diet, 4 replicates of 7 hens) containing 3.0% yellow grease (control), 2.75% yellow grease +0.25% CLA (CLA-YG), 2.5% yellow grease + 0.25% CLA + 0.25% fish oil (CLA-FO), and 2.75% yellow grease + 0.25% fish oil (FO-YG). The CLA preparation consisted of cis-9, trans-11 and trans-10, cis-12 fatty acid isomers as free fatty acids in a ratio of 1:1. The diets were fed for eleven months. Eggs were collected every 28 days for 11 months. Feed consumption, hen day egg production and feed efficiency was monitored. At the end of the trial, blood, cardiac, hepatic and adipose tissues were collected. No effect of diet was found on feed consumption, hen day egg production, feed efficiency, egg weight, yolk weight, shell weight or haugh unit. The CLA-YG and CLA-FO diets produced an increase in CLA and saturated fatty acids in the adipose, heart and liver tissues and egg yolk with a concomitant reduction in monounsaturated fatty acids (P<0.05). Feeding CLA-FO and FO-YG increased the omega-3 fatty acids in egg yolk, liver and heart of hens. Incorporation of CLA was highest in CLA-FO eggs (4.2 mg per g fat or 21 mg per egg) (P<0.05), which is higher than that in ruminant-derived foods (3 mg CLA per g fat). No difference was observed in the number of fat vacuoles or total fat content of hepatic tissue in hens. Plasma prostaglandin E2 was lowest in FO-YG-fed hens (P<0.05). As the hens aged, egg weight and yolk weight increased significantly in all the diets (P<0.05). No difference was noticed in shell weight due to age. The current study demonstrates that "healthy" eggs with increased omega-3 fatty acids and CLA can be produced by minor diet modifications without affecting the production performance or health of birds.

Key Words: egg, conjugated linoleic acid, Omega-3 fatty acid

T16 Effect of different levels of pigment and sources of fat with or without enzyme on egg yolk color and performance of laying hens. F. Zaefarian*, M. Shivazad, and M. Abdollahi, Tehran University, Karaj, Iran.

An experiment was conducted to evaluate the effects of different levels of pigment in diets which contained three sources of fat, with or without enzyme on egg yolk color and laying hens performance. All of the diets were isocaloric and isonitrogenous. The experiment was arranged in a completely randomized design (CRD) with a 3×2×3 factorial trt arrangement. The experiment consisted of 18 treatments with three replicates containing 6 Hy-line W36 laying hens from 23 to 31 weeks of age. The treatments consisted of three basic diets contain sunflower oil, tallow or fatty acid with or without enzyme and three levels of pigments (0, 1100 rpm red pigment with 125 ppm yellow pigment, 1500 ppm red pigment with 225 ppm yellow pigment). The evaluation of different traits were measured daily or periodically. The main effect of pigment levels, enzyme and sources of fat and also their interaction on egg production, egg weight and feed conversion were not significant. Main effect of pigment, fat sources and enzyme for these traits were also not significant (P>0.05). The main effect of pigment level, enzyme and fat sources and also their interaction on blood cholesterol were not significant (P>0.05), but the differences between averages of the three fat sources was significant (P<0.05). Tallow with the average of 188.78 mg/dl had the highest and fatty acid with the average of 146.46 mg/dl had the lowest effect on blood cholesterol. The main effect of pigment and enzyme and also their interaction on egg yolk cholesterol was not significant (P>0.05), but main effect of fat on yolk cholesterol was significant (P<0.05). The effect of sunflower oil on yolk cholesterol was the highest and tallow was the lowest. Analysis of variance for main effect of pigment showed significant effect on yolk color in the first week (P<0.05). The significant effect of pigment continue until the end of experimental period. Main effect of enzyme on yolk colour was not significant (P>0.05), but the main effect of fat on yolk colour was significant (P<0.05).

Key Words: laying hen, pigment, yolk colour

T17 Effect of xylanase or xylanase, amylase and protease in combination with phytase on the nutritional value of a corn/soy-based diet for growing broiler chickens. A. J. Cowieson*, N. K. Sakomura2, N. A. A Barbosa2, and M. Hruby1, 1Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom, 2Faculdade de Ciências Agrarias e Veterinarias, UNESP, Jaboticabal, São Paulo, Brazil.

The aim of this work was to study the effect of a single xylanase or a combination of amylase, protease and xylanase with phytase in corn-soybean diets formulated with or without nutrient reduction on the nutrient ileal digestibility of broiler chicks. A total of 2400 day-old male broiler chicks were allocated to 6 treatments with 10 replicates of 40 chicks each. The experimental design was completely randomized arranged in a 2x3 factorial. The six diets consisted of two controls (Positive (PC)- without nutrient reductions and Negative (NC)- with nutrient reductions), each fed with or without one of two supplemental enzyme treatments. The combination of enzymes (Danisco Animal Nutrition) evaluated were: Phyzyme XP (phytase; P) with Avizyme 1505® (xylanase, amylase, protease; XAP) and Phyzyme XP with Avizyme 1310® (xylanase; X). Ileal digesta were collected at 42 days of age to determine digestible energy (ADE) and digestibility.
coefficients of protein (CPD), dry matter (DMD), calcium (CaD) and phosphorus (PD). There was no effect (P > 0.05) of enzymes or diet (PC vs. NC) for DMD. The XAP+Phy improved CPD (78.18%) compared to controls (76.03%) but the X+Phy did not elicit a response (77.06%). As expected, the ADE of the PC was higher (P < 0.01) than that of the NC. However, XAP+Phy or X+Phy did not improve (P > 0.05) the ADE of the NC but improved (P < 0.05) the ADE of the PC by 3.5% and 2% respectively resulting in a significant diet*enzyme interaction. There was no difference between PC and NC for Ca retention but a lower (P < 0.05) P retention in the NC compared with the PC. The X+Phy improved (P < 0.05) Ca and P retention in the NC but had no effect in the PC. The XAP+Phy improved (P < 0.05) P retention in the PC and NC but had no effect on Ca retention in either control diet. It can be concluded that there are differences in bioefficacy between X and XAP in corn/soy-based diets and the way that the two enzyme systems interact with phytase.

Key Words: enzymes, combination, digestibility

T18 Effect of xylanase or xylanase, amylase and protease in combination with phytase on corn/soy-based diet for growing broiler chickens. N. K Sakomura*, 1 N. A. A. Barbosa1, A. J. Cowieson2, and M. Kruby1, 1Faculdade de Ciências Agrárias e Veterinárias, UNESP, Jaboticabal, São Paulo, Brazil, 2Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom.

The aim of this study was to establish the effect of a single xylanase or a combination of amylase, protease and xylanase with phytase in corn-soybean diets formulated with or without reduction in energy, Ca and P concentration on the performance of broiler chicks. A total of 2400 day-old male broiler chicks (Cobb) were allocated to 6 treatments with 10 replicates of 40 chicks each. The experiment was conducted as a completely randomized design arranged in a 2x3 factorial. The six experimental diets consisted of two controls (Positive (PC)- without nutrient reductions and Negative (NC)- with nutrient reductions), each fed with or without one of two supplemental enzyme treatments. The combination of enzymes (Danisco Animal Nutrition) evaluated were: Phyzyme XP (phytase; Phy) with Avizyme 1505® (xylanase, amylase, protease; XAP) and Phyzyme XP with Avizyme 1310® (xylanase; X). The chicks fed NC showed lower (P < 0.01) feed intake, body weight and higher feed conversion than the PC. The addition of either of the two combinations of enzymes to the NC improved (P < 0.01) feed intake, body weight and feed conversion such that the birds fed on the NC with supplemental enzymes had a performance that was not statistically different from those fed on the PC. Supplementation of the PC with either enzyme did not elicit a significant response in terms of performance. It can be concluded that there are differences in bioefficacy between X and XAP in corn-soy-based diets and the way that the two enzyme systems interact with phytase. These results are likely to also depend on corn quality and it may be that, for some corns, X+Phy is sufficient to improve performance whereas for other corns XAP+Phy would yield a more consistent and larger effect. This may be related to rate and degree of starch degradation and protein quality of both corn and soybean meal.

Key Words: enzymes, combination, performance

T19 Effect of fructooligosaccharides and inulin on intestinal bacteria and pathogens in cecal contents from broiler chickens. F. Tuz-Dzib*, L. Reyes-Gonzalez, L. Garcia-Andrade, D. Ortega-Alvarez, L. M. Guerrero, and G. M. Ruiz-Palacios, 1National Institute of Medical Science and Nutrition, Mexico City, Mexico, 2MegaFarma, Mexico City, Mexico.

The colon of humans and animals harbors a complex microbial ecosystem that is essential for the well being of its host. Prebiotics, such as the blend of fructooligosaccharides plus inulin (FOS-I), are nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacterial species in the colon that can improve the hosts health. The aim of this work was to evaluate the effects of dietary administration of FOS-I on cecal microbial populations in broiler chickens. Broiler chickens were kept under standard commercial conditions in a poultry farm in Veracruz, Mexico. Flocks (15,000 birds) were randomly assigned to experimental (conventional diet supplemented with FOS-I) and control (without FOS-I) groups. After 6 wks, 10 birds in each group were sacrificed, cecal contents were collected and cultured, and selected microbial populations were enumerated by standards microbiological methods: Lactobacillus spp, Bifidobacterium spp, Escherichia coli and Campylobacter spp. Cecal bifidobacteria concentrations increased (p=0.007) in FOS-I fed birds compared with the control group. The experimental diet had no effect on concentrations of E. coli and Lactobacillus spp. Although not statistically significant, cecal Campylobacter populations (4.64 vs 3.19 log10 cfu/g, p=0.08) decreased 1.5-fold in prebiotics-treated birds. Addition of FOS-I to a commercial diet increased the density of bifidobacterial populations and may have the potential to improve the health and performance of broiler chickens under commercial conditions. Our data provide further evidence that FOS-I can stimulate the increase in bifidobacterial populations in birds grown under the stress of commercial conditions. Additionally, results suggest that FOS-I may be contributing to reduce shedding of Campylobacter spp, which is important to prevent transmission to humans and thus, decrease the risks to public health.

Key Words: bifidobacteria, campylobacter, prebiotics

T20 Effects of lipopolysaccharide dosage and injection frequency on broiler performance and organ weights. P. Sirimongkolkasem* and K. C. Klasing, University of California, Davis.

Two experiments were conducted to investigate the effect of Salmonella typhimurium lipopolysaccharide (LPS) dosage and injection frequency on male broiler performance and organ weights. In both experiments birds were fed diets formulated to contain 120% of NRC-recommended nutrient levels and were injected with LPS s.q. at 8 d of age (d0 of expt). Experiment 1 had a 3x2 factorial design with the main effects being LPS dose (1, 4 and 7 mg LPS/kg BW) and number of LPS injections (once on d0 or twice on d0 and d1). In experiment 2, a single LPS injection with 3 doses (0.1, 0.5 and 4 mg LPS/kg BW) was used to determine the effect of lower doses. Uninjected birds served as a negative control in both experiments. There was a significant decrease in average daily gain, feed intake and feed efficiency 24hrs after the first LPS injection in both experiments. The decreased performance was dose dependent, with the highest dose giving the largest depression. In experiment 1, a significant decrease in average daily gain and feed intake due to LPS persisted until d5, however, the dose dependent effect of LPS was not significant after d1. In experiment 2, the decrease
in gain and feed intake due to LPS injection was only observable for the first 24 hrs after injection. In both experiments, there was no difference in feed efficiency between LPS and control groups after d1. The second LPS injection did not impact the growth of the first injection on any parameters measured. 24 hrs after the first LPS injection an increase in the relative liver weight was evident in all treatment groups, whereas a decrease in the relative semitendinosus weight occurred only in those injected with 4 mg LPS. Neither the LPS dose nor the number of injections significantly affected relative organ weights. These results indicate that increasing LPS injection frequency does not prolong or increase its impact on growth performance while a high single dose (greater than 4 mg/kg BW) can prolong the depression in feed intake and average daily gain. Additionally, the dose dependent effect of LPS can only be observed for 24 hrs.

**Key Words:** LPS, broiler, dose

### T21 Comparative thermostability of phytase products in pelleted feeds.

N. E. Ward¹, D. Campbell¹, and A. Korshak², ¹DSM Nutritional Products Inc., Parsippany, New Jersey, ²DSM Nutritional Products Inc., Oerbaek, Denmark.

The stability of commercial phytase products is important to manufacturers of pelleted feeds. Different techniques are used to stabilize phytase products against the heat and moisture of feed milling, and not all are equally effective. Thus, two experiments at different locations determined the stability of phytase products when conditioned and pelleted in commercial type feeds. In Experiment 1 (Danish Tech. Inst., Kolding Denmark), four phytase products (Ronozyme P (CT), Phytase N, Phytase P, and Phytase Q) were pelleted in replicates at 75, 85, 90 and 95°C in wheat-based diets. Non-supplemented mash and pellets at each temperature were taken to adjust for wheat phytase. In Experiment 2 (Kansas State Univ., Manhattan KS), these phytase products were pelleted at 70, 80 and 90°C in corn/soybean meal diets. Conditioning was for 30 seconds in both experiments. The results for Experiment 1 are noted below. At the highest temperature (95°C), the 89% retention of Ronozyme P (CT) was superior (P < 0.05) to all other phytases, followed by 62% for Phytase N, 5% for Phytase P, and 9% for Phytase Q. The superior survivability (P < 0.05) of Ronozyme P (CT) was consistent across all temperatures. Phytase N retention was greater (P < 0.05) than for Phytase P and Phytase Q, while the latter two did not differ across (P > 0.05). Experiment 2 mirrored the results of Experiment 1, but with lower retentions across all phytase products. At 90°C, the retention for Ronozyme P (CT) was highest (75%), followed by Phytase N (34%), Phytase Q (8%) and Phytase P (5%). As pelleting temperature increased, the decrease in phytase survivability was precipitous for Phytases N, P, and Q, as opposed to Ronozyme P (CT). The thermo-stability of phytase products differed substantially. The decline in stability with increased pelleting temperatures was gradual for Ronozyme P, and hence, is less likely to be affected as pelleting temperatures fluctuate throughout the day or across seasons in commercial feed mills. Further, these data confirm previous work that the stability of phytase products may not be the same across different pelleting systems due to inherent characteristics of these systems.

**Table 1. Pelleting Retention (%) of Phytase Products**

<table>
<thead>
<tr>
<th>Phytase Product</th>
<th>75°C</th>
<th>85°C</th>
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<td>Phytase Q</td>
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Retention determined by comparing phytase level at each temperature with level in mash feed. 12 samples analyzed per temperature-phytase. P<0.05

**Key Words:** phytase, pelleting, stability

### T22 Production performance of Pearl Grey guinea fowl pullets fed diets with varying concentrations of dietary metabolizable energy and crude protein.

S. N. Nahashon*, N. Adefope, A. Amenyenu, and D. Wright, Institute of Agricultural and Environmental Research, Tennessee State University, Nashville.

This study was undertaken to assess dietary metabolizable energy (ME) and crude protein (CP) concentrations for optimum production performance of Pearl Gray guinea fowl replacement pullets. In a 3 x 3 factorial arrangement, 540 1-day old Pearl Gray guinea keets were randomly assigned to experimental diets with 2,900, 3,000 and 3,100 kcal of ME/kg of diet; each contained 20, 22 and 24% CP, respectively, from 0-8 wk of age (WOA). From 9-16 WOA, experimental diets had 3,000, 3,100 and 3,200 kcal of ME/kg of diet, and each contained 17, 19 and 21% CP, respectively. At 17-22, 23-27 and 28-56 WOA all experimental birds were fed the same diet at each age period and the diets contained 3,000, 2,900 and 2,800 kcal of ME/kg of diet, respectively. These diets had 18, 17 and 16% CP, respectively. Each dietary treatment was replicated 4 times, and feed and water were provided ad libitum. Body weights were measured weekly from hatch to 22 WOA and at 28-56 WOA the experimental birds were observed for feed consumption (FC), hen-day egg production (HDEP), egg weight (EW), egg mass (EM), feed conversion ratio (FCR), internal egg quality (IEQ), shell thickness (ST) and body weight (BW) at the end of each 28 day lay period for 7 consecutive periods. Mortality was recorded as it occurred. Overall, BW gains were significantly higher (P < 0.05) in birds fed 3,000 and 3,100 Kcal of ME/kg of diet and 24% CP from 0-8 WOA than other dietary treatments. Percent HDEP, EM and IEQ were higher (P < 0.05) and FCR was lower (P < 0.05) in birds fed 3,000 and 3,100 kcal of ME/kg of diet than those on 2,900 kcal of ME/kg of diet at 0-8 WOA. Birds on 22 and 24% CP diets also exhibited higher HDEP, EM and lower FCR than those on 20% CP diets. However, differences in mean EW, BW and ST were not significant (P > 0.05) among dietary ME and CP concentrations. Thus, feeding 3,000-3,100 Kcal of ME/kg of diet and 22-24% CP at 0-8 WOA; and 3,100-3,200 Kcal of ME/kg of diet and 19-21% CP at 9-16 WOA improved HDEP, EM, IEQ and FCR of Pearl Gray guinea fowl laying pullets at 28-56 WOA.

**Key Words:** pearl gray guinea fowl pullets, metabolizable energy, crude protein
T23 Keratinase supplementation in the soybean and cottonseed meal containing diet improves growth performance and nutrient digestibility of broiler chickens. H. Y. Wang1, Y. M. Guo*, and J. C. H. Shih2, 1China Agricultural University, Beijing, China, 2North Carolina State University, Raleigh.

Effects of bacterial keratinase (KE) on growth performance and nutrient digestibility were studied in broiler chicks fed diets with soybean meal (SBM) and cottonseed meal (CSM) as the main protein sources in a 2 x 2 factorially arranged experiment. Four different diets were formulated: soybean meal diet (S), S plus KE (SK), cottonseed-soybean meal diet (C) in which 50% of SBM was replaced by CSM, and C plus KE (CK). The crude preparation of KE, or VersazymeTM, was added at 400,000 EU or 1 g/kg feed. The supplementation of KE birds significantly improved body weight (BW) at age 21 d by 8% (S vs. SK) and 10% (C vs. CK) (P<0.05). During the whole growing period, the presence of KE always significantly reduced feed conversion rates (FCR) (P<0.01). KE also helped reduced mortalities of the birds: 4.79% (S) vs. 4.11% (SK) and 5.29% (C) vs. 4.98% (CK). As expected, protein digestibility was significantly improved by KE in diets (P<0.01). They were 58% (S) vs. 69% (SK) and 54% (C) vs. 64% (CK). To explore the possible mechanism of the beneficial effect of KE, the digestive enzymes and intestinal morphology were studied. The activities of amylase and trypsin in broilers fed SBM or CSM diet tend to be improved by KE in different growth periods. The 2X increase of chymotrysin activities by KE supplement in both kinds of diets and both ages is interesting. Microscopic examinations of the small intestine including the sections of duodenum, jejunum and ileum were conducted. It is of great interest that KE supplementation appeared to stimulate the growth of villi in the lumen at age 21 d, but not in older birds at 42 d. In conclusion, dietary supplementation of KE has beneficial effects on growth performance and nutrient digestibility in broilers. The positive effects on intestinal digestive enzymes and intestinal development warrant further studies. In the presence of KE, the replacement of 50% SBM with CSM caused no negative effect on broilers. It is possible that KE can elevate the nutritional value of some less digestible protein source, in this case, CSM.

Key Words: keratinase, cottonseed meal, broiler chicks


The objective of this study was to evaluate the developmental gene expression of nutrient transporters in the small intestine of chicken lines that had undergone long term selection for high (HH) or low (LL) 8-week body weight and the reciprocal crosses (HL and LH). Nutrient transporters investigated were the peptide transporter PepT1, amino acid transporter EAAT3, and monosaccharide transporters GLUT5 and SGLT1. Chicks were reared in batteries with ad libitum access to feed and water. Chicks were weighed and killed on embryonic day 20 (e20), day of hatch (DOH) with no access to feed), and days 3, 7, and 14 post hatch. Duodenum, jejunum, ileum and liver were collected. DNA extracted from liver was used to sex birds by PCR. RNA was extracted from the intestinal segments of four males from each line and time point except e20 HL (n=3). Expression of nutrient transporters was assayed by real time PCR using the relative quantification method. All genes were induced on DOH relative to e20 in all lines. A line difference in PepT1 was seen with populations with L sires. Lines with L sires (LL and LH) had greater PepT1 RNA expression than lines with H sires (HH and HL) (P<0.01). Expression of PepT1 RNA (P<0.01) and EAAT3 RNA (P<0.01) were greatest in the ileum. Expression of SGLT1 RNA (P<0.01) and GLUT5 RNA (P<0.01) were greatest in the distal intestine. These results show that long term selection for high or low body weight in chickens has had little impact on developmental gene expression of EAAT3, GLUT5, and SGLT1 between the selected lines and the reciprocal crosses. In contrast, developmental gene expression of PepT1 was impacted.

Key Words: chicken, intestine, nutrient transporters

T25 The effects of dietary copper source and concentration on chick growth, tissue copper concentrations, mucosal copper and iron mineral transporters and copper excretion. J. H. Skaggs*,1, M. E. Persia1, B. D. Humphrey2, and W. W. Saylor2, 1University of Delaware, Newark, 2University of Maryland, College Park.

An experiment was conducted to determine the effects of Cu source and concentration in corn-soybean meal diets fed to male broiler chicks from 7-21d. The seven dietary treatments included: basal diet (no added Cu; B); B + 25 mg/kg inorganic (IN) Cu from CuSO4·5H2O (25IN); B + 25 mg/kg organic (OR) Cu from BioplexTM Cu 10% (25OR); B + 100 mg/kg IN Cu (100IN); B + 100 mg/kg OR Cu (100OR); B + 250 mg/kg IN Cu (250IN); and B + 250 mg/kg OR Cu (250OR). Male Ross 708 chicks were weighed, wing banded and assigned to one of the seven diets. Chicks were housed 4 birds per pen with 8 replicate pens for the B, 25IN and 25OR diets and 6 replicate pens for remaining diets resulting in 192 total birds in 48 pens. Performance data were collected over the 7 to 21 d period. Excreta were collected from 15 to 21 d. On d 21, chicks were bled via heart puncture before being euthanized for collection of liver and duodenal mucosa. Cu concentration was determined in plasma, liver, mucosa and excreta samples. Mineral transporter mRNA abundance was quantified in mucosal samples. Body weight gain and feed intake of birds fed the 250OR diet were 14% lower (P<.0001) than that of birds fed the basal diet. Birds fed 250IN and 250OR diets had 61% and 92% higher (P<.0001) liver Cu concentrations, respectively, than those fed the basal diet. Total excreta Cu increased (P<.0001) with increasing dietary Cu. The OR diets resulted in a 21, 37, and 28% increase in Cu excretion for dietary inclusions of 25, 100, and 250 mg Cu/kg, respectively. Dietary Cu treatment had no significant effect on mRNA expression of mucosal transporters CTR-1, and DMT-1, and ATP7A. In this study, feeding 250 mg Cu/kg in the OR form resulted in growth depression that was not observed when the IN form was fed, and that could not be fully accounted for by reduced feed intake.

Key Words: broiler, copper, organic

T26 The effect of feeding quinoa on the Omega-3 PUFA contents of chicken eggs. N. P. Johnston*,1, G. Aduviri2, A. Parker1, R. Hall1, B. T. Slaugh3, and R. T. Davidson1, 1Brigham Young University, Provo, Utah, 2University of San Andres, La Paz, Bolivia, 3Eggland's Best, King of Prussia, Pennsylvania.

In recent years many findings have been published denoting positive health benefits to humans from the greater inclusion of omega-3 PUFAs in the diet. Since quinoa is a pseudo grain whose lipid fraction is reasonably high in alpha linolenic acid (ALA) (8.3%), an omega-3 PUFA (18:3 n-3), it was hypothesized that its inclusion in the diet of...
laying chickens would alter the omega-3 fatty acids levels of table eggs. To test the hypothesis fifteen Single Comb White Leghorn laying chickens were equally divided into three treatments according to the level of quinoa in the grain fraction of the diet (0%, 50%, 100%). Feeding commenced at 20 wks of age and continued for 16 weeks. At periodic intervals nine eggs were collected from each treatment and divided into three pooled replicate groups of three eggs each and analyzed for their omega-3 contents by gas chromatography. Replacing 50% of the corn with quinoa resulted in a significant (P<0.05) increase in the omega-3 content of eggs from 47.9 to 82.1 mg/egg. Replacing all of the corn with quinoa resulted in an additional increase (P<0.05) to 95.9 mg/egg. The respective levels of individual omega-3 PUFAs (ALA 18:3 n-3, EPA 22:5 n-3, DHA 22:6 n-3) were 0% quinoa - 12, 6, 26 mg/egg, 50% quinoa - 28, 6, 44 mg/egg and 100% quinoa - 38, 7, 47 mg/egg. Adding quinoa at both the 50% and 100% level resulted in progressive increase (P<0.05) in 18:3 ALA (12, 28, 38 mg), and an increase (P<0.05) in DHA 22:6 (26, 44, 47 mg) at 50% quinoa but no additional increase at 100%. Adding quinoa at either level did not alter EPA 22:5 (6, 7 mg) concentrations of the egg over the corn-based control. As hypothesized, a valued characteristic of quinoa feeding in lieu of corn is the substantial increase in omega-3 PUFAs egg content.

Key Words: quinoa, Omega-3, PUFA

T27 Bleed–out and mechanical carcass washing impact on chilled water color, pH, chlorine level and carcass bacteria. D. L. Brinson1,2, R. J. Buhr1, and J. K. Northcutt1, 1USDA-ARS, Russell Research Center, Athens, Georgia, 2The University of Georgia, Athens.

Commercial broilers were processed to compare the impact of slaughter and carcass washing treatments on chilling water characteristics including residual color (L* a* b*), pH, total chlorine, turbidity, and carcass bacteria populations. On each of two processing days, eight broilers were electrocuted and not bled and eight broilers were stunned-and-bled conventionally. All carcasses were triple-tank scalded, mechanically defeathered and eviscerated. Four of the electrocuted carcasses and four stunned-and-bled carcasses were washed in an inside-outside carcass washer. The remaining four from either treatment were not washed. All carcasses were chilled for two–20 min periods in ice (2 L) and water (2 L of 20 ppm total chlorine) using an individual bag chilling method. Postchill carcass rinsates were collected and evaluated for E. coli, coliforms, Enterobacteriaceae, and total aerobes. Colorimetric and spectrophotometric readings were used to assess residual chilled water color and turbidity. In addition, final pH and total chlorine were measured postchill. Rines of carcasses slaughtered by electrocution or stunned–and–bled did not differ significantly in post–chill bacterial populations. However, the levels of E. coli and Enterobacteriaceae recovered in carcass rinses were significantly lower from washed carcasses compared to those that were not washed, while numbers of coliforms and total aerobes were reduced by carcass washing. Chill water color and turbidity readings could not differentiate between carcass slaughter or washing treatments indicating similar residual water soluble proteins and suspended solids in the chiller water. For the first chill period, residual chlorine levels were lower for wash carcasses, but all other chill water characteristics were not significantly different between the slaughter or washing treatments. This study indicates that carcass bleed–out during slaughter had no affect on these chill water characteristics evaluated.

Key Words: bleed–out, carcass wash, chiller water color

T28 Nutritional composition of grilled and raw enhanced or non-enhanced chicken breast fillets. J. Kiker1,* J. Howe2, J. Holden2, C. Alverado1, J. Boyce3, A. Luna1, and L. Thompson1, 1Texas Tech University, Lubbock, 2Beltsville Human Nutrition Research Center, Beltsville, Maryland.

USDA Nutrient Database for Standard Reference for poultry products was last updated in 1979. Research was conducted to determine the nutritional value of enhanced (E) and non-enhanced (NE), raw or grilled breast fillets and to update the database. Two trials were conducted, forty fillets per trial were E by injection with a 0.6% NaCl and 0.4% sodium triphosphate solution and forty fillets were not E. Cooking losses in the E-grilled fillets (36.6%) were lower than in the NE-fillets (41.2%, P < 0.05). Percentage moisture was significantly higher in raw fillets (75.3%) than cooked fillets (E-grilled 67.7%, NE-grilled 65.8%, P < 0.05). LSMeans for percentage protein were greater in grilled fillets (NE-fillets, 31.8%; E-fillet, 28.1%) than raw fillets (NE-fillets, 22.2%; E-fillets, 19.9%). E-fillets had a higher ash content (cooked, 2.37 mg/100 g; raw, 1.8 mg/100 g) than NE-fillets (cooked 1.4 mg/100 g; raw, 1.1 mg/100 g). Fat content was lowest in E-grilled fillets (2.17%) compared to the other three treatments (three-mean average = 2.62%, P < 0.05). Sodium and phosphorus contents were significantly higher in the E-fillets (Na, 410.2 mg/100 g; P, 332.2 mg/100 g) than NE (Na, 157.5 mg/100 g; P, 263.01 mg/100 g). NE-grilled fillets had the highest K content (365.5 mg/100 g), followed by E-grilled (335.3 mg/100 g). Enhancement (7.26%) of fillets reduced cooking losses, increased moisture, sodium (166.2%) and phosphorus (29.9%) in the cooked product. Referring to this study, a 100-g serving of E-grilled breast fillet would provide 56.7% of the daily reference value (DRV) for protein, 3.33% (DRV) for fat, 18.63% (DRV) for sodium, and 37.4% of the reference daily intake (RDI) for P. In contrast, a 100-g serving of non-enhanced grilled fillet would provide 63.6%, 4.15% and 7.79% of the RDV for protein, fat and sodium, and 29.4% of the RDI for P.

Key Words: enhanced, flavor, protein, fat, sodium, K, phosphorus, E-Grilled, NE-Grilled

T29 Nutritional composition of two flavors of rotisserie chicken obtained from four regions of the United States. S. M. Mueller1, J. C. Howe2, J. M. Holden2, C. Z. Alvarado1, L. M. Boylan1, A. M. Luna1, D. B. Wester1, and L. D. Thompson1, 1Texas Tech University, Lubbock, 2Beltsville Human Nutrition Research Center, Beltsville, Maryland.

Nutrient data reported in the USDA National Nutrient Database for Standard Reference (SR) was last updated in 1979 and does not contain values for whole, ready-to-eat rotisserie chicken. The objectives of this study were to update this database, compare current (2004) rotisserie chicken composition results to those given for roasted chicken in the SR, and to compare the composition of rotisserie chickens from four regions of the United States. Retail locations in 12 states, three in each of four regions, were chosen for original flavor rotisserie chicken procurement. Chickens were dissected into breast, thigh, drum, wing, back, and skin, combined into location, regional, and national composites for each part, and analyzed for nutrient content. Total fat content was 3.5% in breast meat and 37.1% in skin, and did not significantly differ from the total fat content of roasted chicken reported in 1979 (P ≥ 0.05). Saturated fat content decreased in breast meat and skin from 1.01% and 11.42% to 0.84% and 9.99%, respectively. Polyunsaturated fat content was significantly higher in all parts than values reported in the SR. Cholesterol values were 88.9, 130.1, 140.6, and 159.9 mg/100 g for breast meat, thigh meat, skin, and drum meat, respectively, and were all significantly higher than values reported in
the SR. Sodium and phosphorus contents of all parts were significantly higher than those reported in the SR. Sodium content ranged from 336.7 mg/100 g in thigh meat to 417.0 mg/100 g in drum meat, and phosphorus content ranged from 216.5 mg/100 g in thigh meat to 256.9 mg/100 g in drum meat. This research indicates current rotisserie chicken is very different from roasted chicken in 1979.

T30 Comparative anti-bacterial activity of egg white protein extracts from domestic chicken, turkey, and goose. O. W. Labadie1, J. Picman1 and M.T. Hincke2, 1University of Ottawa, Ottawa, ON, Canada, 2Department of Cellular and Molecular Medicine, University of Ottawa, Ottawa, ON, Canada.

Egg white protein from the eggs of domestic chicken(Gallus gallus), turkey(Meleagris gallopavo), duck(Anas platyrhynchos) and goose(Anser anser) was evaluated in order to compare their food safety. A dozen fresh eggs from each species were washed with deionized water, cracked open and egg whites sampled. Samples were dialysed and lyophilized. Protein samples were analysed by SDS-PAGE, western blotting and antimicrobial assays. Lysozyme content was estimated from enzymatic activity measured by turbidity. SDS-PAGE revealed the presence of a 78kDa and 45kDa band, identified as ovotransferrin and ovalbumin by western blotting, in all species. C-type lysozyme (14 kDa) was present in chicken, turkey and duck egg white samples. The growth of B.subtilis was completely inhibited by all egg white samples (10mg/ml) regardless of the presence of 10mM sodium citrate/50mM sodium bicarbonate. Turkey egg white sample inhibited the growth of S. aureus and P. aeruginosa in the absence of salts. In the presence of 10mM sodium citrate/50mM sodium bicarbonate, chicken and turkey egg white samples inhibited the growth of S.aureus. In the presence of 50mM sodium citrate, all egg white samples inhibited the growth of P.aeruginosa while chicken, turkey and duck samples inhibited the growth of E.coli D31. At lower concentrations(300ug/ml), all egg white samples significantly reduced populations of B.subtilis.

Bactericidal activity was found to correlate with estimated lysozyme content, with chicken egg white showing the greatest bacterial reduction, as well as the highest lysozyme content, followed by turkey, duck and goose egg white. The egg white of the Galliformes(chicken and turkey) was found to possess greater antimicrobial activity than that of the Anseriformes. Interestingly, turkey egg white possessed the greatest bacteriostatic activity while that of chicken showed the greatest bactericidal activity. This study suggests that the Galliform egg is a safer product than the Anseriform egg due to more active ovotransferrin and higher levels of the broad specificity c-type lysozyme in the egg white. Supported by NSERC and PIC.

Key Words: albumen, antimicrobial, bacteriostatic


Avian Pathogenic Escherichia coli (APEC) encompass a division of pathogenic E. coli that cause colibacillosis in young turkey poults. Clostridium perfringens is an enteric bacterial pathogen and is the major contributing factor associated with necrotic enteritis in poultry. These two pathogen groups were studied and targeted for the development of a Bacillus-based direct fed microbial (DFM) product for turkey poults at a commercial turkey company in Iowa. One hundred and five turkey poults at various ages were collected during three samplings over four a month period. Gastrointestinal samples were plated on CHROMagar and Perfringens Agar Base for the enumeration of E. coli and Clostridium, respectively. Up to five colonies of each pathogen per bird were collected for further analysis. Multiplex PCR utilizing primers for the iss, tuaC, tsh, and cvc genes were used to identify APEC from the E. coli isolates. Clostridium perfringens was identified using a multiplex PCR reaction containing the four major toxin genes α, β, ε and iota. A total of 510 E. coli and 92 Clostridium were collected. Multiplex PCR identified 194 APEC isolates and 23 C. perfringens type A isolates. RAPD PCR analysis indicated that at a similarity coefficient of 80%, the 194 APEC isolates belonged to 34 clusters and the 23 C. perfringens type A isolates belonged to six clusters. Representative isolates from each cluster were used in a bacteriocin assay to select candidate Bacillus organisms for a DFM product. Six Bacillus subtilis strains were tested for their antimicrobial activity against 52 APEC and seven Clostridium perfringens type A isolates. Three of the six Bacillus strains showed the highest level of activity and the broadest spectrum by inhibiting 46 of the APEC isolates and four Clostridium perfringens isolates at greater than 50%. The 46 APEC isolates and the four Clostridium isolates represent 91.2% and 82.6% of their respective dendrograms. Future testing will incorporate these three Bacillus subtilis strains into a commercial product to determine its capability to control APEC and Clostridium within turkey poult production.

Key Words: E. coli, Clostridium, direct fed microbial

T32 Where molecular pathogenesis and NMR spectroscopy collide: An integrated approach towards the development of a CPS-based therapy for Campylobacter jejuni. D. J. McNally1, H. C. Jarrell1, M. Lamoureux1, R. A. Coleman*, A. V. Karlyshev2, B. W. Wren2, J–R. Brisson1 and C. M. Szymanski1, 1NRC Institute for Biological Sciences, Ottawa, ON, Canada, 2The London School of Hygiene and Tropical Medicine, London, United Kingdom.

The Gram-negative, spiral-shaped bacterium Campylobacter jejuni is one of the leading causes of bacterial gastroenteritis worldwide. As a result, there is intense effort to elucidate the virulence factors associated with this mucosal pathogen. Capsular polysaccharides (CPSs) are the outermost structure on the bacterial cell and therefore play key roles in the interaction between the pathogen and host as well as its environment. While the Neisseria meningitidis vaccine that is currently in use targets the conserved CPS structure of Group C organisms, for C. jejuni where at least 60 different CPS structures exist, there is no dominant structure associated with pathogenic strains. However, using high resolution magic angle spinning (HR–MAS) NMR, we identified a novel phosphoramidate (CH3O)N modification decorating C. jejuni C genes were used to identify a similarity coefficient of 80%, the 194 APEC isolates belonged to 34 clusters and the 23 C. perfringens type A isolates belonged to six clusters. Representative isolates from each cluster were used in a bacteriocin assay to select candidate Bacillus organisms for a DFM product. Six Bacillus subtilis strains were tested for their antimicrobial activity against 52 APEC and seven Clostridium perfringens type A isolates. Three of the six Bacillus strains showed the highest level of activity and the broadest spectrum by inhibiting 46 of the APEC isolates and four Clostridium perfringens isolates at greater than 50%. The 46 APEC isolates and the four Clostridium isolates represent 91.2% and 82.6% of their respective dendrograms. Future testing will incorporate these three Bacillus subtilis strains into a commercial product to determine its capability to control APEC and Clostridium within turkey poult production.

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Key Words: system biology, therapeutic, campylobacter


**T33**  **Novel method for rapid construction of Campylobacter jejuni deletion mutants.** C. Hansen* and Y. M. Kwon, University of Arkansas, Fayetteville.

*Campylobacter jejuni* is the leading bacterial agent of human foodborne gastroenteritis throughout the developed countries and poultry is the most common source of human infection by this pathogen. Recently various genetic tools have been developed and utilized to identify *C. jejuni* genetic factors required for colonization and virulence. One of the techniques essential to assess gene function is to construct a deletion mutant. Current methods depend on the construction of a suicide vector harboring a deleted target sequence and its use in subsequent transformation, which requires multiple steps of PCR and cloning. In an effort to simplify deletion mutant construction in *C. jejuni*, we used the extension-overlapping PCR protocol to amplify target gene sequence in which an internal fragment was replaced by an antibiotic cassette (chloramphenicol resistance gene). The resulting PCR product can then be introduced into electrocompetent *C. jejuni* to select for chloramphenicol-resistant mutants in which the wild type allele has been replaced by the PCR product. We used this novel approach to successfully construct *C. jejuni* 81-176 mutant with deletion in the Cj0618 gene. Since a transposon insertion in Cj0618 has previously shown to reduce cecal colonization in chicks, we will test the cecal colonization of the deletion mutant. This novel method should simplify the construction of *C. jejuni* deletion mutants and thus facilitate functional characterization of many *C. jejuni* genes.

**Key Words:** *Campylobacter jejuni*, deletion mutant, PCR

**T34**  **A survey on the hatchability of broiler and turkey eggs in the United States from 1985 through 2005.** T. Schaal* and G. Cherian, Oregon State University, Corvallis.

A survey was conducted to investigate hatchability of broiler and turkey eggs set in the US hatcheries from 1985 through 2005. A total of 11 billion broiler eggs and 343 million turkey eggs were set in 2005. This represents a 50% and 25% increase in the total respective number of broiler and turkey eggs set since 1985. However, hatchability during this period remained at 79 to 82% for broiler eggs and 76 to 80% for turkey eggs. The advancements in nutrition, genetic selection and management of broiler and turkey flocks that occurred during this period did not result in any increase in hatchability. Considering the selling price to farmers of day old broiler chicks at 0.21 dollars and day old turkey poult at 1.15 dollars, the losses associated with hatchability cost the US poultry industry over 500 million dollars in the year 2005.

**Key Words:** broiler chicks, turkey poult, hatchability

**T35**  **The efficacy of nipple drinkers and a direct-fed microbial on large white commercial turkey performance.** S. M. Russell* and J. L. Grimes, North Carolina State University, Raleigh.

Concern over the use of antibiotics has lead the poultry industry to find alternatives. PrimaLac® (Star Labs, Clarksdale, MO) is a direct-fed microbial (DFM) that contains viable *Lactobacillus/Streptococcus* sp. In the turkey industry, the use of nipple drinkers is being examined to enhance the growing environment. The objective of this study was to test the efficacy of nipple drinkers and DFM on turkey performance. A 2 by 6 factorial design was used (6 drinker types & 2 feed treatments): 1) control Plasson Minibell (T1), 2) Plasson Easy Start (T2), 3) Lubing Traditional (T3), 4) Lubing Easy Line (T4), 5) ValCo Turkey Drinker (T5), and 6) Ziggity, Big-Z Activator (T6). All drinkers remained in use through 18 wk except T3 changed to the T6 at 6 wk, and T6, changed to T1 at 14 wk. Typical turkey diets were formulated with and without PrimaLac®. Large White Hybrid Converter (Kitchener ON, Canada) hens (30/pen) were reared to 18 wk. Feed consumption (by pen) and BW were determined at 1, 3, 5, 6, 8, 10, 12, 14, 16, & 18 wk. Feed conversion (FC) was calculated. Data were analyzed using the GLM procedure of SAS, Inc, and LS Means procedure was used to separate treatment means (P≤0.05). There were no feed by drinker type interactions. Six wk BW of birds reared on T1 and T3 were higher than birds on T2 and T6 with T4 being intermediate. T3 yielded lower 6 wk BW compared to all other drinkers. There were no longer any differences in BW due to drinker type by 16 wk. BW was higher and FC was improved for birds fed DFM through 8 wk. The T2 had higher percent litter moisture beneath the drinker compared to all other drinkers with T4 being intermediate at 6 wk. We conclude that some nipple drinker systems are effective through the brooding period for turkeys with some systems being capable of carrying birds through to market age. We conclude that the direct-fed microbial used herein is a viable alternative candidate to dietary antibiotics for rearing turkeys.

**Key Words:** nipple drinker, turkey, direct-fed microbial

**T36**  **The influence of probiotics combined with mushroom extract on broiler chickens performance.** W. Willis*, O. Ishkuemhen, Z. Liu, and M. Johnson, North Carolina A&T State University, Greensboro.

A study was conducted to evaluate the effect of combined Shitake mushroom (Lentinus edodes) extract with probiotics (Primalac®) on the performance of broiler chickens. In trial 1, 540 day of hatch chicks were randomly assigned to six treatment groups, and replicated three times with 15 males and 15 females per pen for 3 wks. Dietary probiotics and mushroom treatments were as follows: 1) Control feed + ad libitum tap water; 2) Control feed + skip-a-day mushroom water; 3) Control feed + ad libitum mushroom water; 4) Probiotic feed + ad libitum mushroom water; 5) Probiotic feed + skip-a-day mushroom water. 6) Probiotic feed + ad libitum mushroom water. Body weight gain, feed consumption and efficiency, mortality, bursa, liver, and spleen relative weights of chicks were taken. In trial 2, the performance of broilers from 3 to 7 wks of age withdrawn from the mushroom extract was evaluated with ten males and ten females per pen from trial I. Mortality, weight gain, feed consumption and efficiency, carcass yield, fat pads and bursa weights were assessed. In trial 1, significant P<0.05 differences in female weight gain (trt. 4- 0.62 vs trt. 1- 0.54 kg) and male spleen weights were observed. In trial 2, significant differences were observed in male weight gain (trt. 2- 2.40 vs trt. 4- 1.12 kg), male and female fat pads, male bursa wts (trt. 3- 0.15 vs trt. 6- 0.39), female carcass yield percentage (trt. 1- 77.8 vs trt. 4- 65.5), and feed consumption and efficiency. Body weights were severely depressed in the male broilers receiving the probiotics feed in treatments 4, 5, and 6 but not in the females. These results indicate that differences in gender occur with additives during different grow-out periods in broiler production. It appears that probiotics and mushroom extract offered no combination potential because weight gain was compromised in this study.

**Key Words:** probiotics, broiler chickens, mushroom extract
**T37  Evaluation of drinking water or post-pelleting feed application of a Lactobacillus-based probiotic on broiler performance.** N. Eckert*, D. Hyatt, J. Lee, S. Stevens, P. Anderson, S. Anderson, and D. Caldwell, Texas A&M University, College Station.

The present investigation was conducted to evaluate the effects of either drinking water or post-pelleting feed application of a probiotic on broiler performance during a 48 day grow-out. The trial consisted of 1,000 straight run broilers placed in 40 pens. Broilers were placed on litter consisting of half used litter from a commercial broiler house and half fresh pine shavings. Feed and water were provided to all broilers ad libitum. Four treatments were used in this trial, including a non-treated control, continuous probiotic water application, intermittent probiotic water application, and post-crumble or pelleting feed application. Each experimental group had 10 replicate pens. All broilers were fed a standard corn-soy ration containing Coban-60® (90 grams per ton) in a four diet feeding program (starter, grower, finisher, and withdrawal). Drinking water application of probiotic was by a medicator system in place within the grow-out barn. An increase in body weight was not seen in association with any of the probiotic experimental groups as broilers in the probiotic groups had final weights similar to the broilers in the control group. Broilers in the feed applied and continuous water applied probiotic groups showed a trend of reduced feed conversion between day 19 and 48 of grow-out but these values did not prove to be statistically different following analysis. The trends observed in this trial suggest that this Lactobacillus-based probiotic applied to the feed following crumbling / pelleting or continuously in the drinking water, may be conducive to reduced feed conversion and potentially heavier body weights in commercially-reared broilers, but further investigation is required. This trial is currently being replicated on completely non-medicated feed to investigate potential protection by this probiotic against microbial challenge from the rear ing litter.

**Key Words:** probiotic, drinking water application, feed application


In house composting of litter is one possible method to reduce the number of foodborne pathogens that reside within a poultry house. Reducing these numbers should reduce the amount that enters the processing plant and eventually onto the final processed product. In this experiment used litter was obtained and then formed into three compost piles. Temperature probes were used to measure the internal and external temperatures with the data being recorded hourly. Initial bacterial counts to determine the amount of Salmonella, Campylobacter and *Clostridium perfringens* that was present in the litter was performed. These initial results show that there was no Salmonella or Campylobacter, even after enrichment; on average there was determined to be 2.6 log, cfu/g of *Clostridium perfringens*. From each compost pile two 50g samples were removed and inoculated with 10⁸ cfu of the following: (2) *S. enteritidis*, *S. typhimurium*, *S. kentucky*, *S. heidelberg*, (3) *Clostridium perfringens*, *Ca. coli* and (2) *Ca. jejuni*. The number in parenthesis denotes how many different strains for each species was used. These six 50g inoculated samples were then wrapped in cheesecloth and one was placed in the interior and exterior of each compost pile. After seven days the inoculated samples were collected and tested to determine the number of inoculated bacteria that survived. Additionally each sample was enriched to verify that all of the inoculated organisms were destroyed.

No detectable Salmonella or Campylobacter were detected in the inoculated samples that were placed inside the compost pile. Additionally no Campylobacter was recovered from the samples that were on the exterior of the compost pile. Salmonella in the exterior samples survived; however they were only detected after enrichment. Biochemical testing of this enriched sample indicated that *S. kentucky* was the sole Salmonella that survived. *Cl. perfringens* was recovered from the interior and exterior samples; however the amount recovered was less than 1 log₁₀ cfu/g. The results show that in house composting of litter is an effective way in either eliminating or reducing foodborne pathogens from a poultry house.

**Key Words:** foodborne pathogens, compost

**T39  The effect of quicklime (CaO) on litter condition and broiler productivity.** V. Ruiz¹, D. Ruiz¹, A. G. Gernat⁰¹, J. L. Grimes², J. G. Murillo¹, M. J. Wineland³, K. E. Anderson³, and R. Maguire³, ¹Escuela Agricola Panamericana, Zamorano, Tegucigalpa, Honduras, ²North Carolina State University, Raleigh, ³North Carolina State University, Raleigh.

Waste management and disposal is among the most critical issues confronting confined animal feeding operations. There is an urgent need for innovative methods of collecting, processing, and disposing of manure, mortalities and by-products such that the environmental impact is minimized. The objective of this study was to develop a process using quicklime (CaO) that will result in a pathogen reduced manure that can re-used as a treated bedding material which is economically important in modern broiler production and have physical characteristics acceptable for land application. A common source of used broiler litter was treated with CaO at different percentages. The used treated and untreated litters were stock-pile-separated for 10 days before allocation to assigned pens. The four litter treatments were T1) fresh wood shavings; T2) used broiler litter; T3) used litter with 10 % CaO, calculated on weight per volume basis; and T4) used litter with 15 % CaO calculated on weight per volume basis. The four litter treatments were allocated in a randomized complete block design to the 16 experimental pens providing four replicates per treatment. Body weight (BW), cumulative feed consumption, and feed conversion (feed:BW) were determined on a weekly basis through 42 days of age. Bird foot pads and breasts were observed for potential burns and blemishes on a weekly basis through 42 d of age. A second trial was conducted using the same procedures. Mortality was recorded daily. Carcass weights and percentages of carcass yield without giblets were determined prechill. Litter was sampled for pH, total phosphorus (P), nitrogen (N), soluble P, percent moisture and total plate counts (TPC) from the different litter treatments days 1 and 10 prior to bird placement and days 7 and 42 after bird placement. No significant differences were found for body weight, feed consumption, feed conversion, mortality, carcass weight or yield nor were blisters observed on the foot pads or breasts. The addition of CaO to used broiler litter before the bird placement increased pH and reduced soluble P and TPC. T4 had significantly (P < .001) higher pH on day 7 (11.1) and day 42 (8.7) when compared to T1 (day 7 = 5.6, day 42 = 7.6). Soluble P (ppm) was significantly (P < .001) lower for T4 (2.7) when compared to T1 (42.2), T2 (43.9), and T3 (35.0). Though not significant, T4 had lower TPC cfu/g in comparison to the other treatments on day 7 and 42. The authors conclude that the use of CaO as a treatment for broiler litter will initially reduce bacteria load in the litter and reduce soluble P without negatively affecting bird productivity per the conditions of this study.

**Key Words:** broiler, litter, lime

Standards for poultry drinking water state that there should be fewer than 100 CFU/ml total bacteria and fewer than 50 CFU/ml coliform bacteria. Two experiments were conducted to evaluate the effects of coliform presence in broiler drinking water on performance. Cobb 500 by-product male broiler chicks were housed in Petersime batteries equipped with a nipple water system. Chicks were fed a standard corn-soybean meal diet and allowed ad libitum access to feed and water. Chick weight, feed intake, and water consumption were recorded weekly throughout the 35 and 21 day Experiments. In both Experiments, five replicate pens of ten birds were allotted to the water treatments which consisted of 0 and 500 CFU/ml of coliforms, and 4 replicate pens of ten birds were allotted to the water treatments consisting of 0 and 5000 CFU/ml of coliform contaminated water. Water treatments were mixed on a weekly basis. Water analysis for total coliforms and total plate counts were conducted weekly and the samples were taken directly from the water nipples. The average of the coliform counts for the 0, 50, 500, and 5000 CFU/ml treatments were 7.4, 111.6, 704.4, and 1924, respectively, for Experiment 1 and 6.1, 125.3, 530.3 and 5360 respectively, for Experiment 2.

Addition of 5000 CFU/ml of coliforms in the drinking water of broiler chickens significantly reduced weight gain during the first week in Experiment 1. However, overall coliform addition in the drinking water up to 5000 CFU/ml of coliforms had no effect on weight gain, feed intake, feed efficiency (gain:feed) or water intake in both experiments. Based on these results, up to 5000 CFU/ml did not impact broiler performance however, levels of 5000 CFU/ml or greater may reduce broiler performance during the first week posthatching. Based on previous research the negative effects of coliform bacteria were observed only in combination with other water contaminates or environmental stresses which confirms the findings herein and suggest that bacteria contamination alone may not be the reason for poor broiler performance but it is likely due to a combination of water contaminates and environmental stresses.

Key Words: broilers, water, coliforms

T41 Association of IL-10 gene clusters and Salmonella response in chicken. S. B. Ghebremicael1,2, J. R. Hasenstein1, and S. J. Lamont1, 1Iowa State University, Ames, 2Wageningen University, Wageningen, The Netherlands.

Salmonella enteritidis (SE) lipopolysaccharide stimulates IL-10 gene expression in chickens. We investigated associations of single nucleotide polymorphisms (SNP) of IL-10 and linked genes with response to Salmonella. Genes in the IL-10 cluster (PIGR, IL-10, MAPKAP2, and LGTN) and DYRK1A were investigated using the F8 generation of two related intercross lines (AIL) of the Iowa salmonella response resource population (ISRRP). The ISRRP was generated by crossing outbred broilers with dams of two highly inbred lines (Leghorn and Fayoumi). Intercrossing continued within the two dam lines. The F8 chicks (n=132) were intraesophageally inoculated at one d with SE. At d 7 or 8, both spleen tissue and cecal contents were cultured to quantify SE load. First, about 800 – 1000bp of each gene were sequenced from 3 birds per line. The SNP numbers in the sequenced region of PIGR, IL-10, MAPKAP2, LGTN and DYRK1A were 8, 7, 4, 7 and 16 respectively. The F8 population was genotyped for one SNP per gene by using Multiplexed SNaPshot assay. Association of genes with SE bacterial burden was analyzed by general linear model. The pIgR, IL-10 and LGTN SNP had no significant associations. MAPKAP2 was highly significantly associated with SE burden in spleen tissue (P < 0.0001) and SE burden in cecal luminal contents (P < 0.01) in the broiler X Fayoumi AIL, but not the broiler X leghorn AIL. DYRK1A and SE count in spleen tissue and cecal content were significantly associated (P < 0.05) in the broiler X Fayoumi AIL. Genetic differences between the AIL imply that sufficient genetic variation exists to select for reduction of SE burden in poultry. The two significant genes are reported to play roles in gene expression regulation and cell proliferation, including stress and inflammatory responses. The results suggest that SNP in both genes are associated with Salmonella burden, and may be valuable in generating resistant birds.

Key Words: lipopolysaccharide, IL10 gene cluster, salmonella

T42 A database for chicken full-length cDNAs. Y Wang, Z. G. Wang, and F.C. Leung*, Department of Zoology, The University of Hong Kong, Hong Kong.

Collection of full-length cDNAs is essential to functional genomics studies. Projects for constructing the human and mouse full-length cDNAs database have generated a large amount of data and such databases are important research resources and tools for the scientific community. With the completion of the chicken genome sequencing, the same project in chickens can be initiated and we introduce a database that may facilitate future research work in chicken system biology. In the database, chicken ESTs were aligned over human and mouse full-length cDNAs or ORFs on the basis of high similarity in BLAST alignment. The alignment data are helpful to experimental researchers to confirm the corresponding full-length cDNAs in chicken. A total of over 540,000 chicken ESTs were used to find alignment positions on about 160,000 full-length templates from the NEDO, RIKEN and MGC databases. A part of the templates have known biological functions, and their homologous chicken genes in the EMBL database are given in the database. We also collect known chicken full-length cDNAs and continue to update the database for public use.

Availability: http://bioinfo.hku.hk/chicken/

Key Words: chicken, cDNA, database

T43 Characterization of Duck Pit-1 cDNA and genomic DNA. N. Kansaku1, T. Ohkubo2, D. Guemene3, U. Kuhnlein3, and D. Zadworny4, 1Azabu University, Sagamihara, Kanagawa, Japan, 2Kagawa University, Miki-Cho, Kagawa, Japan, 3INRA-SRA, Nouzilly, France, 4McGill University, Ste. Anne de Bellevue, PQ, Canada.

Pituitary transcription factor (Pit-1) involves the expression of growth hormone and prolactin. Our previous study demonstrates the association between genetic variation of chicken Pit-1 intron1 and egg production traits. Since intron1 contains the alternative transcription starting site, expression of Pit-1 isoform (gamma) may be related to variation and traits. In birds, only chicken and turkey pit-1 was cloned and sequenced. It is thus necessary to obtain information of Pit-1 sequence in the other birds to investigate the mechanism of Pit-1 gamma expression and association between genetic variation and egg production traits. Accordingly, this study aimed to clone and characterized the duck Pit-1 cDNA and genomic DNA.
Based on the chicken and turkey Pit-1 cDNA sequence, primers were designed. Reverse-transcribed product was subjected to PCR amplification. After sequencing of product, 5' and 3' regions were cloned by RACE. Genomic structure of duck Pit-1 gene was characterized by using newly designed primers. Based on the sequence of intron1, Pit-1 gamma specific primer was designed and used to examine the isoform expression in the anterior pituitary gland.

Of the 2575 nucleotides which were sequenced, 71, 1499, and 1005 bases represented 5', 3', and open reading frame which encoded a peptide of 335 amino acids. Approximately 12.6 kb of duck Pit-1 gene was sequenced and exon-intron boundary was characterized. Duck Pit-1 gene consists of 7 exons and 6 introns as in turkey. Intron1 of duck Pit-1 consist of 3Kb and shows 0.7kb longer than these of chicken and turkey. Both Pit-1alpha and gamma was detected by RT-PCR in the duck anterior pituitary gland. These result may indicating that inserted 0.7 kb sequence in the duck Pit-1 intron1 does not involve the expression of Pit-1 gamma. In conclusion, sequence information of duck Pit-1 cDNA and genomic DNA allows future determination of the genetic variation. This may be important since variation of chicken Pit-1 intron1 have been associated with egg production trait. Genetic variation of duck Pit-1 may explain or associate the different egg production trait in the various duck strains and breeds.

**Key Words:** duck, Pit-1, isoform

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### T44 Cloning and expression of chicken AMP-activated protein kinase subunit genes

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AMP-activated protein kinase (AMPK) is involved in maintaining cellular energy homeostasis and, on the whole animal level, in the regulation of energy balance and food intake. The AMPK enzyme complex consists of one catalytic (alpha) and two regulatory (beta and gamma) subunits. There are two known isoforms for the alpha and the beta subunits and three for the gamma subunit, each of which is encoded by a separate gene. Because so little is known about chicken AMPK subunit genes, the present study was designed to clone, sequence and characterize the seven gene homologues. A molecular cloning strategy involving RT-PCR and 5'-RACE was developed to sequence cDNAs corresponding to complete coding regions and portions of the 5'- and 3'-untranslated regions of chicken AMPK subunit mRNA transcripts. AMPK alpha-1, alpha-2, beta-1 and beta-2 genes code for predicted proteins of 560, 552, 273 and 272 amino acids, respectively. The beta-2 gene produces multiple transcript variants that differ at the 5'-end; however, all code for the same predicted amino acid sequence. The presence or absence of one coding exon in AMPK gamma-1 gene transcripts results in two variants that code for predicted proteins of 298 or 276 amino acids. Use of an alternate promoter and transcription initiation site and/or alternative splicing of gamma-2 gene transcripts results in four different variants that code for predicted proteins of 567, 452, 328 and 158 amino acids. Alternative splicing of exon 3 in the gamma-3 gene results in a shift of the open reading frame and the production of two transcript variants that code for predicted proteins of 382 or 378 amino acids. Each of the AMPK subunit genes exhibited a unique tissue-specific expression pattern. In general, chicken AMPK subunit genes displayed similar structures and high sequence homology as compared to corresponding mammalian genes. Understanding chicken AMPK subunit gene structure and expression patterns provide new insight into the role of the AMPK pathway in metabolic regulation in poultry.

**Key Words:** AMP-activated protein kinase, gene structure, chicken

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### T45 Gastrointestinal maturation is accelerated in turkey pouls supplemented with a mannan-oligosaccharide yeast extract (Alphamune™)

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Alphamune™ is a yeast extract antibiotic alternative that has been shown to stimulate the immune system and increase BW in pigs. The influence of Alphamune™ on gastrointestinal tract (GIT) development of turkey pouls has not been reported. Two trials were conducted to evaluate the effects of Alphamune™ on gut maturation of 7 and 21 d old turkey pouls. Pouls were fed a standard control unmedicated turkey starter diet or the same diet supplemented with either 1 lb/ton or 2 lb/ton Alphamune™ (n = 18 pouls/group). On d 7 and 21, a 2-cm section was collected from the mid-point of the duodenum, jejunum and ileum of each bird (9 pouls/day/treatment) and fixed in a 10% formalin solution for 72 h and then stained. Twenty measurements of villus height, villus surface area, lamina propria thickness and crypt depth were taken per section per poult. On d 7, villus height and surface area of the duodenum and ileum were consistently greater for the 2 lb/ton Alphamune™ group. The crypt depths were deeper and the number of neutral goblet cells higher for all areas of the GIT evaluated in the Alphamune™ supplemented birds compared to controls on d 7. The intestinal morphology of the duodenum was not different between the controls and treated birds on d 21. However, in the jejunum villus height, villus surface area, lamina propria thickness and crypt depth were increased for both doses of Alphamune™ supplementation compared to controls in both trials. The ileal villus height was higher in the 2 lb/ton Alphamune™ birds and ileal surface area was increased for both doses of Alphamune™ compared to controls in both trials. The ileal crypts were deeper for all treatments compared to controls. These results suggest that feed supplemented with Alphamune™, a mannan-oligosaccharide, may accelerate gastrointestinal maturation in turkey pouls.

**Key Words:** Alphamune™, gastrointestinal tract, yeast extract

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### T46 Adrenal hormones play important roles to tolerate acute heat stress in broilers


When broilers are exposed to a high temperature (38°C), most of them die within 3 hours. However, some of them can tolerate the high temperature, indicating that an adaptation mechanism exists. We hypothesized that adrenal activation and glucose supply to the heart play key roles in the adaptation due to the following information. Heat dissipation by panting is supported by increased cardiac rate and blood flow. Epinephrine (EP) increases plasma glucose concentration. Norepinephrine (NE) increases cardiac glucose uptake and corticosterone (CCT) enhances lipolysis and glycogenogenesis. Therefore, we observed the effects of the hormones on adaptation to high temperature in broilers. Twenty-eight or twenty nine days old broiler chickens were divided into control (Cont) and EP groups with 6 replicates. They were fed basal diet (CP30%, ME3030 kcal / kg) made mainly from maize and soy protein isolate for 4 days. EP (0.1mg / kg BW) was injected subcutaneously, followed by exposure to heat (38°C) for 6 hours. Water was offered ad libitum during the heat exposure. Birds were decapitated and blood was collected when body temperature exceeded 45°C to measure hepatic and cardiac glycogen contents and...
plasma glucose concentration (Exp. 1). Exp. 2 and 3 were conducted similarly as Exp. 1 except for those described below. CTC (50mg / kg BW) was injected 4 hours before the heat exposure in Exp. 2, and NE (1mg / kg BW) was injected 1 hour before the heat exposure in Exp. 3. The birds were tolerant when EP was injected. Hepatic glycogen was significantly increased by EP while cardiac glycogen was decreased significantly. Plasma glucose tended to be increased. The birds were also tolerant when CTC was injected. Hepatic and cardiac glycogen contents were increased significantly by CTC while plasma glucose concentration was not changed. The birds seemed to be more tolerant when NE was injected (mortality: 1/6). Hepatic glycogen and plasma glucose were not changed while cardiac glycogen tended to be increased by NE. In conclusion, adrenal hormones, especially NE, play important roles in tolerance of acute heat stress in broiler.

Key Words: heat stress, adrenal hormones, broiler

T47 Study of the effects of dietary lutein on semen parameters in roosters. H. Pizzev* and G. Y. Bedecarrats, University of Guelph, Guelph, ON, Canada.

Antioxidants such as vitamin E have been shown to improve sperm quality and fertilizing ability by protecting sperm plasma membranes against lipid peroxidative damages. A preliminary study conducted in our laboratory indicated that supplementing the diet of broiler breeders with lutein, a xanthophyll carotenoid with anti-oxidative properties, improved hatchability. However, whether this effect was due to increased fertility was not determined. Thus, the objective of this study was to determine if dietary lutein can improve sperm quality in mature roosters. Fifteen Barred Rock roosters housed in individual battery cages were stimulated with a 14h photoperiod at 18 weeks of age. At 40 weeks of age, birds were randomly assigned to 3 experimental groups (n=5 per treatment) and fed ad libitum a standard diet supplemented with 0, 30, or 120 ppm lutein. Semen was collected from each rooster by abdominal massage twice a week starting two weeks before the beginning of the experiment, and sperm analyses were performed on individual semen samples collected the day before (d0) and 19 (d19) and 29 (d29) days after introduction to diets. Sperm concentration was determined by spectrophotometer and sperm motility assessed by CASA (computer-assisted sperm analyser). Sperm viability was determined using SYBR-14 and PI fluorescent staining, with a manual count of viable and non-viable sperm under a fluorescent microscope. Data were analyzed using repeated measures ANOVA. Although no significant difference in sperm concentration, motility, and viability was observed between treatments, roosters fed the 120 ppm lutein diet tended to display a higher sperm motility and viability at d19 and d29. In conclusion, unlike vitamin E, dietary lutein supplementation does not significantly improve sperm quality in mature roosters.

Key Words: lutein, rooster, sperm

T48 3β-HSD and cAMP in GC of hens subjected to heat stress. H Taira* and M. M. Beck, University of Nebraska, Lincoln.

Heat stress (HS) interferes with reproduction in laying hens, at least in part through reductions in LH, P₄ and E₂. In earlier studies, granulosa cells (GC) from hens subjected to acute and chronic HS produce less P₄, even when stimulated by LH, and that 3β-HSD activity is correspondingly reduced; stimulation with LH and, to a greater extent, with LH+FSH, increases the activity. In addition, strain differences in response to the hormone treatments have been shown. In order to further investigate mechanism(s) by which HS affects steroidogenesis, this study was conducted in two parts: 1) effect of HS on gene expression of GC 3β-HSD; and 2) effect of HS on GC cAMP, as the second messenger operational in the steroidogenic pathway. Three strains of Hy-Line® laying hens were used in the first study (W36, W98 and Browns); subjected to 22C, 35C (24h, acute HS) or 35C (2wk, chronic HS); and GC from the largest 3 follicles were collected. RNA was extracted and reverse transcribed using oligo dt primers and superscript III reverse transcriptase. Samples were subjected to RT using primers for 3β-HSD and GAPDH and JumpStart Ready Mix Taqman polymerase. Log transformed data were normalized using GAPDH. Expression of 3β-HSD RNA was suppressed by acute (P=0.0077) and chronic (P=0.028), but there were no strain differences. In the 2nd study, Hy-Line® W98, W36 and CV20 hens were subjected to 22C or chronic (2wk) HS (35C). GC from the largest follicles were isolated and enzymatically dispersed. Aliquots of 100,000 viable cells were incubated with or without LH+FSH and cAMP was measured. HS decreased cAMP compared to TN by ~34% (P<0.0001). No strain differences were observed in response to 22C (W36 vs W98; P=0.0945, W36 vs CV20; P=0.5267, and W98 vs CV20; P=0.2869). However, under HS, cAMP levels of CV20 were lower than either W36 (P=0.0020) or W98 (P=0.0112). LH+FSH did not improve cAMP levels (P=0.4528). In previous studies, HS reduced 3β-HSD activity and LH+FSH restored it differentially by strain and LH has been shown to increase CAMP in hen thecal cells. The lack of response to LH+FSH in this study suggests that the relationship between cAMP and 3β-HSD in HS GC is not direct.

Key Words: 3β-HSD, cAMP, heat stress

T49 Effect of blindness on reproductive performance in a White Leghorn chicken line. P. M. Kirby* and G. Y. Bedecarrats, University of Guelph, Guelph, ON, Canada.

The objective of this study was to evaluate the reproductive performance in a chicken line displaying naturally occurring blindness. Smoky Joes are genetically modified pigmented White Leghorn chickens which harbor a sex-influenced autosomal recessive mutation resulting in retinal degeneration. In this experiment, 2 successive generations were used. Chickens were raised in brooding battery cages under an 8h photoperiod until 17 weeks of age, and then hens were transferred to individual battery cages and stimulated with a 14h photoperiod. Egg production for the 1st and 2nd generations was recorded daily until the 42nd and 7th week post-photostimulation, respectively. In addition, egg weight was also recorded for at least 7 weeks. Sexual maturation was estimated by determining the age at first egg, and overall egg production was calculated as hen-egg-day. In both generations, blind hens reached sexual maturity earlier than sighted birds, with over 93% of blind and 76% of sighted hens laying their first egg before 22 weeks of age. Similarly, blind hens reached peak production on average 1 week earlier than sighted hens, though no difference in peak production was observed. However, blind hens also declined from peak of lay earlier than sighted birds, and after a 42 week production period, blind hens' laying rate was 12% compared to 21% for sighted hens. Overall, total egg production during the 42 weeks period was similar between blind (131 ± 51) and sighted (145 ± 50) hens. For both generations, no significant differences in weight were observed between eggs laid by blind and sighted hens. In conclusion, it appears that the lack of retinal stimulation in blind Smoky Joe hens results in a...
shift in egg production with an advanced sexual maturation as well as an advanced drop in production.

Key Words: chicken, blindness, reproduction

T50 Effects of thermal stress during incubation on some embryo physiological parameters. R. D. Malheiro*, V. M. B. Moraes, M. Macari, J. Buyse, and E. Decuyper†, 1Universidade Estadual Paulista-UNESP, Dracena, SP-Brazil, 2Universidade Estadual Paulista-UNESP, Jaboticabal, SP-Brazil, 3Lab for Livestock Physiology and Immunology-KUL, Leuven, Belgium.

The aim of the present study was to verify the effects on embryo metabolism when subjected to 4 hours of heat stress (39.0°C). By that way 400 eggs were set to incubation (200 eggs each group), one group was designated as control (CONTROL) and second was designated as heat stress (HEAT). On the 13th day of incubation, the HEAT group of eggs was transferred to another incubator where they were submitted to a heat challenge of 39.0°C for 4 h. At the end of heat treatment on Day 13, 10 eggs were withdrawn from each group, and a blood sample was obtained for measurement of plasma glucose, triglyceride, uric acid and corticosterone levels and creatine kinase (CK) activity. A similar procedure was repeated on embryonic Days 14, 15, 16 and 17. In essence, the duration of heat treatment of embryos ranged between 4 h on Day 13 to 20 h for eggs remaining to the end of the 17th Day. In CONTROL embryos, plasma glucose started to increase significantly from Day 16 onwards. In HEAT embryos, this increase in plasma glucose occurred already on Day 15 and was of a larger magnitude, resulting in significantly higher plasma glucose in HEAT embryos from Day 16 onwards (heat treatment by age interaction; P<0.05). There were no significant overall differences between heat treatment neither in plasma corticosterone and uric acid levels nor in plasma CK activities. For all these plasma indices, a significant increase with embryonic age was observed from Day 15 or 16 onwards, irrespective of temperature. In contrast, HEAT embryos were readily characterized by significantly lower plasma triglyceride and this did not fluctuate significantly with embryonic age in either temperature treatment. Based on these first observations, it can be inferred that the age-related increase in circulating corticosterone is a causative factor for the age-related hyperglycemia, hyperuricacidemia and deteriorating muscle membrane integrity (increased CK activity) as already demonstrated in postnatal broilers. In conclusion, profound changes do occur in intermediary metabolism (hormonal-driven) in late-stage embryos and these ontogenic changes are subject to environmental temperature.

Key Words: incubation, embryo stress, embryo metabolism


Gangrenous dermatitis (GD) is a complex disease characterized by necrosis of the skin, subcutaneous tissue, and underlying musculature. Although a variety of microorganisms have been isolated from clinical specimens, Clostridium has been the bacterium most often associated with the incidence of GD. The purpose of this study was to better understand the etiology of this disease by comparing clostridial isolates from the environment of diseased farms as well as from organs and tissues of affected birds. A total of 76 samples were collected over a two month period from broiler farms in Delaware that were currently experiencing outbreaks of GD. Samples were from a variety of different sources including wet and dry litter, gastrointestinal tracts, blood, livers, joints, and skin lesions. Most organs and tissues were harvested from recently deceased birds although a few sample sets were collected from clinically infected live birds. The samples were plated on Perfringens agar and isolated Clostridium colonies were picked. Multiplex PCR, targeting both α-toxin genes of C. perfringens and C. septicum, was used to verify species identification. Both C. perfringens and C. septicum were observed over the course of the trial. RAPD PCR was performed and used to construct dendrograms to determine the genetic diversity. The dendrograms, containing 115 isolates of C. perfringens and 84 isolates of C. septicum, indicated an index of diversity equal to 2.03 and 1.53 respectively. Although both species were similarly prevalent, C. perfringens was more likely to be isolated from litter samples. Litter isolates appear to be distinct from the majority of isolates that were isolated from the birds. Both C. perfringens and C. septicum were isolated from skin lesions, GI tracts, and joint samples however only C. septicum was isolated from liver samples. The results of this study seem to suggest a selective proliferation of environmental isolates through the gastrointestinal tract leading to a bacteremic state prior to the bird’s death.

Key Words: gangrenous dermatitis, Clostridium

T52 Natural presence of Campylobacter and Salmonella in the spleen, liver/gallbladder and reproductive tract of commercial Leghorn laying hens. N. A. Cox, R. J. Buhr*, M. T. Musgrove, L. J. Richardson, and P. J. Fedorka-Cray, USDA-ARS-PMRSU-Russell Research Center, Athens, Georgia, USDA-ARS-ESQRU-Russell Research Center, Athens, Georgia, USDA-ARS-BEAR-Russell Research Center, Athens, Georgia.

Campylobacter and Salmonella are known to cause acute bacterial gastroenteritis in humans and poultry products have been implicated as a significant source of these infections. The objective of this study was to determine whether Campylobacter and Salmonella could be isolated from the reproductive tissues, lymphoid organs, liver/gallbladder and ceca of commercial leghorn laying hens. Two flocks were sampled. Hens (n=15) were obtained at 58 and 104 wk of age from separate facilities. Hens were euthanized, de-feathered and necropsy aseptically performed. To minimize the possibility of cross-contamination between samples, the ovarian follicles, spleen, liver/gallbladder, upper (infundibulum, magnum, and isthmus) and lower (shell gland and vagina) reproductive tracts were aseptically removed prior to the ceca. Individual samples were placed in sterile bags, packed on ice and transported to the laboratory for evaluation. In this study naturally colonized Campylobacter spp. were found in 3/10 ovarian follicles, 1/15 spleens, 4/15 liver/gallbladders, 7/10 upper reproductive tracts, 7/10 lower reproductive tracts, and 12/15 ceca. Naturally colonized Salmonella were found in 1/10 ovarian follicles, 1/15 liver/gallbladders, and 1/15 ceca but was not recovered from the spleen, upper or lower reproductive tract. Campylobacter were present in 93% of the hens sampled and Salmonella were present in 13% of the hens sampled in this study. The results of this study clearly show that commercial table egg laying hens housed in cages on wire floors, without the presence of roosters were naturally colonized with Salmonella and Campylobacter in their internal organs, reproductive and intestinal tracts.

Key Words: campylobacter, Salmonella, lymphoid organs
Avian reoviruses (ARV) can cause tenosynovitis, malabsorption syndrome, and chronic respiratory disease in commercial chickens. In addition, different antigenic subtypes exist, which make choosing the proper vaccine problematic. Our objectives were to develop a rapid and highly specific detection method utilizing Real-time RT-PCR to detect ARV infections in the chickens and to use the test to differentiate avian reovirus isolates based on pathogenicity, point of origin, and antigenicity. The protocol consists of two sets of one-step real-time RT-PCRs, which are conducted on a Roche LightCycler. Sample viral RNAs were first screened for ARV with primers and probes from a highly conserved S3 gene. This procedure was fast, sensitive, and could rapidly detect ARVs from cell culture and embryonating eggs. Experiments are now under way to detect ARVs directly from clinical tissue specimens as well as testing positive ARV samples using specific primers and probes from the highly variable region of S1 gene. It is hoped that these reagents can group ARVs according to their pathogenicity, point of origin, and antigenicity. If so, the test will aid in the epidemiology of ARV infections as well as help in the development of improved vaccines.

**Key Words:** avian, reovirus, real time PCR

Bursae of Fabricius harvested from Nigerian commercial chickens, which were suspected of having very virulent (vv) infectious bursal disease virus (IBDV) infection, were obtained. The birds had a history of clinical signs and lesions indicative of vvIBDV. The tissues were treated in phenol: chloroform: isomyl alcohol (25:24:1, pH 6.6) and exported to the U.S with the permit number 44226. IBDV RNAs were treated in phenol: chloroform: isoamyl alcohol (25:24:1, pH 6.6) and imported to the U.S. with the permit number 44226. IBDV RNAs were isolated from the tissues. The hypervariable regions of VP2-encoding genes of seven samples were amplified using nested reverse transcription polymerase chain reaction (nested RT-PCR) and their sequences determined using an automated machine. Their sequences were compared with that of IBDV reference strains in the GenBank database. Sequence analyses revealed that the IBDVs were very virulent, which agreed with the clinical picture as seen in Nigerian poultry. Sequences also showed 96.6% identity indicating that the viruses were from the same ancestor, which was probably imported into the country with poultry from nearby countries as had recently occurred with influenza virus.

**Key Words:** infectious bursal disease virus, RT-PCR, Nigeria

A commercially available lactobacilli-based probiotic (FM-B11™, Ivesco LLC), has shown efficacy against Salmonella when poultry are treated via drinking water (DW). In this study the probiotic (B11) was administered by spray application consistent with hatchery use. In two experiments, day-of-hatch chicks were challenged with Salmonella enteritidis (SE) by oral gavage (10⁶ cfu/chick) alone, challenged with SE and treated by coarse spray application of B11 (25 mL per 100 chicks, 10⁹ cfu/mL), or challenged with SE and treated with B11 continuously in the DW (10⁷ cfu/mL). Chicks in hatchery trays were placed under bright halogen light for 2.5 min after spray application. At placement, chicks were held in brooder batteries (n=40) and provided free access to feed and water. At 5 days post-challenge, 20 chicks per pen were humanely killed and subjected to necropsy with aseptic removal and culture of cecal tonsils for presence or absence of SE by established protocol. In Exp. 1, near-simultaneous administration of B11 with spray and immediate placement of chicks did not significantly reduce SE recovery. However, B11 treatment, by either spray or DW application significantly (p<0.05) reduced SE recovery (55% and 50% respectively, controls 85%) when chicks were held for 8h prior to challenge and placement. Similarly, when B11 spray treatment and challenge occurred simultaneously, with placement 8h after treatment, a marked and significant reduction of SE recovery was noted after 5d (55% controls, 10% treated). In Exp. 2, when B11 spray treatment and challenge occurred simultaneously, with placement 8h after treatment, a significant reduction of SE recovery was noted in both the spray and DW application (80% controls, 15% spray, 15% DW). Taken together, these results suggest that spray application of B11, when performed in

**Key Words:** Salmonella enteritidis, transposon mutagenesis, essential genes

Human infection by egg-associated Salmonella is an important public health problem in the United States. Among other serotypes implicated in human illness, *S. enteritidis* is the only serotype that routinely colonizes the reproductive tract of hens, leading to subsequent production of contaminated eggs. In this study, we used TnAraOut transposon system to identify *S. enteritidis* genes essential for *in vitro* growth. Such genes are important for understanding essential cellular mechanisms for growth and have a great potential as targets for development of novel antibiotics. TnAraOut is a mariner-based transposon containing arabinose-inducible promoter facing outward. Our screening strategy was based on the assumption that a mutant harboring TnAraOut insertion in promoter region of an *in vitro* growth essential gene shows arabinose-dependent growth pattern. The first step was to generate random insertion mutants and identify the mutants that form pinpoint colonies on LB plates containing low concentration (0.001%) of arabinose. These colonies were then tested for the growth on LB plates containing low (0.001%) and high concentrations (0.1%) of arabinose to identify the mutants with arabinose-dependent growth phenotype. Among 811 mutants forming pinpoint colonies, we identified 13 mutants showing arabinose-dependent growth phenotype, including an insertion in *atpI*. We will continue screening to obtain a comprehensive collection of TnAraOut mutants with insertions in essential genes. They will be further characterized for arabinose-dependent growth kinetics, *in vitro* competition assay, and sequencing of insertion sites.

**Key Words:** Salmonella enteritidis, transposon mutagenesis, essential genes
the manner described above, can be effective for protection of chicks against Salmonella infection.

**Key Words:** Salmonella, probiotic, hatchery

**T57 Methods to improve the economics of egg antibody production.** D. L. Trott*,1 M. Yang1, P. L. Utterback2, K. W. Koelkebeck2, and M. E. Cook1, 1University of Wisconsin, Madison, 2University of Illinois, Urbana.

The number of markets where egg antibody can be utilized is limited by egg cost. A series of experiments were conducted to: 1) attempt to decrease the cost of antibody production by using molted/spent hens; or 2) to increase egg antibody levels by modification of adjuvant or immunization schedule. In all experiments, hens received a standard immunization (i.m. injection of 1 ml over 4 sites of Freund complete adjuvant (FCA) containing 3mg/ml of phospholipase-A2 (PLA2) antigen on day 0 and with Freund incomplete adjuvant on day 7). Antibody titers to PLA2 in yolk were determined by ELISA. Antibody titers in eggs from 58 week-old non-molted hens compared to 110 week-old molted hens did not differ. In a second molt experiment, antibody titers did not differ between molted and non-molted hens receiving the first immunization either before or after molting period (2x2 factorial). These experiments suggest that the cost of antibody production can be reduced by using molted/spent hens. In a study to increase egg antibody levels, *Escherichia coli* bacterin was added to FCA, and antibody titers were found to be decreased 50% relative to standard immunization (p<0.01). In a second study, adjuvant was modified by addition of *Staphylococcus aureus* bacterin to FCA, and immunization schedules (0,7d v 0,14,28d) were compared in a 2x2 factorial. Addition of *S. aureus* bacterin to FCA increased antibody titers 2.2-fold, and the modified immunization schedule (0,14,28d) increased titers 1.9-fold compared to 0,7d immunization. The combination of *S. aureus* bacterin and modified immunization schedule did not appear to be additive (2.3-fold above standard). In summary, molting did not change egg antibody titers; *E. coli* adjuvant decreased titers; and *S. aureus* adjuvant or modified injection procedure increased titers. The economics of egg antibody production was improved by using spent laying hens and by enhancing egg antibody levels through use of adjuvant combinations or optimized immunization schedules.

**Key Words:** egg antibody, molt, immunization protocol

**T58 Supplementation of the probiotic MitoMax enhances immune responses to coccidiosis in broiler chickens.** S-H. Lee1, H. Lillehoj*,1 D-W. Park1, R. Dalloul1, Y-H Hong1, E. Lillehoj2, and J. Lin3, 1Animal and Natural Resources Institute, ARS, USDA, Beltsville, Maryland, 2University of Maryland, Baltimore, 3Imagilin Technology, Frederick, Maryland.

Avian coccidiosis is one of the most economically important diseases of the poultry industry. As the banning threats of chemotherapeutic control of coccidiosis increase, the industry looks for new ways to control the disease. As such, we investigated the role of the commercial probiotic MitoMax®, containing Pediococcus and Saccharomyces, on coccidiosis using weight gain, oocyst shedding, splenocyte proliferation, and antibody responses as parameters. Day-old broiler chicks were fed regular (REG) or probiotic- diets supplemented with MitoMax at 0.01% (MM 0.01), 0.1% (MM 0.1), or 1.0% (MM 1.0) of diet, and challenged two weeks later with 5,000 oocysts of either *Eimeria acervulina* (EA) or *Eimeria tenella* (ET). All groups fed the MitoMax-supplemented diets and infected with EA or ET showed lower oocyst shedding with no significant effect on weight gains. Splenocytes of chickens fed 0.1% MitoMax and tested 10 days post infection showed increased (P < 0.05) proliferation rates compared with those of birds fed the other diets. Further, MM 0.1 birds infected with EA exhibited higher (P < 0.05) serum *Eimeria*-specific antibodies than other groups. These results demonstrate that MitoMax may enhance the resistance of birds against coccidiosis when included at 0.1% of the broiler diet.

**Key Words:** probiotic, broiler, coccidiosis
Environment and Management: General Environmental Effects on Poultry

131 Including corn distiller’s dried grains with solubles, wheat middlings, or soybean hulls in laying-hen diets lowers manure ammonia emission. S. Roberts*, H. Xin, B. Kerr, J. Russell, and K. Bregendahl, Iowa State University, Ames.

Ammonia (NH₃) emission is a major concern for the poultry industry. We hypothesized that fiber in corn distiller’s dried grains with solubles (DDGS), wheat middlings (WM), and soybean hulls (SH) would lower NH₃ emission by increasing bacterial growth in the large intestine, which would 1) repartition N excretion from uric acid to bacterial protein and 2) produce volatile fatty acids that could lower manure pH, slowing bacterial conversion of uric acid to NH₃ and shifting the NH₃ equilibrium towards less volatile ammonium (NH₄⁺). Hy-Line W-36 hens, 45 wk of age, were housed 2 per cage in a randomized complete block design (16 blocks, 2 replications/block). The 4 corn and soybean meal-based diets included a control and experimental diets containing 10% DDGS, 7.3% WM, or 4.8% SH, which contributed equal amounts of neutral-detergent fiber. Diets contained 2,840 kcal/kg ME, 0.67% digestible TSAA, and 0.71% digestible Lys. Uric acid, Kjeldahl N, pH, and DM contents of fresh manure (n = 32) were measured and NH₃ emission was measured over 7 d by placing pooled 24-h manure samples (n = 6) in NH₃-emission vessels. Egg production was recorded daily and egg weight measured weekly. Data were analyzed by ANOVA with treatments compared to the control using contrasts. Dietary DDGS, WM, or SH lowered (P ≤ 0.01) 7-d cumulative manure NH₃ emission from 3.9 g for the control to 1.9, 2.1, and 2.3 g, respectively, and lowered (P ≤ 0.05) daily NH₃ emission rate. The treatments did not affect (P > 0.10) total manure N excretion or uric acid N as a percent of total N, indicating that N excretion was not repartitioned to bacterial protein. However, dietary DDGS, WM, and SH lowered (P ≤ 0.06) manure pH (6.77, 6.80, and 6.85, respectively) compared to the control (7.08). There were no treatment effects (P > 0.10) on egg production or egg mass (egg production × egg weight). Results of this study show that dietary inclusion of 10% DDGS, 7.3% WM, or 4.8% SH lowers NH₃ emission from laying-hen manure by up to 50% without affecting egg mass.

Key Words: ammonia, urease inhibitor, layer manure

132 The use of an urease inhibitor to control ammonia release from layer manure. W. D. King*1, A. J. Pescatore1, A. Singh2, R. S. Gates3, K. D. Casey3, M. J. Ford1, and A. H. Cantor1. 1University of Kentucky, Lexington, 2University of Kentucky, Lexington, 3Texas Agricultural Experiment Station, Texas A&M University, Amarillo.

Ammonia emissions from layer operations are becoming increasingly important. One approach to decreasing ammonia emissions in poultry houses is to block the activity of the urease enzyme. Two experiments were conducted using an equilibrium chamber gas sampling technique. In both experiments, twelve containers were placed below groups of three cages of two hens each, such that the bird feces dropped into the respective trays. At the start of experiment one, 5 kg of broiler litter was placed into each of the 12 containers, 6 of which, were treated with, the urease inhibitor, N-(n-butyl) thiophosphoric triamide (NBPT) at the rate of .0792 ml/kg of litter, and the rest were retained as untreated controls. The urease inhibitor was again applied at day seven of the experiment. The application of urease inhibitor decreased equilibrium ammonia concentrations. A further decrease was seen after reaplication at day seven. Mean equilibrium ammonia concentrations for the treated trays were significantly lower then for the control to day 21. In experiment two, layer manure was allowed to accumulate in the trays for ten days prior to the experiment. Urease inhibitor was applied at 0 and 31 days and samples were taken 3 times a week for 48 days (22 total samples). A significant reduction in equilibrium ammonia concentration was seen at day 2 and day 5 in the treated trays. This effect was no longer significant after day 7 due to wide variation in ammonia equilibrium measurements. After the second application there was a reduction in the ammonia equilibrium concentration however this was not significant. Based on this work, urease inhibitors demonstrate potential in the reduction of ammonia emissions from high moisture content layer fisses; however frequent reaplication appears necessary to sustain the effect.

Key Words: ammonia, urease inhibitor, layer manure

133 Determination of the nitrogen budget of commercial broilers raised from 0 to 42 days of age. L. Miran*1, J. Harter-Dennis1, J. Timmons1, and J. Meisinger1, 1University of Maryland Eastern Shore, Princess Anne, 2USDA-ARS, Beltsville, Maryland.

The emission of ammonia from poultry houses contributes to odor problems, decreased birds productivity and increases the risk of nitrogen (N) deposition to neighboring ecosystems. To quantify the rate of ammonia (NH₃) emission from commercial broilers, an experiment was conducted to determine a nitrogen budget including the major sources of N input and output. Five environmentally controlled chambers (37.2 m²) equipped with automatic feeding and watering systems were used. Used wood shaving/sawdust litter was thoroughly mixed, weighed and equally distributed into the chambers. Five hundred one-day old birds (250 males, 250 females) were placed per chamber and raised for 42 days. Samples of litter, feed and birds were collected at the beginning, at the end, and at every feed change (feed only) during the experiment to determine the nitrogen content. Ammonia emissions were directly determined throughout the trial by sampling the exhaust air and trapping the ammonia in large gas scrubbing tubes containing dilute phosphoric acid. Mean daily ammonia emissions ranged from 0.13 to 0.78 g (NH₃-N)/bird/day, with a mean of 0.37 g NH₃-N/bird/day and a coefficient of
135 Reducing broiler air emissions through diet. W. Powers1, R. Angel2, S. Zamzow1, and T. Applegate1, Iowa State University, Ames, University of Maryland, College Park, Purdue University, West Lafayette.

The impact on air emissions of feeding broilers reduced protein (LP) diets and diets with typical industry protein (control, C) were determined. Ross 308 male broilers were allocated to each of eight emission chambers at hatch and grown for 42 d. Three sequential experiments (Exp.) were conducted; each constituting a flock. The C treatment (Trt) was a four phase feeding program: starter (St), grower (Gr), finisher (Fn), and withdrawal (Wd) diets. The LP Trt was a six phase feeding program: prestarter (PreSt), St, Gr1, Gr2, F, and Wd diets. Formulated CP were 22.1, 20.0, 17.2, and 16.6% for the C Trt St, Gr, Fn, and Wd diets, while those for the LP Trt PreSt, St, Gr1, Gr2, Fn, and Wd diets were 22.0, 18.6, 18.1, 17.3, 15.8, and 15.0%. Synthetic Lys, Met, Ile, Thr, Val, Trp, and Arg were included in LP diets while Met and Lys, only, were added in C diets. Emissions of NH3, H2S, CO2, CH4, and non-methane total hydrocarbons (NMTHC) were calculated by sampling the incoming air followed by sequential sampling of each of the chambers for 15 min (10 min purge followed by a 5 min data recording period). Concentrations and airflow were measured every 30 sec and averaged for the 5-min period. At the start and end of each phase chamber BW was determined. Mean daily concentrations of NH3, H2S, CO2, and CH4 did not differ (P>0.05) by diet (207 ppb, 1.72 ppb, 1153 ppm, 2.153 ppm, respectively). Mean NMTHC concentration was greater in rooms offered the C diet than in rooms offered the LP diet (299 ppb and 294 ppb, respectively). Average daily NH3 emissions were greater in rooms where the C diet was fed (1663 vs. 1407 mg/d). Daily emissions of H2S, CH4, and NMTHC were not different by Trt (13.2, 323.6, and 863.2 mg/d). Daily CO2 emissions were greater from rooms offered the LP diet than rooms offered the CP diet (299 ppb and 294 ppb, respectively). Average daily chamber BW of broilers fed the C Trt was greater (50.8 kg vs. 49.9 kg); however, both groups were within typical industry performance. Results show that a 15% reduction in NH3 emissions can be achieved by feeding reduced CP diets without compromising performance relative to that observed in industry.

Key Words: air emissions, broilers, protein

136 Percent carbon and C:N of broiler litter and cake over consecutive flocks. C. D. Coufal*1, A. D. Collins2, and J. B. Carey3, Mississippi State University, Starkville, Texas A&M University, College Station.

Broiler production generates large amounts of litter material that must be properly disposed of each year. Quite often litter materials are directly land applied after removal from the broiler house. However, if weather conditions, equipment availability, or soil nutrient load does not allow for the immediate application of litter, then this material must be temporarily stored until final disposal is possible. Stored litter materials are often used as a carbon source for the composting of mortality carcasses. Composting of broiler litter can also increase the value of broiler litter as a soil amendment. However, little data has been published regarding the carbon content of loose and caked broiler litter. The C to N ratio (C:N) is also important information to assure the success of the composting process. Litter and cake samples from a previous study were analyzed for carbon content on a dry matter basis.
Samples were collected after each of eighteen consecutive flocks that were reared under simulated commercial conditions to 40-42 days of age with an average ending body weight of 2.2 kg. New rice hulls were used for litter in flock 1, and litter was decayed and recycled after each flock. All birds and feeds were obtained from a commercial broiler integrator. The C content of new rice hulls was 38.2% and the C:N was 82:1. Litter C content dropped significantly (0.9%) after the first flock, but then leveled off for several flocks. Litter C at the end of each flock averaged 36.5% for all 18 flocks. Cake C was similar to litter C, averaging 36.7%. Litter C:N dropped significantly to 18:1 after the first flock. Litter C:N continued to decrease for the next 4 flocks, and leveled off at approximately 9:1. Higher N values for cake resulted in lower cake C:N compared to litter. Cake C:N for flock 1 was 10.7:1, with cake C:N ranging from 6.7 to 8.7:1 for all other flocks. This data demonstrates that additional carbon materials will need to be added to broiler litter that has been recycled for several flocks to achieve the C:N needed for successful composting.

**Key Words:** broiler litter, carbon, C:N

137 **Potential for reducing manure mineral levels of trace minerals by using low levels of dietary mineral proteinates.** A. E. Sefton*1, and S. Leeson2, 1Alltech Canada, Guelph, ON, Canada, 2University of Guelph, Guelph, ON, Canada.

With increasing concern about the impact of animal agriculture on the environment it was of interest to look at methods for reducing trace mineral content of layer manure. Three mineral levels were looked at in this study: Control, inorganic premix with commercial trace mineral levels; Treatment 1, proteinated trace minerals (Bioplex™, Alltech, Inc. Nicholasville, KY) at approximately 10% levels compared to the inorganic premix; and Treatment 2, no supplemental trace minerals. The trial ran from 28 to 60 weeks of age, 8-28 day periods. Percent egg production, and total eggs did not differ. Egg weight was reduced slightly in late lay in the no supplemental trace mineral treatment. Layers fed Bioplex or no supplemental minerals had similar manure levels of Zn, Mn and Cu. In both cases Zn manure level was reduced by 67% while Mn and Cu were reduced by 80% and 10% respectively, compared to the inorganic control. These results indicate that, Bioplex minerals, fed at reduced levels, is a strategy for reducing manure mineral levels while maintaining productivity and thus reducing the environmental impact.

**Key Words:** layer, organic trace minerals, manganese

138 **Humoral immunity of chickens in different housing environments.** H. Karami* and H. Sunwoo, University of Alberta, Edmonton, AB, Canada.

Current poultry housing environments create increased risk of pathogens and bacteria exposure within the flock. Because of these present bacteria, a strong immune system is crucial for both chickens and chicks. The objective of this study is to examine the humoral immunity of chickens against different bacterial species in two different housing environments. Table eggs from caged and free-run chickens were purchased from local markets. Egg yolk antibodies (IgY) were isolated by water-dilution method. The specific IgY titer against 13 different bacteria, including Aeromonas hydrophila, Bacillus cereus, Campylobacter jejuni, Clostridium perfringens, Escherichia coli O157,

**Key Words:** metabolites, pesticides, viable egg assay

139 **Viable chicken egg assay used to evaluate metabolites of the herbicide Diuron.** T. Carro1, V. Gaddamidi2, S. W. Bookhart, III2, M. E. Persia1, and W. W. Saylor1, 1University of Delaware, Newark, 2DuPont Ag Products, Inc., Newark, Delaware.

Laying hen assays have been the industry standard in pesticide development to determine nature (metabolites) and magnitude of residues. There is interest in a more economical, less time-consuming methodology to predict hen metabolites. An experiment was conducted to compare metabolites produced by Single Comb White Leghorn (SCWL) hens with those produced by a viable egg assay when Diuron, a nonpolar herbicide was administered. 14C N-(3,4 dichlorophenyl)-N, N-dimethylurea (Diuron) was solubilized in polyethylene glycol-400 (PEG) to create a dosing solution (DS) of 6.4 mg/ml (specific activity 6.04 µCi/mg). Fertile SCWL eggs were incubated at 99°F and 50% RH for 6 d. Viable eggs were allotted to replicates of 10 eggs and randomly assigned to treatments (200 µl/egg): DS into yolk, DS into albumen, PEG into yolk, PEG into albumen, and sham (shell puncture). On d 15, fractions were harvested from viable eggs for analysis: allantoic fluid, yolk, embryo, shell, and remaining fluid (pooled by treatment). The final supernatants from extracted samples were subjected to reverse phase HPLC analysis using similar conditions prescribed for the hen assay procedure. Metabolites were confirmed using electrospray ionization liquid chromatography/mass spectroscopy. Total radioactive recovery was 86% for the albumen injection site and 92% for the yolk site. Site of injection had no influence on radioactivity distribution among fractions or metabolites produced in each fraction. Metabolites identified and confirmed in this study were analogous to those of the SCWL assay: N-(3,4 dichlorophenyl)-N, N-dimethylurea (parent compound), 3,4-dichlorophenylurea, N-(3,4 dichlorophenyl)-N’-methylurea, N-(4,5-dichloro-2-hydroxyphenyl)acetamide, 3,4-dichlorobenzeneamine, N-(2-hydroxy-4,5-dichlorophenyl)urea. This methodology may provide an economical preliminary assay for evaluating metabolites of pesticides.

**Key Words:** chicken housing systems, Humoral immunity, IgY
The effect of L-arginine supplement on intestinal nitric oxide and microflora of broilers. M. Putsakum*, L. L. McWilliams, Y. V. Thaxton, J. P. Thaxton, A. Corzo, and S. W. Anderson, Mississippi State University, Starkville.

This study evaluated the effects of L-arginine supplementation on the intestinal nitric oxide and microflora in broilers. Eighty-four cecal pouches and large intestines were collected from two groups of six weeks old broilers that were fed either basal diet (0.98% digestible arginine; control group) or basal diet supplemented with 0.1% L-arginine (1.08% digestible arginine; treatment group). Cecal and large intestine contents were analyzed for nitric oxide as nitrite by using Griess reagents, and were analyzed for microbial populations (total aerobic and anaerobic) by standard plate counting techniques. The nitric oxide contents and bacterial populations between each intestinal section and each group were correlated (Pearson correlation coefficient). In cecal contents, nitric oxide was increased (P<0.05) in birds that were supplemented with L-arginine, whereas nitric oxide in large intestines was different between control and treatment groups. The microbial populations in both intestinal sections were not significantly different between two treatments. In control group, a positive correlation coefficient between nitric oxide contents and bacterial populations was found both in ceca and large intestine (r=0.324 and 0.381, respectively, p<0.05). However, in the treatment group, a positive correlation coefficient (r=0.403, p=0.01) between nitric oxide contents and bacterial populations was found only in large intestine. These results indicate that arginine does not affect nitric oxide production by bacteria, but does stimulate nitric oxide production by intestinal tissues.

Key Words: nitric oxide, microflora, broiler


Two strains of broilers were subjected to bright-long or dim-step-up lighting programs and typical or cooler temperatures late in the growing period to assess effects on live and processing performance. Fifty males of two strains (Strain A, moderate yield; and Strain B, high yield) were placed by strain in two pens in each of 12 lighting programs and typical or cooler temperatures (avg. daily low and high of 17 and 21°C) or cooler (avg. daily low and high of 17 and 24°C) temperatures. Ten birds per pen were processed at 55 d to determine parts weights and yields. Data were analyzed for main effects and their interactions as a 2x2 factorial arrangement with rooms as experimental units. Dim-step-up lighting reduced BW to 28 d, feed consumption to 35 d, and feed conversion (FC) to 42 d; however, these variables were not affected at 55 d. Dim-step-up lighting generally reduced weights and yields of total breast, fillet, and tender; however, fat pad, wing, and leg weights and yields were generally increased. Strain A had greater BW and feed consumption from 7 to 55 d, and reduced FC to 35 d. Fillet and total breast yields of Strain B were greater; however, wing and leg weights and yields were reduced. Cooler temperatures increased BW at 55 d and feed consumption from 42 to 55 d, but did not affect FC. Cooler temperatures generally increased parts weights; however, yields were generally unaffected. Uniformity and mortality were not significantly affected by lighting program, strain, or temperature. There were no notable interaction effects on any of these variables. These results indicate that the processing performance of different strains may be negatively impacted by lighting programs generally accepted to improve live performance.

Key Words: lighting program, temperature

Assessing the performance of an actively heated and ventilated broiler transport prototype. S. L. Cochran, K. P. C. Hui*, T. G. Crowe, K. Bligh, H. L. Classen, and E. M. Barber, University of Saskatchewan, Saskatoon, SK, Canada.

Animal welfare based challenges are encountered when moving large numbers of broilers in a wide range of ambient conditions. Previous research conducted by the University of Saskatchewan discovered broiler chickens experience heterogeneous temperature and humidity conditions during transportation in extreme Canadian Prairie climates. Results showed that current passive (natural) ventilation systems on transport vehicles are not efficient in providing a comfortable environment for broilers during winter transport. A research project was developed to improve environmental conditions inside poultry transport vehicles. The project included the development and assessment of an actively heated and ventilated transport vehicle. A prototype was built by the Department of Agricultural and Bioresource Engineering at the University of Saskatchewan. A series of paired road tests were conducted during the winter of 2005, comparing environmental conditions inside commercials vehicles versus the prototype system. The field data were then analyzed using the modified AET (Apparent Equivalent Temperature) model. This model is used to identify locations inside the loads presenting unsafe combinations of temperature and relative humidity levels, which may subject birds to physiological stress.

This presentation will provide an overview on how the original AET model (developed by Malcolm Mitchell & Peter Kettlewell) was modified to assess typical conditions presented within transport vehicles during Canadian winters. Results of the analysis show that approximately half of the space within commercial trailers could compromise bird welfare. The prototype vehicle, with supplemental heat and active ventilation, was able to reduce the proportion of space presenting dangerous conditions to less than 10% of the load. This demonstrated that the concept has merit and should be considered in future designs of poultry transport vehicles.

Key Words: broiler transport, active ventilation, heating

Timing of photostimulation affects female broiler breeder carcass and reproductive traits at sexual maturity. A. Naeima*, R. A. Renema, A. Pishnamazi, and F. E. Robinson, University of Alberta, Edmonton, AB, Canada.

The effects of age at photostimulation (PS) on carcass characteristics and ovarian morphology at sexual maturity (SM) (first oviposition) were investigated in Ross 308 pullets. Upon arrival, the 720 pullets were housed in one of 8 floor pens and reared to 16 wk of age. A total of 240 pullets were randomly assigned to individual cages (16/room) and photostimulated (PS) at 17, 19, 21, or 23 weeks of age. Body weight and external measures of frame size were taken at SM. Each bird was dissected and weights of breast muscle, abdominal fatpad,

A study was conducted to determine the effects of reduced dietary crude protein (CP) on biological and financial performance of Ross 308 broilers fed from hatch to week 7. 1,440 straight-run broiler chicks were randomly assigned to 4 treatments containing 30 birds each. Diets were formulated to be isocaloric and to have the minimum digestible level for lysine (Lys), and the same minimum ideal amino acid ratios to lysine for total sulfur amino acids (TSAA), threonine (Thr), valine (Val), isoleucine (Ile), arginine (Arg), and tryptophan (Trp) across the four phases [starter (0-2wks), grower (2-4wks), finisher (4-6wks), and withdrawal (6-7wks)]. An industry standard diet served as the control (A) and the benchmark for performance. The remainder of the treatments (A-0.5%, A-1.0%, and A-1.5%) had CP reduced in 0.5% increments. Birds were weighed at 2, 4, 6, and 7 weeks of age for feed to gain calculation. At week 7, 4 birds per pen (48/trt) were sacrificed and had fat pad and carcass weighed, and carcass and meat yield determined. Feed cost savings (FCS) per metric ton (MT) of live body weight (BW), FCS/MFT carcass, FCS/MFT breast meat, income over feed cost/MFT carcass, and income over feed cost/MFT breast meat, were calculated. Treatments had no effect (P> .05) on performance throughout the 7-week period. At week 7, birds fed A-1.5% had a higher (P< .05) percentage of fat pad when compared to A (2.98% versus 2.52%, respectively for A-1.5% and A). The remainder of the treatments did not differ from the control (P>.05). In addition, treatments had no effect (P>.05) on carcass and breast meat yield at 7 weeks of age. For BW, relative to A, FCS was $2.50/MT when A-1.5% was fed; for carcass, $3.42/MT; and for breast meat, $15.01. Therefore, birds fed A-1.5% CP resulted in an increased income of $3.42/MT carcass and $15.00/MT breast when compared to A. Overall, these results a decrease of CP by 1.5%, as compared with industry standards, did not affect performance, carcass, and meat yield, and resulted in significantly higher revenues.

Key Words: low crude protein, Ross 308, economics

Influence of grower period length and amino acid level in the finisher period on broiler performance and economics. D. Hoehler*1, A. Lemme1, C. Fisher2, and C. Kemp2,1Degussa Corporation, Kennesaw, Georgia, 2Aviagen Ltd., Edinburgh, Scotland.

Broiler nutritionists need to make decisions about the energy and nutrient content of feed during the grow-out period, and the length of time or amount each feed should be fed as part of the feeding program. This trial considered two sexes x 4 finisher diets x 3 times of change from grower to finisher. Six replicates resulted in a total of 96 pens with 90 Ross 308 birds per pen. All birds received the same feed up to 21 d. Male birds were fed 80, 90, 100, and 120%; female birds were fed 70, 80, 90, and 100% balanced amino acid (AA, related to the Ross recommendations) diets in the finisher period. Age at change from grower to finisher diets were 21, 28, or 35 d. Broilers were weighed at 10, 21, 28, 35, 42, and 49 d; processing samples were taken at 28, 35, and 42 d. Both AA level and the age when birds are changed from grower to finisher feed significantly affected growth, feed conversion, carcass yield, breast meat yield and bird fatness. There were no effects on mortality or on the yield of leg or wing portions. When the protein content of the finisher is low there is a large effect of age at change from grower to finisher. If the AA content of the finisher is higher or the change from grower to finisher is made at a later age, then the effects are smaller. This is because the degree of AA deficiency being caused by the change (if any) is smaller. In males the effects of time of change disappear at 120% AA and in females it appears that this would occur at about 110% AA. Economic inputs and revenue outputs were combined with the bird performance data to give an estimate of margins and costs. In males the treatment 120% AA/21 d change produced the highest margin at all weights. In females, the highest AA level tested (100%) also produced the highest margin in small birds (1.7 kg), but the 70% AA feed introduced at 28 or 35 d tended to produce higher margins in higher body weight females. The results demonstrate that effective phase feeding can only be achieved by the application of a simple economic model customized for local broiler production conditions.

Key Words: broiler, amino acids, economics
146 Improved performance of Cobb 500 birds fed increased amino acid density in wheat or maize based diets. R. B. Shirley*, R. D. Parker1, M. Vázquez-Anón1, C. D. Knight1, and A. G. Marangos2,1Novus International, Inc., St Louis, Missouri, 2Nutrition Solutions, Winchester, United Kingdom.

The objective of this experiment was to evaluate the impact of increasing amino acid density of commercial broiler diets that are based on either wheat or maize. There were three dietary regimes: Diet 1 was formulated to be similar to the Cobb Broiler Nutrition Guide (2004) for minimum feed cost (FC); Diet 2 was based on the Cobb guidelines for maximizing white meat yield (WM) and Diet 3 was similar to WM but had the addition of higher amino acid levels (AA). Diets were fed in three phases and ME levels for the Starter (2968 kcal/kg), Grower (3053 kcal/kg) and Finisher (3154 kcal/kg) were calculated to be the same across all treatments. The starter diets were fed crumbled and the Grower and Finisher diets were fed pelleted to eight replicates of 24, 1-day old Cobb 500 chicks that were randomly allocated to 96 floor pens and grown until 36 days of age. Since there were no significant gender x diet, gender x level, or diet x level interactions for any of the production parameters, only the main effects are presented. As expected male birds outperformed female birds in most parameters across diet type and amino acid supplementation level. Body weight gain (BWG) and feed consumption were significantly influenced by amino acid density. Broilers consuming the FC diet had the lowest BWG and poorest feed conversion, while broilers consuming the AA diet had the greatest BWG (p=0.0315) and best feed conversion (p≤0.0001). Despite the latter differences, feed intake was not affected by amino acid density. On a dietary ingredient basis birds fed the wheat based diets tended to have lower gains (p≤0.0285) and lower feed consumption (p≤0.0041), resulting in no net change in feed conversion when compared to birds fed maize based diets. Carcass analysis showed a significant reduction (p≤0.0008) in fat pad weight and a significant increase (p≤0.0082) in breast meat yield at the highest level of amino acid inclusion. Economic analysis of the trial also illustrated an improved return over feed costs when Cobb 500 broilers were fed a high amino acid diet.

Key Words: broiler chicken, dietary amino acid density, Cobb 500

147 Individual arginine requirements in Ross 308 broilers at 7, 21 and 42 days of age. R. A. Coleman*, R. D. Kirschenman1, S. Moehn, and D. R. Korver1, University of Alberta, Edmonton, AB, Canada, 2University of Queensland, Gatton, Queensland, Australia.

Traditional techniques to determine amino acid (AA) requirements in poultry use growth as an indicator when diet AA levels increase from deficient to sufficient. The Indicator Amino Acid Oxidation (IAAO) technique has been developed to determine Arginine requirements in poultry by measuring the change in oxidation rate of a radiolabelled AA indicator (L-[1-14C] Phenylalanine) when the bird is fed different levels of Arginine. Arginine requirements were determined during 4-hr indicator oxidations in which each bird received a priming dose of 111 kBq/kg BW followed by repeated oral doses of the AA indicator of 64 kBq per 0.5 h per kg BW. Ross 308 broilers at 7 (BW = 93.5 ± 1.55g, n = 31), 21 (BW = 733.91g ± 16.90g, n = 19) and 42 (BW = 2486.59 ± 40.73g, n = 34) d of age were adapted to a pelleted, purified test diet formulated to be isoenergetic, isonitrogenous and complete except for Arginine. Six test diets ranging from deficient to in excess (6.05 to 17.88g Arginine/kg diet) of NRC recommendations were fed to each test age group. New protocols were developed to determine the selection criteria and adaptation period; birds were adapted to the environmental chambers for 4 days, followed by 3 days of adaptation to the test diet. Mean Arginine requirements (bicarbonate retention factor (BRF) corrected) for Ross 308 broilers at d 21 and 42 were 14.75 ± 0.12 and 8.56 ± 0.04 g/kg diet, respectively. The Arginine requirement at d 7 (non–BRF corrected) was 14.80 ± 0.68 g/kg diet. NRC recommendations for 0 to 3 and 3 to 6 wks old broilers are 12.5 and 11.0 g Arginine/kg diet respectively. To date, we have had difficulty obtaining BRF for broilers with <100g BW due to variability in water and feed consumption in birds < 7 d of age. Controlling for these factors will allow future IAAO studies in very young birds to be appropriately corrected for BRF. The IAAO technique allows for determination of individual bird AA requirements at specific ages and for different types of birds over short periods of time and gives poultry nutritionists a valuable tool to allow for more accurate diet formulation.

Key Words: Arginine, broiler, requirement

148 Comparison of endogenous ileal amino acid and total nitrogen flow in turkey poult and broiler chicks. S. A. Adedokun*, C. Parsons2, M. Lilburn1, O. Adeola1, and T. J. Applegate1, Purdue University, West Lafayette, Indiana, 2University of Illinois, Urbana, The Ohio State University, Columbus.

Ileal endogenous amino acid (IEAA) and N flow in turkey poult and broiler chicks at three ages (5, 15, and 21 d) were compared by feeding a N-free diet (NFD) or graded levels of casein (CDP). The semi-purified diets contained 0 (NFD), 50, 100, or 150 g casein/kg diet as the only source of amino acids. Each diet was fed for 5 d prior to the collection of ileal digesta. Each diet was fed to six replicate cages containing 30 (5 d), 10 (15 d), or 8 (21 d) birds per cage. At d 5, IEAA and N flow (mg/kg DM intake ) in poult fed the NFD, and graded levels of casein at d 5 was higher (P < 0.05) in poult than in chicks (NFD: Met, poult=391 and chick=153; Thr, poult=1,173 and chick=567; 5% casein: Met, poult=339 and chick=276; Thr, poult=1,081 and chick=870: 10% casein: Met, poult=472 and chick=346; Thr, poult=1,425 and chick=998; 15% casein: Met, poult=539 and chick=399; Thr, poult=1,595 and chick=1,208). Within each species, there were differences (P < 0.05) in IEAA and N flow between 5 d and 21 d. The IEAA flow (mg/kg DM intake ) in poult on d 15 (Met, 86; Thr, 427) and d 21 (Met, 85; Thr, 442) were not different from that of chicks fed the NFD on d 5 (Met, 153; Thr, 567). Similar trends were observed in the remaining three diets. An interaction between species and age was observed for most of the amino acids and N in birds fed NFD (Met, P=0.06, Thr, P=0.01), 5% casein (Met, P=0.23; Thr, P=0.02) 10% casein (Met, P=0.02, Thr, P=0.0002) and 15% casein (Met, P=0.09, Thr, P=0.04). The results from this study suggest that at younger ages poult have significantly higher concentration of IEAA and N relative to chicks, however, by 15 d and 21 d, the species differences in IEAA and N flow were not significant. The increased IEAA flow observed at the younger age should be taken into consideration when formulating starter diets on digestible protein basis.

Key Words: amino acid, endogenous, nitrogen-free diet
149 Standardized ileal amino acid digestibility of meat and bone meal in broiler chicks using a nitrogen-free or casein diet. S. A. Adedokun1, C. Parsons2, M. Lilburn1, O. Adeola1, and T. J. Applegate1,1Pardee University, West Lafayette, Indiana, 2University of Illinois, Urbana, 3The Ohio State University, Columbus.

The aim of this study was to determine the effect of bird age and meat and bone meal (MBM) source on standardized ileal amino acid (SIAA) digestibility. The SIAA digestibility coefficients (DC) were standardized using basal endogenous amino acid and nitrogen (N) flow values obtained from chicks fed a N-free diet (NFD) or a diet containing 10 % casein (CDP). Each of 4 diets was formulated to contain 20 % CP using MBM as the only source of CP and fed for 5 d prior to collection of ileal contents (6 cages of 30 or 8 birds/cage at 5 and 21 d, respectively). Using NFD for standardization, the SIAA DC for Met (MBM1, all beef) was 74.9 % (d 5) or 67.8 % (d 21), and for CDP was 81.6 % (d 5) or 72.9 % (d 21). The SIAA DC for Thr (NFD: MBM1) was 72.4 % (d 5) and 60.7 % (d 21), and for CDP was 79.8 % (d 5) and 64.1 % (d 21). The SIAA DC for Met (NDF: MBM2, all pork) increased from 54.1 % (d 5) to 76.3 % (d 21), and for CDP from 58.9 % (d 5) to 79.9 % (d 21). The SIAA DC for Thr (NFD) increased from 48.4 % (d 5) to 70.7 % (d 21), and for CDP from 54.1 % (d 5) to 73.3 % (d 21). The SIAA DC for Met for MBM3 (NFD; mixed species) increased from 50.0 % (d 5) to 70.6 % (d 21), and for CDP from 55.0 % (d 5) to 74.3 % (d 21). The SIAA DC for Thr for MBM3 (NFD) increased from 46.7 % (d 5) to 66.3 % (d 21), and for CDP from 52.9 % (d 5) to 69.1 % (d 21). The SIAA DC for Met from MBM4 (NDF; MBM4, mixed species) increased from 60.1 % (d 5) to 75.3 % (d 21), and for CDP were from 64.2 % (d 5) to 78.3 % (d 21). The SIAA DC for Thr from MBM4 (NFD) increased from 51.0 % (d 5) to 69.0 % (d 21), and for CDP from 56.6 (d 5) % to 71.5 % (d 21). The coefficient of variation between the two sources of standardization was 6.5 to 9.4 % on d 5 and 3.9 to 7.1 % on d 21 for Met and 9.7 to 12.4 on d 5 and 3.6 to 5.4 % on d 21 for Thr. Results from this study showed that standardization using NFD or CDP diets resulted in different SIAA DC with a reduction in the margin of variation with age.

Key Words: amino acid, meat and bone meal, standardized ileal digestibility


Growth rate differences of strain crosses currently grown are very pronounced. Presently, there is an ongoing discussion on the positive interaction between genetics and dietary protein. This interaction is expected to provide a greater benefit for strain crosses with slower initial growth rate, narrowing their performance differences with faster growth rate birds. In this study, 1,890 male broilers from two strain crosses (Fast and Slow initial growth rate) from similar breeder ages were placed in 70 floor pens, 27 birds per pen. Broilers were fed programs with a pre-starter to 7 d, a starter to 21 d, a grower to 34 d and a finisher to 40 d. The dietary program was composed by 3 ideally balanced protein levels (Dig. SAA:Lys = 75%; Dig. Thr:Lys=65%), which were set by Dig. Lys levels 15% apart (Low, Medium, High). Digestible Lysine of the Medium protein feeding program was, respectively: 1.23, 1.10, 1.00, 0.95%. At day 21, half of the broilers from Low protein were given High protein and half of those in High protein were given Low protein to 37 d. Birds on Medium protein were kept in the same ideal protein program. Six broilers from each pen averaging its mean were processed at 31 and 37 d of age. Body weight was higher and FC was better for broilers of Fast growth rate strain at both processing ages. Feeding Low protein diets from placement or at 21 d resulted in poorer BW and FC at both processing ages; however, there were no differences between birds receiving High protein from placement or from 21 d on when compared to Medium protein. Broilers from Slow growth rate strain produced a higher percentage of breast fillets at 31 d but no differences were observed at 37 d. Feeding Low protein from placement or at 21 d led to a reduction in breast meat yield, but High protein given from 21 d on and Medium protein given during the entire study produced similar results. There were no interactions between diet and Strain Cross for any response. Therefore, improvements provided by increased dietary protein were similar for the two strain crosses studied.

Key Words: broiler, lysine, ideal protein


International market for small broiler carcasses is usually supplied with female broiler chickens. Theoretically female griller with higher initial growth rate are more efficient feed converters. Growth rate differences of strain crosses currently grown are very pronounced and there is an ongoing discussion presently on the positive interaction between genetics and dietary protein. This interaction is expected to benefit strain crosses with slower initial growth rate narrowing their body weight differences with faster growth rate birds. In this study, 2,100 female broilers from two strain crosses (Fast and Slow growth rate) from similar breeder ages were placed in 70 floor pens, 30 birds per pen. Broilers were fed programs with a pre-starter to 6 d, a starter to 21 d, a grower to 31 d and a finisher to 37 d. Dietary program was composed by 3 ideally balanced protein levels (Dig. SAA:Lys = 75%; Dig. Thr:Lys=65%), which were set by Dig. Lys levels 15% apart (Low, Medium, High). Digestible Lysine of the Medium protein
of period. Mortality was not affected by the treatments. In the majority of responses there were no significant interactions between Strain and Dietary Protein. Exceptions were abdominal fat and total breast meat, which had the Fast growth strain with increased proportions of fat and breast meat as protein intake increased at 34 d.

Key Words: broiler, ideal protein, strain cross

152 Changes in tissue accretion during the acute phase response. P. Sirimongkolkasem* and K. C. Klasing, University of California, Davis.

The acute phase response (APR) to inflammation is characterized by decreased appetite, increased hepatic protein synthesis and muscle wasting. Previously, we found that diets containing essential amino acid (EAA) above NRC recommended levels (120%, 130% and 140%) did not lessen the decrease in growth performance during an APR, nor did they promote compensatory growth after an APR. This indicates that dietary EAA is not a factor limiting growth during APR. The present experiment was conducted to determine quantitatively the impact of APR on liver, pectoralis, semitendinosus and immune tissue weights and growth performance. APR was activated by injecting 2 mg/kg BW of lipopolysaccharide (LPS), s.q., into 8 d old male broilers. Body weight, feed intake and organ weights were measured on d 0 (prior to injection), 12 hrs, 24 hrs and 4 days post-injection. Uninjected birds were used as a negative control. Each treatment-time combination was replicated in 4 pens with 4 birds per pen. APR activation resulted in a significant decrease in average daily gain (66%), feed intake (28%) and feed efficiency (50%) 12 hrs post LPS injection. The depression in growth performance as a result of LPS injection was not significant at later times. A significant interaction between treatment and time was observed for both actual and relative liver weight (P<0.05). APR-induced increases in both actual (28%) and relative (26%) liver weights persisted for 24 hrs after injection, but were no longer significant by d 4. No treatment by time interaction was observed for other organs. The absolute, but not relative, semitendinosus weights of LPS injected birds were significantly lower (10%) than controls at 24 hrs post injection (P<0.05). Actual and relative weights of pectoralis, bursa, thymus or spleen were not affected by LPS. These results indicate that activation of APR results in an increase in liver weight concomitant with a decrease in skeletal muscle accretion. Assuming no major change in AA composition within organs occurs during an APR, dietary nutrients are repartitioned from growth toward hepatic immune functions.

Key Words: acute phase response, broiler, tissue accretion

153 The effects of different nutrient regimes on Ross broilers during stress and post-stress recovery. W. S. Virden*, A. C. DeLeon, A. Corzo, and M. T. Kidd, Mississippi State University, Mississippi State.

Two experiments were conducted to determine the effects of different nutrient regimes on corticosterone (CS) stress response, and post-stress recovery of broilers. Experiment 1 examined the effects of diets with increased glucogenic or ketogenic amino acids (AA), or L-carnitine. Ross x 308 broilers (432) were placed in 36 floor pens and given a common starter diet from 1 to 20 d of age. From d 21 to 30, broilers were given ad libitum access to the following dietary treatments: 1) Control (digestible (d) TSAA, 0.75%; d Lys 1.00%; d Thr 0.67%; d Trp 0.21%); 2) control + 15 mg CS/kg diet; 3) as 2 + L-Lys HCl (1.15% d Lys); 4) as 2 + DL-Met (0.82% d TSAA) and L-Thr (0.74% d Thr); 5) as 2 + L-Trp (0.24% d Trp); 6) as 2 + L-Carnitine (50 mg/kg d L-Car); 6 treatments/6 replications). Experiment 2 measured the effects of feeding stressed broilers diets varying in Trp or AA density. Ross x 308 (360) broilers were placed in 30 floor pens and fed a common starter diet from d 1 to 20. From d 21 to 25, chicks were given ad libitum access to dietary treatments: 1) Control diet (d TSAA, 0.75%; d Lys 1.00%; d Thr 0.67%; d Trp 0.21%); 2) control diet + 15 mg CS/kg diet; 3) as 2 + L-Trp (0.25% d Trp); 4) moderate AA density (18.5% CP; d TSAA, 0.82%; d Lys, 1.10%; d Thr, 0.74%); 5) low AA density (18.5% CP; d TSAA, 0.79%; d Lys, 1.00%; d Thr, 0.67%); (5 treatments/6 replications). From d 26 to 46, broilers received the control diet. Live performance was measured on d 30 and 48 for experiment 1, and d 25 and 46 in experiment 2. During stress, BW gain was lower (P<0.05), and feed conversion was higher (P<0.05) for broilers given all treatments containing CS than birds given control in both experiments. However, in experiment 1, broilers receiving treatment 3 had higher (P<0.05) BW gain than broilers given treatments 4 or 6, but feed intake (FI) did not differ. However, in experiment 2, FI was higher (P<0.05) for all treatments fed CS than control. Deleterious effects on 26 to 46 d BW gain and feed intake were ameliorated (P<0.05) only by supplemental Trp, but feed conversion differences did not occur.

Key Words: broiler, stress, tryptophan

154 Developmental regulation of peptide and amino acid transporter mRNA in the small intestine of broiler chicks. E. R. Gilbert1, H. Li1, D. Emmerson2, E. A. Wong1, and K. E. Webb, Jr.1,1Virginia Tech, Blacksburg, 2Aviagen, Huntsville, Alabama.

The objective of this research was to investigate the mRNA abundance of peptide and amino acid transporters in the small intestine of two genetic lines of broilers, selected on corn-soybean (line A) or wheat (line B) based diets. The genes examined included the peptide transporter, PepT1, nine amino acid transporters (rBAT, b(o)mCAT1, CAT2, LAT1, y(o)LAT1, y(o)LAT2, and EAAT3), and a digestive enzyme, aminopeptidase N (APN). Intestine was collected from four male birds from both lines at the following times: embryo day 18 (e18) and 20 (e20), day of hatch (doh), and d 1, 3, 7 and 14 after hatch. Birds were given ad libitum access to a low-protein, corn-soy based diet, as this has been shown to accentuate differences in body weight between the two lines. At e18 total intestine was collected, and thereafter, intestine was divided into duodenum, jejunum, and ileum. Total RNA was isolated and mRNA abundance was assayed using real time PCR and the absolute quantification method. For PepT1, Line B had greater quantities of mRNA (P = 0.0007) compared to Line A, suggesting that Line B may exhibit a greater capacity to assimilate amino acids as peptides. The PepT1 mRNA was greatest in the duodenum (P = 0.0001), while EAAT3, b(o)mCAT1, CAT2, LAT1, y(o)LAT1, y(o)LAT2, and APN mRNA were greatest in the ileum (P = 0.0001). Quantities of APN mRNA increased linearly with age (P = 0.0001), and were greatest compared to other genes. Quantities of CAT1, CAT2, and LAT1 mRNA decreased linearly with age (P = 0.0001), suggesting relatively more important roles in the embryo. In conclusion, these results demonstrate that nutrient transporter and digestive enzyme mRNA are expressed differentially among intestinal segments and with age, and between genetic lines.

Key Words: amino acid transporter, PepT1, real time PCR
155 Intestinal Clostridium perfringens and lactobacilli populations in broiler chickens fed protected glycine and proline based diets. J. P. Dahiyat*, D. Hoehler, A. G. Van Kessel, and M. D. Drew. University of Saskatchewan, Saskatoon SK, Canada, and Degussa Corporation, Kennesaw, Georgia.

Previous work in our laboratory showed that certain protein sources used in broiler diets increased gut C. perfringens populations and may predispose birds to necrotic enteritis (NE). When gelatin was used as protein source a positive correlation between dietary protein-bound glycine (Gly) content and gut C. perfringens counts was confirmed, however, since gelatin also contains high levels of proline (Pro), a causative link between Gly and NE could not be conclusively established. A study was therefore conducted to determine if there is a causative relationship between dietary Gly and NE in broiler chickens. Since crystalline Gly is rapidly absorbed in the duodenum, it is largely unavailable to C. perfringens populations in the distal gut. Fat encapsulated Gly was used to slowly release the amino acid along the entire length of the gut. An initial study showed that Gly concentrations were significantly higher (P < 0.05) in jejenum and ileum of birds fed encapsulated glycine (1.26% and 1.05%) compared to free glycine (0.98% and 0.62%). In the main study, two cages of 6 birds (14 d post-hatch) were assigned to one of 3 ideal protein-balanced diets: a control diet containing 19% crude protein and 1.15% lysine, the control diet with 4% encapsulated Gly added or the control diet with 4% encapsulated Pro added. All diets contained 3.30 Mcal/kg ME. The birds were orally challenged with C. perfringens type A on d 14-21 and killed on d 28. The majority of birds were dull, depressed and diarrheic during first 5 days after gavage with 4% mortality. There was a significant increase (P < 0.05) in C. perfringens populations in ileum and cecum of birds which received the encapsulated Gly diet compared to those receiving the control or encapsulated Pro diets. Lactobacilli counts in ileum declined significantly (P < 0.05) in the ceca of birds fed the encapsulated glycine diet compared to other 2 groups. We conclude that Gly is an important determinant of C. perfringens growth in the intestinal tract of broiler chickens.

Key Words: broilers, Clostridium perfringens, glycine


Necrotic enteritis is a worldwide poultry disease caused by Clostridium perfringens. Previous studies in our laboratory have shown a significant effect of protein source and high protein concentrations on C. perfringens growth in intestinal tract of broiler chickens. This experiment was conducted to examine the effect of low protein diets, formulated on net energy basis, on necrotic enteritis in broiler chickens. A total of 144 day-old male broiler chicks were kept in two battery brooders in separate rooms (12 cages of 6 birds) and were provided with a medicated, ideal-protein balanced starter diet for first 2 weeks after hatch. From d 14 onwards, 4 cages in each battery brooder were randomly assigned to one of 3 different ideal-protein balanced diets containing 16, 18 or 20% crude protein. Diets were isonenergetic and met NRC nutrient requirements. All birds were orally challenged with either a C. perfringens type A broth culture or sterile cooked meat broth from d 14 to 20 and euthanized on d 28. The majority of the birds gavaged with C. perfringens broth culture became dull, depressed and diarrheic. There was 8.33% and 1.39% mortality in the challenged and unchallenged groups, respectively. No significant differences were observed in the ileal or cecal C. perfringens populations among different diets or between challenged and unchallenged birds. Lactobacillus spp. counts were significantly higher in the birds fed 18 and 20% crude protein in the challenged birds. In conclusion, all diets supported very low intestinal colonization by C. perfringens however, a reduction in C. perfringens-associated lesion scores suggested that low protein diets may lower incidence of necrotic enteritis.

Key Words: necrotic enteritis, Clostridium perfringens, broiler
Microbial phytases are widely utilized to reduce inorganic phosphorous supplementation and excretion. The influence of day length and phytase supplementation on the degradation extent and location of phytate (IP6) degradation were investigated. Two hundred forty Ross 708 chicks were placed in four rooms, with 6 cages per room and 10 chicks per cage. All birds were fed a commercial type starter diet from 0 to 20 d. On day 20, 3 cages per room were maintained on a commercial type starter diet, and 3 cages were fed the same diet with 500 FTU of Quantumâ"¢ 2500D phytase. All diets were nutritionally complete with 0.45% aP. At the same time, 2 rooms were maintained on a 24 h lighting program, while 2 rooms were changed to 12 h light: 12 h dark. On day 24, all birds were euthanized, and the contents of the crop, proventriculus and gizzard (pooled), duodenum and jejunum (pooled), ileum, and a sample of excreta were collected, frozen and freeze dried. Samples were analyzed for acid insoluble ash marker content, and the level of water soluble and total IP6 and its degradation products (IP5 to IP2). Phytase supplementation increased feed intake, but had no effect on BW gain, thereby increasing feed conversion. These results are likely due to an increase in feed passage rate. As all diets contained adequate aP, no improvement in feed conversion would be expected. Phytase reduced the level of total IP6 and increased IP4 and IP3 in the crop, while unsupplemented diets showed higher levels of water soluble IP6 and IP5. Similar results were seen in the proventriculus and gizzard samples. Phytase reduced IP6 and increased the level of IP5 to IP3 in all small intestinal samples and the excreta. Solubility of all inositol phosphates was negligible in the small intestine and excreta. Lighting program only significantly reduced IP6 and increased other inositol phosphates in the small intestine, but not in the excreta. The interaction showed short day-length can increase IP6 dephosphorylation by phytase.

Key Words: phytase, phytate, dephosphorylation

Two experiments (Exp) determined the effects of phytate and phytase concentration (conc.) on nutrient utilization, mucin conc. in the jejenum and cecal volatile fatty acid (VFA) conc. of laying hen. In both Exp, hens were fed normal and low phytate-P diets (0.22 and 0.16% in Exp 1; 0.21 and 0.13% in Exp 2) with and without phytase supplementation (400 U Quantum phytase/kg) in a 2 x 2 factorial arrangement. Low phytate diets were made using degermed and debranned corn and corn bran in place of corn in a corn-SBM diet. In Exp 1, 28 wk-old hens were fed experimental diets for 17 d prior to sample collection. Phytate or phytase did not affect feed intake, egg production or hen BW gain. Distal jejunal mucin decreased by 28% and cecal propionic acid increased by 17% in hens fed the normal phytate diet (P<0.05). In Exp 2, 45 wk-old hens were fed experimental diets for 13 d prior to sample collection. As in Exp 1, egg production was not different among the treatments. Phytase supplementation increased feed intake and reduced BW loss regardless of dietary phytate conc. The low phytate diet reduced feed intake. Ileal P digestibility was increased by 14% with phytase supplementation and reducing phytate content of the diet tended to increase P digestibility. Reducing dietary phytate increased ileal AMEn by 136 kcal/kg. Apparent ileal N digestibility was not affected by dietary treatment, but apparent ileal thr digestibility increased by 4.6 %-units in birds fed the low phytate diets. Distal jejunal mucin production was not affected by diet. Cecal acetate was 15% greater in birds fed the normal phytate diet (P=0.01). Phytase supplementation decreased cecal butyric acid conc. in birds fed diets containing normal phytate conc. but not in diets with reduced phytate (P=0.05). Normal dietary phytate conc. increased cecal total VFA conc. In conclusion, dietary phytate conc. and to a lesser extent supplemental phytase can affect intestinal dynamics in laying hens.

Key Words: laying hens, phytase, phytate

To evaluate the effects of dietary phosphorus (P), calcium (Ca), and phytase on broiler performance and P utilization, 2,016 Ross 508 broiler chicks were distributed among 72 floor pens with 14 male and 14 female chicks per pen. Each pen received 906 g per bird of a standard broiler starter feed after which 18 dietary treatments were applied in a randomized complete block design to each of 4 replicate pens from 14 to 42 d of age. A 3 x 3 x 2 factorial treatment structure was used with three levels of available P (AvP) (0.35%, 0.30%, and 0.25%) combined with three levels of Ca (0.80%, 0.69%, and 0.57%) with two levels of phytase (0 and 600 FTU; Quantum™) applied. All diets were pelleted with conditioning temperatures in excess of 80 C. BW of male and female broilers were determined separately while feed intake of mixed sex pens was determined at 0, 14, 28, and 39 d of age. At 39 d average BW gain and feed conversion ratio corrected for mortality (AdjFCR) was 2,413 g and 1.62 g:g across all treatments, respectively. Results showed no evidence of either a two-way or three-way interaction of dietary Ca, AvP, or phytase on the broiler performance. Combinations of AvP and Ca level had no effect on BWG or AdjFCR to 28 or 42 d. However, the stepwise reduction in dietary AvP intake did result in a significant linear increase in mortality to 28 d but not between 28 and 42 d, although effects remained significant for cumulative 42 d mortality. Phytase addition increased female BW gain from 14 to 28 d but only positive numerical effects of phytase were found for male and female BW gain to 42 d. In this study, adjusting the AvP and Ca levels and supplementing phytase had no detrimental impact on performance, although lowering the AvP intake significantly increased early mortality.

Key Words: poultry, broiler, phosphorus
161 Studies of the effects of adding a combination of dietary Ca, L-alPHA-OH cholecalciferol, and phytase to a diet deficient in available phosphorus. A. Liem*, G. M. Pesti, and H. M. Edwards Jr., University of Georgia, Athens.

Previous research has shown that supplemental phytase and L-alpha-OH cholecalciferol (L alpha D3) increases phytate P utilization. Decreasing Ca level in the diet also increases phytate P utilization. The current study was conducted to see if there is a three way interaction among these 3 factors and generate mathematical models of the results to study in detail the two and three way interactions. The criteria measured were 16 day body weight gain, feed intake, incidence of Ca and P rickets, percent and mg/tibia bone ash, and disappearance of phytate. The study used a 3 dimensional rotatable design with 5 levels of Ca (0.5, 0.6, 0.8, 1.0, 1.08 %), L alpha D3 (2.2, 3, 5, 7, 7.8 µg/kg), and phytase (2.27, 2.40, 2.70, 3.00, and 3.12 log of units/ kg). An experiment was conducted with 480 Cobb x Cobb mixed sex 1 day old chickens raised to 16 day. The diet was primarily corn and soybean meal with total P and available P content 0.5% and 0.24% respectively. The p-value in the full models for the 3 way interactions for body weight gain =0.1364, feed intake =0.3535, bone ash % =0.0278, mg bone ash/tibia =0.0909, calcium rickets =0.9394, phosphorus rickets =0.4892, tibial dyschondroplasia =0.5927, and phytate P disappearance =0.0882. Reduced models were used to generate surface response of each criteria measured. The body weight gain response showed significant effects of all three variables, however, the Ca levels are a major effect on body weight gain and on the response to L alpha D3 and phytase. The bone ash response indicates that higher phytase levels, lower Ca, and higher L alpha D3 levels of the diet are needed to obtain maximum bone ash. These results indicate that studies such as this to simulate practical dietary conditions may be conducted to identify the best level of nutrients to add to a diet where complex 3 way interactions exist affecting several criteria.

Key Words: 1 alpha-OH cholecalciferol, phytase, calcium

162 Incorporation of wheat middlings, citric acid, and phytase in a corn soybean meal diet: Effects on phosphorus utilization and growth in the grower and finisher phases. T. O'Connor-Dennie* and J. L. Emmert, University of Arkansas, Fayetteville.

Previous research has indicated that citric acid (CA) improves phosphorus (P) utilization of chicks in the starter phase, but has no additive effect when combined with wheat middlings (WM), despite high levels of intrinsic phytase activity in WM. One hypothesis for this lack of synergism is the underdevelopment of the GI tract of young broilers. To test this theory an experiment was conducted utilizing broilers from 18 d of age. Birds were placed on a common diet adequate in P from d 0 to d 18, on d 18 chicks were weighed and allotted to experimental diets. Twenty or 15 broilers were allotted to 15 treatments of 5 replications each, for grower (18 to 29 d) and finisher periods (29 to 43 d), respectively. Diets 1 through 4 consisted of a P deficient diet with graded levels of supplemental P (0, 0.04, 0.08, or 0.12% P respectively). Diets 5 through 15 were as diet 1 with phytase (300 or 600 FTU/kg), CA (3%) or WM (10%), alone or in combination. During the grower and finisher periods increasing dietary P, phytase and CA increased bone response variables. Increasing P and phytase levels increased growth, with 600FTU/kg negating all effects of decreasing dietary P. To assess bioavailable P release standard curves were used on data for grower and overall periods. Adjusted bone strength (ABS) (kg/mm2), gain (kg) and percent bone ash were the dependent variables and supplemental P consumption (kg) the independent variable. During the grower period adding phytase released a minimum of 0.06 % P based on ABS and gain values. There was an additive effect of phytase on CA, or CA and WM (P < 0.001) using ABS values, CA also had an additive effect on WM (P < 0.001). There was no additive effect using gain values. For the finisher phase a similar trend was observed using ABS and gain values. Therefore combining phytase, CA and WM is better than phytase alone for releasing P and negate negative effects of a severely deficient P diet on bone variables.

Key Words: citric acid, phytase, wheat middlings


Six replicate pens of 35 Ross 508 male broiler chicks were used for each of 12 treatments in an experiment to determine the effect of varying dietary Ca and P on the responses to a fungal (FP) or bacterial (Quantum™ 2500D, QP) phytase. Corn-soy based diets were formulated to provide all nutrients at NRC requirement levels or greater (positive control (PC)), as the PC but with 0.14% and 0.13% less AvP in the starter (0-21d) and finisher (21-42d) respectively (Low P), or as the PC but with 0.15% less Ca in the starter and finisher (Low PCa). To each series of diets was added either 0, 250 or 500 units of QP or 500 units of FP phytase. Gain, intake and FCR data were analysed by ANOVA with main effects of diet CaP, enzyme type/dose and their interaction investigated with means being separated by use of the lsmeans pdiff procedure (p<0.05). There was a clear reduction in gain and intake when the Low P and Lo PCa control diets were fed compared with the PC at both 21 and 42d. At 21, but not 42d, the Low PCa fed birds ate more and weighed more than the Low P fed birds. An interaction between dietary CaP and enzyme for gain and intake at both 21 and 42d of age occurred due to the lack of any enzyme effects on the positive control but large responses on the negative control. At 42d of age, the addition of 500 units of QP to the Low P diet resulted in superior gain to that of the FP treatment. In the Low PCa diets no such difference was apparent due to an improvement in FP Lo PCa performance relative to the Low P diet, QP performance remained relatively stable regardless of Ca concentration. FCR at 42d of age was improved by addition of phytases to the Low P but not the Low PCa diets. Optimum weight corrected FCR was achieved on the 500 unit dose of QP on the Low P diet. These data suggest that reduction in Ca as well as P is required for optimum functionality of the fungal phytase whereas the E. coli-derived phytase is able to perform equally well over a wide range of dietary Ca levels. Optimal overall performance was achieved on the low P diet supplemented with 500 units of phytase.

Key Words: phytase, calcium, phosphorus

164 Effect of different phytase sources on broiler performance and yield when added to the mixer and pelleted at two temperatures. T. Parr* and C. Wyatt, Syngenta Animal Nutrition, Research Triangle Park, North Carolina.

A previous study has been published indicating that a non-coated thermo-tolerant phytase (Quantum™) supported broiler performance
and significantly outperformed a coated fungal phytase (CFP) when pelleted at 80°C (Parr et al., 2006). A second 49-day trial was conducted to compare performance and carcass yield of broilers fed two different sources of phytase when pelleted at 81 or 87°C. A commercial four-phase feeding program consisting of corn/soybean meal/meat-bone meal diets was formulated and fed to 11 replicate pens (17 male broilers/pen) for each diet. Two similar formulations were used for the Quantum in this study: Phytase D (QPXD) and Phytase XT (QPXT). The dietary treatments consisted of a positive control (PC), a negative control (NC: nutrient reduction of 45 kcal/kg ME, 0.13% available P, 0.10% Ca, 0.01% Lys, 0.29% Thr and 0.18% TSAA), NC + 500U/kg CFP, NC + 500U/kg QPD, or NC + 500U/kg QPXT added to the mixer and pelleted. Birds fed QPD and QPXT diets pelleted at 81°C were heavier (P<0.01) than CFP, NC and PC-fed birds at both 40 and 49d. At 87°C, QPD and QPXT-fed birds weighed more (P<0.01) than CFP and NC-fed birds at 40d, whereas by 49d the QPXT-fed birds had heavier (P<0.01) weights than the other diets. At d40, both feed intake and FCR were improved (P<0.01) in QPXT-fed birds compared to NC and CFP birds at both pellet temperatures. FCR at d49 was not different (P< 0.05) between phytase sources at 81°C, but at 87°C, the QPXT-fed birds were more efficient (P<0.01) than the QPD or CFP-fed birds. Feeding the NC or CFP diets pelleted at both temperatures resulted in significantly less carcass yield compared to QPXT, QPD and PC-fed birds. The difference in carcass yield was found to be correlated to an increase leg quarter % compared to breast yield % with birds fed Quantum having the highest leg %. This study further validates that Quantum can support performance and yield when using the high nutrient reduction in diets pelleted up to 87°C compared to the CFP sources.

**Key Words:** phytase, Quantum, broiler

### 165 Dietary phytase activities and the efficiency of energy utilisation in chickens.

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Exogenous phytase is often added to poultry diets to increase mineral availability, growth performance of the birds and reduce environmental pollution. Although it has been hypothesised that dietary phytase may also increase the efficiency of dietary energy utilisation, there is a lack of scientific data supporting this hypothesis. The aim of this experiment was to determine the effect of dietary phytase on performance and efficiency of gross energy retention (GER) and metabolisable energy retention (EMER) when fed to young broiler chickens. Forty-eight male Ross broilers (from 7 to 17d age) were used and four soy-a-maize based diets (positive control (PC), negative control (NC), NC + 500, + 12500 FTU (phytase units/kg feed)). The enzyme used was derived from an evolved E. coli phytase (Quantum 2500U: Syngenta Animal Nutrition Inc.). There were six replicates of each diet in a randomised block design. Birds offered the diet containing 12500 FTU performed significantly better (P<0.05) than the NC group and tended (P<0.05) to have better growth performance compared to PC fed birds. The GER and EMER for the enzyme supplemented diets were significantly higher (P<0.05) compared to the negative control. The result of this study support the hypothesis from previous research that dietary phytase improves the efficiency of energy utilisation and, as a result, improves nutrient utilisation and the performance.

**Key Words:** phytase, broilers, efficiency of energy retention (EER)

### 166 Broiler performance on phytase-supplemented defatted rice bran diet during heat stress.

M. O. Smith*1 and O. Pumninn2,
1The University of Tennessee, Knoxville, 2Kasetsart University, Kamphaengsaen, Nakom Pathom, Thailand.

An experiment was conducted to determine broiler performance and mineral utilization of defatted rice bran diets supplemented with phytase under two different environmental temperatures. Six replicate groups of chicks were assigned to five dietary treatments consisting of a control corn-soybean meal based diet with 25% cornstarch and four diets containing two levels of defatted rice bran (10 and 25%) with or without commercial phytase (500 units/kg diet) supplementation. Birds were weighed weekly and feed intake determined. On day 21 birds were transferred to either a thermoneutral (23.9 C) or a heat stress (23.9-35 C, diurnal cycling) environmental chamber. Digesta retention time was determined and a 5-day total excreta collection was done at 35 days. Birds were slaughtered at 49 days, tibias harvested, and intestines collected. Including up to 25 % defatted rice bran in the diets of broilers was not detrimental and feed cost per weight gain of birds fed 25 % defatted rice bran was lower. Percent phosphorus, zinc, and manganese in tibia of birds fed 10 % defatted rice bran was improved by supplemental phytase. The adverse effects of heat stress on bird performance was not improved by phytase supplementation.

**Key Words:** defatted rice bran, broiler heat stress, phytase

### 167 Manipulation of dietary calcium, phosphorus, and phytase in broilers. 2. Effects on total and soluble phosphorus excretion.

A. B. Leytem*2,1, P. W. Plumstead1, R. O. Maguire1, E. Oviedo1, and J. T. Brake1, 1North Carolina State University, Raleigh, 2USDA-ARS, Kimberly, Idaho.

To address the effects of phosphorus (P), calcium (Ca), and phytase on manure and litter P excretion in broilers, 2,016 Ross 508 broiler chicks were distributed among 72 floor pens with 14 male and 14 female chicks per pen. Each pen received 906 g per bird of a standard broiler starter feed after which 18 dietary treatments were applied in a randomized complete block design to each of 4 replicate pens from 14 to 42 d of age. A 3 x 3 x 2 factorial treatment structure was used with three levels of available P (AvP) (0.35%, 0.30%, and 0.25%) combined with three levels of Ca (0.80%, 0.69%, and 0.57%) with two levels of phytase (0 and 600 FTU; Quantum™) applied. The AvP level of phytase amended diets was held constant by replacing 0.10% of the inorganic P from dicalcium phosphate with 600 FTU of phytase, while Ca and AvP levels of diets were varied by altering proportions of limestone, dicalcium phosphate, and an inert filler. To assess treatment effects on P excretion, fresh litter and manure were collected when the broilers were 39 and 41 d of age, respectively. Litter and manure was analyzed for total and soluble P. Results indicated that the inclusion of phytase at the expense of inorganic P, or reductions in AvP decreased the ratio of Ca:AvP in the diets pelleted at 80°C compared to the CFP diet. The Ca and AvP levels of diets were varied by altering proportions of limestone, dicalcium phosphate, and an inert filler. To assess treatment effects on P excretion, fresh litter and manure were collected when the broilers were 39 and 41 d of age, respectively. Litter and manure was analyzed for total and soluble P. Results indicated that the inclusion of phytase at the expense of inorganic P, or reductions in AvP decreased the ratio of Ca:AvP in the diets pelleted at 80°C compared to the CFP diet.
168 Effects of varied levels of dietary nonphytate P and Ca on P excretion and relationship between plasma inorganic P and urinary excretion of P in broilers. M. K. Manangi* and C. N. Coon, University of Arkansas, Fayetteville.

Two 5-d bioassays were conducted to evaluate the relationship between dietary NPP and plasma inorganic P (iP) levels in relation to nonphytate P (NPP) retention using normal birds and urinary P excretion using colostomized birds when the birds were supplemented with varied levels of NPP and Ca. For Experiment (Expt) 1, 40-d old Cobb-500 male broilers chicks were placed in individual metabolic cages and offered corn soybean test diets consisting of 8 levels of NPP (0.08, 0.13, 0.18, 0.23, 0.28, 0.33, 0.38, and 0.45%) combined with a fixed level of Ca (0.5%) and phytate P (0.17%). Reagent grade CaHPO4,2H2O was added to the basal diet as additional NPP source and 2% acid insoluble ash was used as a marker. Ten broiler chicks were fed each of the 8 test diets for the 80 experimental units. On day 5 of the Expt, blood samples were collected from 5 birds for each treatment group. Another group of 40-d Cobb-500 broiler chicks previously colostomized at 3-4 wks of age were fed the 8 experimental diets in order to collect excreta and urine samples separately. Expt 2 was conducted the same as Expt 1 using 50-d old birds, however Ca was maintained at 0.9% for all diets. Expt 2 was identical to Expt 1 with the exception of dietary Ca levels. Segmented line regression methodology was used to determine the break point estimates for plasma iP, urinary P and Ca excretion, and NPP retention. The estimates at the break points for plasma iP and feed NPP content (X), urinary P excretion and X, urinary Ca excretion and X, NPP retention and X for Expt 1 were 8.13mg/dL and 0.26%, 6.02mg/d and 0.28%, 4.12mg/d and 0.30%, and 78.36% and 0.29%, respectively, and for Expt 2, these estimates were 7.51mg/dL and 0.27%, 1.93mg/d and 0.21%, 11.16mg/d and 0.30%, and 82.21% and 0.25%, respectively. Increasing dietary NPP increased plasma iP concentration and increased % NPP retention until the broilers reach a point of physiological threshold for P. The excess P beyond physiological threshold is eliminated as reflected by decreased efficiency in % NPP retention.

Key Words: colostomized, urinary P and Ca, NPP retention

169 Apparent ileal digestibility and total tract nutrient retention of chickens receiving a cocktail of carboxydrases and protease or phytase individually or in combination. O. A. Olukosi*, A. J. Cowieson2, and O. Adeola1, 1Purdue University, West Lafayette, Indiana, 2Danisco Animal Nutrition, Marlborough, Wilshire, United Kingdom.

The effect of adding a cocktail of xylanase, amylase and protease (XAP) or Escherichia coli-derived phytase (ECP) individually or in combination on ileal nutrient digestibility and total tract nutrient retention of chicks receiving corn-soybean meal-based diet was investigated. Six hundred d-old chicks were used for the 21-d study and were allocated to 5 dietary treatments in a randomized complete block design. The treatments were: positive control with supplemental inorganic P (PC), negative control (NC) marginal in P and energy; NC plus XAP added at 0.2 g/kg to supply 650; 1,650; and 4,000 units of xylanase, amylase and protease, respectively per kg feed; NC plus ECP added at 1,000 FTU/kg; and NC plus XAP added at 0.2 g/kg and ECP added at 1,000 FTU/kg. Ileal digestibility of DM was higher (P < 0.05) in PC compared with NC, phytase improved (P < 0.05) ileal DM digestibility above the NC diet; but XAP alone or combined with ECP did not improve DM digestibility. Ileal nitrogen digestibility was improved (P < 0.05) above the NC by the addition of XAP or phytase individually. Ileal P digestibility was highest (P < 0.001) in diet with ECP and lowest in NC diet. Ileal ME was higher (P < 0.01) in PC than NC, but there were no effects of the enzymes individually or in combination on ileal ME. Total tract DM retention was lower in NC (P < 0.01) than PC but was improved (P < 0.05) above the NC by the addition of the enzymes individually and in combination. Total tract P retention was highest (P < 0.01) in diet with ECP and lowest in NC. Total tract N retention was significantly improved (P < 0.01) above the NC diet by the addition of XAP and ECP individually and in combination. Both enzymes alone and in combination improved (P < 0.01) total tract DM retention whereas only ECP improved (P < 0.05) ileal DM digestibility. In conclusion, XAP and ECP individually and in combination improved ileal digestibility and total tract nutrient retention of N and P in chickens fed corn-soybean meal-based diet that is marginally deficient in energy and phosphorus.

Key Words: carboxydrases, digestibility, phytase

170 Performance parameters and egg ω3 fatty acids content in laying hens fed flaxseed diets without or with enzyme supplementation. W. Jia*, B. A. Slominski1, W. Guenter2, A. Humphreys3, and O. Jones5, 1University of Manitoba, Winnipeg, MB, Canada, 2Maple Leaf Animal Nutrition, Winnipeg, MB, Canada, 3Canadian Bio-systems Inc., Calgary, Canada.

A 2x2 factorial experiment was conducted to evaluate the effects of diet type [flaxseed (150 g/kg diet)] or Limpro® [flaxseed : peas, 1:1 wt/wt (150 g/kg diet)] and enzyme addition (none or 0.2 g/kg diet) on egg production parameters, egg ω-3 fatty acids content and nutrient digestibility in Hy-Line CV-20 laying hens. The enzyme supplement contained cellulase, pectinase, xylanase, glucanase, mannanase, and galactanase activities. Each of the four treatments was randomly assigned and replicated six times with 18 hens per cage unit for a total of 108 birds per treatment from 39 to 63 weeks. The experiment was divided into two phases of three 28 days periods each. Performance data from each phase were combined and analyzed statistically by mixed procedure as repeated measurements. All diets were pelleted and crumbled. Phase I and Phase II diets contained 19% and 18% CP, respectively. Hens consuming the Limpro diets had overall higher egg production (84.7%; P<0.0001), lower feed consumption (98.5g/hen/day; P=0.02), and therefore better feed efficiency (1.95g feed/g egg; P<0.001) than those fed the flaxseed diets (79.4%, 100.1g and 2.09, respectively). Enzyme supplementation significantly increased (P<0.01) egg production (from 78.0 to 80.9%) and improved (P<0.001) feed efficiency (from 2.15 to 2.03) in hens fed the flaxseed diet. There was no significant effect of enzyme addition on egg production (84.7 vs 84.6%) and feed efficiency (1.97 vs 1.93) in hens fed the Limpro diet. Neither diet type nor enzyme supplementation affected the egg size which averaged 60.3g for the entire trial. Hens fed the Limpro diets produced eggs with superior shell quality (P<0.0001) and egg specific gravity higher than that from birds consuming the flaxseed diets (1.0793 vs 1.0755). Enzyme supplementation significantly increased (P<0.01) the specific gravity of the eggs produced by hens fed the flaxseed diet in Phase I (1.0800 vs 1.0773) but not in Phase II of the experiment. Both diet type and enzyme supplementation significantly affected ω-3 fatty acids deposition in the egg. Eggs produced by hens fed the flaxseed diets had higher (P<0.0001) ω-3 content (562 mg/60g egg) and lower ω-6 to ω-3 ratio (1.30) than those from hens consuming the Limpro diet (427 mg/60g egg and 1.71, respectively). Enzyme supplementation increased the
egg \(\omega-3\) content for the flaxseed diet (from 546 to 578 mg/60g egg; \(P=0.02\)) and for the Lirnpro diet (from 415 to 438 mg/60g egg; \(P=0.07\)). As well, an overall decrease (\(P=0.01\)) in \(\omega-6\) to \(\omega-3\) ratio (from 1.53 to 1.47) was noted. Enzyme addition increased (\(P=0.02\)) the NSP digestibility from 17.2 to 24.6\%. There was no significant effect of enzyme addition on total tract fat digestibility. Overall, hens fed the Lirnpro diets had higher (\(P=0.02\)) fat digestibility than those fed the flaxseed diets (95.6 vs 89.9\%). It could be concluded from this study that both dietary ingredient (i.e., Lirnpro) and diet processing along with enzyme supplementation had positive effects on feed utilization and the production of \(\omega-3\)-enriched eggs.

**Key Words:** laying hens, flaxseed, \(\omega-3\) eggs


Enzyme inclusion in broiler feeds has been increasing. Theoretically, enzyme blends can show a larger spectrum to improve nutrient utilization from low digestible substrates. In this study, 960 Cobb X Cobb 500 broiler chicks were placed in 32 floor pens. All birds were fed corn-soybean meal all vegetable diets allocated to 4 different treatments having energy and nutrients to meet or exceed NRC.

**Key Words:** broiler, enzyme, amylase

Physiology, Endocrinology, and Reproduction: Physiology

172 Can a novel lighting program for turkey breeder hens delay the expression of photorefractoriness and boost late-season egg production? J. A. Proudman* and T. D. Siopes*, USDA-ARS, Beltsville, Maryland, University of North Carolina, Raleigh.

Turkey breeder hens are commonly photostimulated to lay using a day length of at least 14 h of light (14L:10D), which results in a rapid onset and high peak of egg production. Some lighting programs then increase day length further as the reproductive season progresses. Long day length leads to photorefractoriness (PR) and an end to the breeding season in many hens. We have previously shown that a 12h photoperiod will not induce PR, but it also will not reliably stimulate maximum egg production. In this study, we photostimulated hens with a 16L:8D photoperiod for 8 wk to achieve maximum peak production and then reduced day length to 12L to reduce PR. After 7 more wk, we increased day length to 18L to boost late-season production in hens that remained photosensitive. Control hens received 16L:8D until 15 wk and then 18L:6D until the experiment was terminated at 34 wk. Results showed that hens receiving the experimental photoperiod had a lower incidence of PR than controls over 34 wk of production (10% vs 27%), and that egg production was significantly higher in the experimental group between 17 and 34 wk of lay. However, overall egg production did not differ between groups because 10% of the treated hens ceased laying during the 12 h light treatment period. These hens remained photosensitive and resumed lay when returned to a longer photoperiod (18L). We conclude that a reduction in photoperiod to 12L after 8 wk of conventional photostimulation will reduce PR, extend photosensitivity, and permit a subsequent boost in late-season egg production. Additional studies are needed to achieve a lighting program that will extend photosensitivity while maintaining egg production in all hens.

**Key Words:** turkey, photorefractoriness, photoperiod

173 Can typical poor egg production by turkeys during the summer be accounted for by insufficient lighting and reduced photoperiodic drive? T. D. Siopes*, North Carolina State University, Raleigh.

This experiment tested the hypothesis that typical poor egg production during the summer is a consequence of insufficient lighting and reduced photoperiodic drive. Large White turkey breeder hens were photostimulated at 30 wk of age with incandescent light on April 12 for summer (off-season) egg production and continued for 28 wk. The lighting treatments were given in a 2 x 2 factorial arrangement with day length and light intensity as main effects. Day length used was 15L:9D and 18L:6D whereas the intensities were 567 ± 67 and 22 ± 2 lux. All the treatments were within a light controlled building and there were 8 replicate pens of 5 hens for each treatment. Data were collected, by pen, for onset and the rate of lay; BW and feed consumption at 4 wk intervals; EW at 4 wk intervals including the weight of the first 14 eggs per cage, 6 replicates per treatment. Birds with 24 days of age received the grower feed for 4 days of adaptation and 3 days of total excreta collection. Body weight, feed intake and feed conversion were significantly improved for birds of Positive Control when compared to the Negative Control. The enzyme blend added to the Negative Control demonstrated a complete recovery in performance, similar to the Positive Control. However, differences between the two enzyme levels were not seen. Results from the metabolism assay showed consistency in formulated versus analyzed ME’s. Improvements in analyzed ME values of 2,06 and 4,36% were observed after inclusion of 300 and 400 grams of the enzyme blend, respectively. Viscosity of excreta samples collected at 42 days and the yield of carcasses and commercial cuts were not affected by the treatments.

**Key Words:** broiler, enzyme, amylase
A quantitative assessment of the role of photoreceptors in the eye on gonadal development is not clear in avian species. Enucleation studies have shown that eyes have little effect, on subsequent gonadal development. The current study was done to assess the role of eye on reproduction by chemical induction of blindness (elimination of rods and cones), and to analyze the effect of the chemical on encephalic photoreceptors (EPRs). Formoguanamine HCl (FG) has been shown to cause selective blindness in several avian species. Male broilers were raised on a short photoperiod (LD 8:16) and were injected with either FG (200mg) or saline. At 2 wk, FG injected birds were given a feed mixed with Sulfamethazine (SMZ), a compound with progonadal effects (FG+SMZ; n=12). Saline injected birds were either on an SMZ diet (SAL+SMZ; n=12), or a regular ration (SAL+CON; n=12).

Photoperiod was shifted to LD 16:8 for 3 wk. Blood samples were collected on days 0, 3, 6 of LD16:8 and assayed for FSH and LH. Based on visual response, the FG+SMZ group was further divided into fully blind (FB+SMZ; n=5) and partially blind (PB+SMZ; n=5) individuals. There was a difference in plasma LH and FSH on days 3 and 6 of SAL+SMZ versus SAL+CON groups. Plasma LH and FSH levels of FG treated birds on Day 6 were different from SAL+CON. Testes weights (mean±SEM) of each group were: SAL+SMZ: 0.65±0.10; FB+SMZ: 0.475±0.47; PB+SMZ: 0.452±0.04; SAL+CON: 0.365±0.02. There is a 27% reduction in testes weights of FB birds compared to SAL+SMZ. Preliminary neuron (VIP-ir) count results in lateral sepal organ, a proposed EPR, showed no difference in cell numbers in SMZ-fed SAL and FG groups (546 and 507 neurons respectively) (n=2) suggesting that FG had no effect on proposed EPRs. Although there is no significant suppression in testes weights from birds lacking retinal photoreceptors compared to controls, the numerical values (27% reduction) suggest that the eyes possibly play a minor role on gonadal development. Supported in part by grant # IBN-0315793 from the NSF to WJK.

**Key Words:** reproduction, photoreceptor, sulfamethazine

### 174 Effect of eyes on reproduction in Formoguanamine injected male chicks.

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Determining the role of the eye and the brain photoreception in the decline in reproductive activities was the objective of this study. Animals: 130 broiler breeder hens at 23 wk of age were divided into nine environmental and light controlled rooms (n=15), equipped with individual battery cages. Three rooms were photostimulated (14L:10D) with full light spectrum (white light; 29 lux; 0.16 W/m²), and served as control. Six rooms were equipped with two lighting systems provided; red (0.16 W/m²) and green (27.5 lux). Upon photostimulation three rooms were photostimulated by increasing red light to 14 h of light (green light remained on 6 h) and the last 3 rooms were photostimulated by increasing green light to 14 h of light (red light remained on 6 h). Reproductive activities were recorded daily, monthly blood samples were collected and plasma level of ovarian steroids, as well as LH was recorded. At 65 wk of age birds were killed, hypothalamic tissue and pituitary were removed and assay for GnrH, GnIH, VIP mRNA levels.

Photostimulation with green light caused a significant delay in the reproductive activities manifested by low egg production and plasma gonadal steroid levels during the 12 wk of photostimulation. Cumulative eggs were the lowest during all the period of experiment. Hens photostimulated with red light had higher egg production, compared to white control and green light treated birds. Photostimulation with red light caused significant elevation in both GnrH and GnIH mRNA level. Retinal photostimulation (green light) together with non-photostimulation of extra-retinal photoreceptors (red light) delayed reproductive activities; where as extra-retinal photostimulation (red light) together with retinal non-photostimulation (green light) accelerated reproductive activities.

**Key Words:** broiler breeder, photostimulation, photoreception

### 175 The role of the retinal and extra retinal photoreceptors in reproductive activities of broiler breeder hens.

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The role of light in biological activities associated with egg production is well known. The decline in the rate of egg production during the reproductive season of the hen can be the result of incubation behavior as well as photorefractoriness both connected to photostimulation. Determining the role of the eye and the brain photoreception in the decline in reproductive activities was the objective of this study.

Animals: 130 broiler breeder hens at 23 wk of age were divided into nine environmental and light controlled rooms (n=15), equipped with individual battery cages. Three rooms were photostimulated (14L:10D) with full light spectrum (white light; 29 lux; 0.16 W/m²), and served as control. Six rooms were equipped with two lighting systems provided; red (0.16 W/m²) and green (27.5 lux). Upon photostimulation three rooms were photostimulated by increasing red light to 14 h of light (green light remained on 6 h) and the last 3 rooms were photostimulated by increasing green light to 14 h of light (red light remained on 6 h). Reproductive activities were recorded daily, monthly blood samples were collected and plasma level of ovarian steroids, as well as LH was recorded. At 65 wk of age birds were killed, hypothalamic tissue and pituitary were removed and assay for GnrH, GnIH, VIP mRNA levels.

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**Key Words:** reproduction, photoreceptor, sulfamethazine

**Effect of arginine on blood gases , acid–base balance and plasma corticosterone in broilers.** L. L. Hale-McWilliams*, M. Putsakum, S. W. Anderson, A. Corzo, Y. Vizzier-Thaxton, and J. P. Thaxton, Mississippi State University, Mississippi State.

Blood gases (pO2 and pCO2), acid-base balance as indicated by blood pH, electrolytes (HCO3-, Na+, K+, Ca2+, and Cl–), and plasma corticosterone (CS) concentration, were determined in 43 d broilers. These broilers (Ross x Ross 708 males) were raised with common feeds up to 21 d of age, and then fed from 21 to 43 d a grower–phase diet either marginal (0.98% digestible arginine; CON) or supplemented with 0.1% L–Arginine (1.08% digestible arginine; ARG). Arginine supplementation improved (P<0.01) the feed conversion of the ARG birds when compared to the CON treatment, thus validating that ARG was dietary marginal. From a hematological standpoint, the only effect attributable to ARG treatment, as compared to CON diets, was a decrease in blood pO2. Plasma CS levels were separated into high (3,327 to 10,100 pg/mL), medium (992 to 2,947 pg/mL) and low (296 to 943 pg/mL) concentrations, regardless of nutritional status. Blood pO2 levels were not different among the three CS groups. However, birds that received ARG treatment and possessed high CS levels had the lowest pO2 of all ARG and CS combinations. Dietary ARG is known to cause increased synthesis of creatine phosphate in growing broilers. Therefore, it is probable that arginine favors assimilation of a metabolic oxygen reserve via formation of creatine phosphate.

**Key Words:** oxygen, arginine, corticosterone

The developmental profile of hepatic gene expression was examined in chickens divergently selected for either high growth (HG) or low growth (LG) rate. Body weight in these INRA lines diverges after 3 wk with a greater than 2-fold difference at 11 wk. Furthermore, relative abdominal fat weight of HG birds was 14-fold greater than that in the LG at 11 wk. Liver samples were collected from HG and LG cockerels (6 birds per line) at 1, 3, 5, 7, 9 and 11 wk. Del-Mar 14K Chicken Integrated Systems microarrays were used for a transcriptional scan in liver during juvenile development using a balanced block hybridization design. Log2-transformed fluorescence intensities were analyzed with a two-stage mixed model. The initial analysis revealed 557 genes that showed a significant interaction between genotype and age. The largest number of differentially expressed genes (357) was found at 7 weeks of age, where 199 genes were up-regulated in the HG line and 176 genes were up-regulated in the LG line. At 9 wk, only 36 genes were up-regulated in the HG line, whereas 17 genes were up-regulated in the LG line. The differential expression of several genes was confirmed by quantitative RT-PCR. Genes that showed significantly higher transcript levels in the liver of HG birds include CEBPA, SULT1, CPT1, FASN, DLAT, and HMGLC. Among hepatic genes with verified higher expression in LG birds were PTGDS, CEBPB, SOD, AVL-Pr57, ANX5, and LDH. The differentially expressed genes include many metabolic enzymes, acute phase proteins, immune factors and transcription factors that could control key metabolic processes and therefore expression of production traits (growth rate and body fat content). Several of these functional genes map to QTL identified in a novel F2 resource population created from a cross of the HG and LG lines.

Key Words: microarray, functional genes, metabolic pathways

178 Inosine ameliorates the effects of hemin induced oxidative stress in broilers. C. N. Seaman1, G. Casotti2, E. A. Falkenstein1, J. S. Moritz1, K. Van Dyke1, and H. Klandorf1.

Previous studies have shown that chronic treatment of chickens with hemin decreases plasma concentrations of uric acid (PUA) and increases oxidative stress whereas the inclusion of inosine produces an inverse effect. The objective of our study was to determine whether inosine could lower the oxidative stress induced by hemin. Four-wk-old broilers were individually banded and divided into four treatment groups (Control, Hemin, Inosine, Hemin/Inosine). Throughout the study control birds (n=10) were injected daily with a buffer solution, while hemin birds (n=10) were injected daily with a 20mg/kg body weight hemin buffer solution. Leukocyte oxidative activity (LOA) and PUA were measured on day eight. Results showed that hemin birds had higher levels of LOA (P=0.0333) and lower PUA (P=0.1174). On day 10, control and hemin birds were subdivided into inosine birds (n=5) and hemin/inosine birds (n=5). These birds were given 0.6M/kg of feed/d of dry inosine. Plasma concentrations of uric acid and LOA were then measured on day 15. Results showed that inosine raised concentrations of PUA (P=0.0001) and lowered LOA (P=0.0044) as induced by hemin. In a separate study stereological analyses of inosine vs. control birds revealed no anatomical differences in kidney morphology between treatments (P<0.05). The results of these studies support the view that uric acid reduces oxidative stress by functioning as an antioxidant. Uric acid treatment has the potential to decrease the amount of damage generated by free radicals during times of oxidative stress associated with disease states.

Key Words: uric acid, oxidative stress, hemin

179 Patho-physiological changes associated with rapid growth in commercial broilers. S. Nain*, B. Laarveld, and A. A. Olkowski.

This work examines patho-physiological changes in commercial male broilers reared in lowered environmental temperature either fed ad-lib or subjected to a feed restriction regime. The birds were housed in pens with raised perforated floors in an environmentally controlled room. The temperature during the first 7 d was maintained at 34°C followed by a gradual decrease to a level approximately 30% lower than that set for normo-thermal brooding. A total of 83 birds were allocated to an ad-lib fed group and 39 to a feed-restricted group. Feed restriction set at 70% ad libitum commenced at day 7. All birds were monitored several times a day for overt signs of disease. Morbidity and mortality data were collected daily. Basic physiological data evaluating cardiovascular and respiratory function were obtained during the 5th wk of the trial using randomly selected apparently normal birds from each group. There was no mortality in the feed restricted group and all birds remained clinically normal throughout the trial. In the ad-lib fed group 6% and 46% succumbed to sudden death syndrome (SDS) and ascites, respectively. Broilers fed ad-lib had a significantly (P<0.05) lower heart rate (HR: mean 322 BPM) and a higher respiration rate (RR, mean 56) compared to the feed restricted group (HR: 370 and RR, 51). Blood gas analyses revealed marked hypercapnia (pCO2, 48.3), hypoxemia (pO2, 38.3) and lower hemoglobin O2 saturation (69.3%) in the ad lib fed group, as compared to the restricted group (pCO2: 36.02; pO2:41.88; and hemoglobin O2 saturation 71.2%). ASCitic birds showed severe hypercapnia (pCO2 58.2), hypoxemia (pO2 21.3) and the lowest hemoglobin O2 saturation (30.6%). We conclude that many individuals in a population of commercial broilers are predisposed to heart failure and that low temperature and rapid growth are important factors precipitating patho-physiological changes in cardiac and respiratory functions in the susceptible broilers.

Key Words: broilers, heart failure, mortality


A study was conducted to evaluate the effects on broiler breeder females of two feed allocation programs during the rearing period followed by two feed increase rates from photostimulation to peak egg production. Twelve replicate pens of 190 females each were randomly assigned to two treatments (sigmoid or line) during the rearing period (1 to 21 wk of age) and two feed increase treatments (slow or fast) from photostimulation to peak egg production in a 2 x 2 factorial design with three replicate pens each. The flock was photostimulated at 21 wk of age when Ross 344 males and Ross 308SF females were
housed and mixed in the production facility. There were no differences in rate of lay but females that had been reared on the sigmoid feeding program exhibited significantly reduced mortality during the laying period that resulted in a significantly increased number of eggs per hen housed (185.3 versus 175.6). Fertility was not affected but fertile hatchability was significantly improved by the sigmoid rearing program (93.1% versus 90.9%) due primarily to fewer early and late dead (not including pipped) embryos. There were no differences due to the two different feed increase programs from photostimulation to peak egg production.

Key Words: broiler breeders, feeding programs, fertility

181 The effects of skip-a-day feeding during the early lay period on reproductive physiology in broiler breeder hens. L. C. Gibson*, A. J. Davis, and J. L. Wilson, University of Georgia, Athens.

Skip-a-day (SAD) feed restriction is a common industry management technique that is used from 2 wk of age until 5% egg production in broiler breeders. The current study examined whether SAD feeding after light stimulation to 5% egg production is detrimental to overall reproductive performance. During rearing pullets were weighed weekly, and all pullets were fed on a SAD basis through 20 wk of age. At 21 wk of age, pullets and cockerels were moved into 30 lay pens each having 35 females and 4 males, and provided 14 h of light to stimulate reproduction. From 21 to 26.5 wk, 15 of the pens were provided ED feeding while the remaining 15 pens continued on SAD feeding until 8% egg production. At 26.5 wk, all hens were placed on ED feeding. Blood samples were collected from the hens of one individual pen from each treatment group at 26.5 and 30.5 wk. Bird weight and the coefficient of variation of bird weight were not significantly different between the two treatments from 20 wk of age through 62 wk of age. Plasma progesterone and estradiol concentrations were significantly depressed in the SAD hens at 30.5 wk. Through 62 wk of age hens that were provided ED feeding have a hen-day egg production of 163.0 eggs versus 145.6 eggs from the SAD birds. This significant difference in egg production is based on a consistently lower production of 163.0 eggs versus 145.6 eggs from the SAD birds. This study used radiographs to quantify fracture incidence in hens. This study used radiographs to quantify fracture incidence in six lines of non-commercial high-producing laying hens. Euthanyl Forte was used to euthanize 451 hens (n=71 to 78) at 47 wk [White Leghorn-Black (WL-BLK), WL-Blue (WL-BLU)], or at 65 wk of age [Barred Rock (BR), Columbian Rock (CR), Rhode Island Red (RIR), and WL-Burgundy (WL-BUR)]. Carcasses were stored at -20°C and thawed prior to being x-rayed. Radiographs were obtained with birds in lateral (left side down) and dorso-ventral positions. Fractures were classified as new (sharp edges without apparent tissue reaction) or old (edges undefined or callus noted). Damage to bones of the head, neck, and feet was not evaluated and difficulties were encountered in analyzing the ribs, sternal processes, and vertebrae. Contingency chi-square analysis was used to compare lines within age groups. The overall incidence of birds with at least one fracture was 15.7 and 6.6% (65 and 47 wk, respectively) with 88 and 100% of the fractures classified as old. The incidence of hens with fractures in the lines observed at 47 wk was not different (WL-BLK: 6.4%; WL-BLU: 6.8%) and fractures in these lines occurred primarily in the wing and pubic bones. The incidence of hens with fractures in the 65-wk-old birds was 29.5% (RIR), 18.2% (BR), 9.5% (CR), and 4.2% (WL-BUR); (RIR>BR, RIR>CR and WL-BUR, BR>WL-BUR). Fractures occurred primarily in the furculum, pubic bones, and wing bones with more fractures of the furculum for RIR than the other three lines (17.9 vs. 0 to 5.4%), while BR hens had more fractures of pubic bones (14.3 vs. 1.3 to 1.4%). These data show variation in bone fragility and bones susceptible to fracture among the lines studied, and demonstrated that radiographs are a useful means for gathering data on fracture incidence.

Key Words: radiograph, fracture, bone

182 Changes in the microbiota populations and gastrointestinal tract development of the jejunum and ileum. B. S. Lumpkins*, A. B. Batal, and M. D. Lee, University of Georgia, Athens.

The bacterial population in the gastrointestinal tract (GIT) influences a variety of physiological processes of the GIT and exerts a profound effect on the overall health and development of the bird. However, little is known about how the presence of different intestinal bacterial community compositions affects the development of the GIT in chickens. Three 21 d preliminary experiments were conducted to observe changes in the microbiota populations and GIT development of Cobb 500 chicks. In Experiment 1, a corn-soybean meal (SBM) and a corn-fish/poultry by-product meal diet and in Experiment 2, a corn-SBM and a semi-purified corn gluten meal-casein-soy protein concentrate diet were fed to 8 replicate pens of 20 chicks. In Experiment 3, chicks were sexed, allocated to 8 replications of 20 chicks, and each fed a corn-SBM diet. At 4, 7, 14, and 21 d of age, chicks were randomly selected for jejunum and ileum sampling. The bacterial DNA was isolated from the digesta, and denaturing gradient gel electrophoresis (DGGE) was used to examine PCR amplified fragments of 16s ribosomal DNA. In Experiment 1, chicks fed the corn-fish/poultry by-product meal diet had greater jejunum weights and villi height at 4 and 14 d of age compared to chicks fed the control diet, but at 7 and 21 d of age there was no difference in GIT length, weight, villi height or width between treatments. A difference in bands using DGGE was observed between treatments as well as with age, and at 14 and 21 d there was an increase in high G + C bacteria such as clostridium. In Experiment 2, an increase in intestinal length and biodiversity of the microbiota population characterized by more low and high G + C bacteria, lactobacillus and clostridium respectively, were observed in chicks fed the semi-purified diet compared to the corn-SBM diet. In Experiment 3, there were no differences in GIT measurements or the microbiota population due to sex. Based on DGGE analysis, it was concluded that the developmental changes of the GIT were related to changes in microbiota populations.

Key Words: microbiota, gastrointestinal tract, denaturing gradient gel electrophoresis
Post–cooking contamination of Ready–to–Eat (RTE) meat and poultry products by *Listeria monocytogenes* (LM) is a major food safety problem as well as an economic hardship to the food industry for several years. Various post–processing interventions like in–package pasteurization, high pressure processing, and application of various antimicrobial agents alone or in combination have been tested to eliminate LM from RTE meat surfaces. The objective of this study was to determine the effect of combining nisin and/or lysozyme surface application with in–package pasteurization on the survival of LM on RTE turkey bologna during storage at 4°C. Bologna samples were subjected to surface application of 4 treatments–control (no antimicrobial), nisin (2000IU/ml), lysozyme (10mg/ml), and a combination of nisin and lysozyme (2000IU nisin+10mg lysozyme/ml). Samples were inoculated with 10⁵cfu of the organism and vacuum packaged. A set of 4 treatments were stored without subjecting to in–package pasteurization. Another set of 4 treatments were subjected to in–package pasteurization at 65°C for 1.3 minutes. All treatments were sampled for LM growth at 0day, 1, 2, 3, and 4 weeks of storage. Treatments subjected to in-package pasteurization showed a 3–4 log initial reduction and also a significant reduction over 4 weeks of storage in LM population compared to treatments without pasteurization. Pasteurized control and lysozyme treated samples showed a 2 log reduction over 4 weeks whereas pasteurized nisin and nisin–lysozyme combination treatments showed a 4 log reduction (no viable cells of the organism from 3⁴week). Results of this study indicate that combining nisin and nisin–lysozyme combination treatments with in–package pasteurization is effective in eliminating LM from RTE meat and poultry products. Results would be significant to the industry considering the fact that the reduction in bacterial population was achieved by a relatively short pasteurization time.

**Key Words:** turkey bologna, antimicrobials, in–package pasteurization

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During processing of poultry products, bacteria from the carcass can attach to wet surfaces which can lead to biofilm formation providing a source for cross contamination for subsequent carcasses. The purpose of this study was to determine susceptibility to bacterial attachment and biofilm formation with and without poultry products of different conveyor belts including polyurethane with mono polyester fabric, acetal (3.2 % open mesh), polypropylene- mesh top (24% open mesh), polypropylene (48% open mesh), stainless steel –single loop (80% open mesh) and stainless steel–balance weave (70% open mesh). Experiment 1 –Surfaces were inoculated with *Salmonella* cocktail (without any poultry product) in BPW to achieve final inoculum level of 5 log CFU/ml. Test surfaces were analyzed by sponge and swab method at 0, 1, 2, 4, 6, 8, 12, 24 and 48 hr. For aerobic plate count, the stainless steel belts (single loop and double loop) showed significant reduction in APC when compared to other belts. Initial attachment (0 hr) of *Salmonella* did not show any significant change in all belt types; however, canvas belts showed a significant attachment over time. Experiment 2 –Attachment of bacteria with poultry products was determined with test chips. Chicken breasts were inoculated with *Salmonella* or *Listeria monocytogenes* culture for one hour and rinsed with PBS. Test chips were immersed in this solution and evaluated (1, 6, 12, 24 and 48 hr). At 1 and 48 hr, attachment of *Salmonella* and *Listeria monocytogenes* was lowest in the stainless steel single loop (0.403 log CFU/cm²), and stainless steel–balance weave (0.364 log CFU/cm²). Experiment 3 –Attachment of *Listeria monocytogenes* to form a biofilm was determined. Initial biofilm formation was very low on the stainless steel belts but by day 4 all belts had biofilm formation. Therefore, stainless steel belts allowed for less growth and attachment of bacteria over time. However, even stainless steel belts must be cleaned and sanitized to prevent biofilm formation over time.

**Key Words:** poultry processing, biofilm, bacteria
187 Effect of alkaline scald conditions on Salmonella or Campylobacter recovery during commercial turkey processing. S. M. Stevens*, 1 J. A. Byrd, 2 A. P. McElroy, 1 S. M. Anderson, 1 D. J. Nisbet, 1 and D. J. Caldwell, 1 Texas A&M University, College Station, USDA-ARS-SPARC, College Station, Texas, Virginia Tech, Blacksburg.

Despite several published reports performed with broilers, scant attention has been given to the scalding environment as a potential area of bacterial reduction in commercial turkey processing. Research conducted in broiler plants has shown that proper operation of scald tanks results in significant log-scale reductions of Campylobacter on carcasses. Further, raising the pH of scald water during broiler processing (pH=9.0) has similarly been shown to increase thermal killing of Salmonella on broiler carcasses. To determine if similar reductions occur during commercial turkey processing, we compared Salmonella or Campylobacter incidence and direct recovery from carcasses following alkaline or normal pH scald conditions. Sodium carbonate or sodium hydroxide (Plant 3 only) was used to raise scald tank water pH (pH 9-10). In each of three distinct commercial facilities, sampling consisted of taking 50 pre-scald and 100 post-feather pick carcass rinses (50 normal pH scald and 50 alkaline pH scald) for Salmonella or Campylobacter recovery from collected rinse fluid. Two of three plants sampled revealed slightly increased Campylobacter recovery (1% or 4% whole carcass incidence) following alkaline scald as compared to normal pH scald conditions. All three facilities were associated with increased Salmonella recovery from carcasses (20%, 35%, or 40% whole carcass incidence) following alkaline scald conditions when compared to normal pH scald incidence. These findings differ from previous reports using broilers as a model. While alkaline pH scald did not appear to increase thermal killing of Salmonella or Campylobacter based upon our collected data, increased or facilitated bacterial detachment from carcasses by a pH dependent mechanism at this point in processing could have impacted our observed data.

Key Words: turkey processing, bacterial recovery, scald conditions

188 Effect of a high level chlorine rinse on the recovery of Salmonella and enumeration of bacteria from broiler carcasses. L. N. Bartenfeld*, 1 D. L. Fletcher, 1 and J. K. Northcutt, 1 The University of Georgia, Athens, USDA-ARS, Athens, Georgia.

A study was conducted to determine the microbiological impact of exposing broiler carcasses to a high concentration chlorine rinse (500 ppm sodium hypochlorite). During each of five replicate trials, eviscerated pre-chill carcasses were obtained from a commercial processing plant. Test carcasses were subjected to a 1 min rinse in 500 mL of a 500 ppm chlorine solution (HOCl), then removed from the bag and rinsed for an additional 1 min in 500 mL of sterile water. Control carcasses were treated the same way except sterile water was used in place of chlorine. Both chlorine-treated and control carcasses were then subjected to a whole carcass rinse (WCR) in 450 mL of buffered peptone water, with 50 mL of the rinsate removed for immediate enumeration of total aerobic bacteria (APC), Escherichia coli (EC), and total coliforms (TC). The entire carcass was then incubated overnight at 37°C in the remaining 400 mL of buffered peptone for recovery of Salmonella. Levels of bacteria recovered from WCRs were 1.3, 0.6 and 0.6 log10 cfu/mL lower for APC, EC and TC, respectively when carcasses were rinsed with chlorine instead of sterile water. However, there was no significant difference in prevalence of Salmonella between the two treatments (14/38 positive for control; 16/38 positive for HOCl). These results suggest that a high concentration chlorine rinse may significantly reduce the numbers of bacteria recovered from broiler carcasses without lowering the prevalence of Salmonella.

Key Words: broiler carcasses, carcass microbiology, chlorine


A study was conducted to determine the effectiveness of various interventions on the reduction of Campylobacter spp in chilled poultry. A total of 6 interventions, 2% lactic acid (LA), 2% acetic acid (AA), 1000 ppm acidified sodium chloride (ASC), 2% Trichloromelamine (TCM), 10% Trisodium Phosphate (TSP) and Hot Water (82°C) (HW), were compared to a rinse with Ambient Water (CONTROL) and to no rinsing (UNTREATED CONTROL). A total of 72 carcasses were assigned to the 8 treatments in three replications. In the pathogen processing area at Texas Tech University, a cocktail mixture of 4 strains of Campy spp were prepared and added to chicken carcasses by dipping to yield a population of approximately 7.0 log10 cfu/g of rinsate from the carcasses. Bacteria were allowed to attach for 1 h prior to application of interventions or sampling. The USDA poultry rinse method was used to sample the chickens. Standard FDA-BAM methods were used to enumerate Campylobacter spp on the carcasses. Prior to treatments, the average number of Campylobacter spp were 6.95 log10 cfu/ml of rinsate. The CONTROL and UNTREATED CONTROL samples contained 6.78 and 6.95 log10 cfu/ml of Campylobacter spp after treatments. The TSP and ASC treatments gave almost a 99.9% (3 log cycles) reduction of Campy spp compared to the control samples with numbers of 4.20 and 4.08 log10 cfu/g, respectively. The LA, AA, TCM, and HW treatments all resulted in approximately a one log reduction (90%) of Campylobacter spp on the treated carcasses compared to the controls. Treatment with ambient water did not result in a reduction of Campylobacter spp on the carcasses. No apparent sensory differences were evident after treatment. It is recommended that treatments with TSP and ASC are most effective in reducing Campylobacter spp. loads in poultry.

Key Words: Campylobacter, postharvest interventions, chicken

190 EU promoted research towards zootecchnical feed additives for the safe use in poultry production. V. Klose*, R. Phil*, M. Mohn*, S. Nitsch, and G. Schatzmayr, University of Natural Resources and Applied Life Sciences, Tulln, Austria, Biomin GmbH, Herzogenburg, Austria.

Livestock industry in Europe is facing new feed additive regulations banning the use of antibiotic growth promoters by 2006 as these could cause drug resistance in microbes that afflict humans. A multinational project (C-EX QLK-CT-2002-71662) funded by the European Union was initiated and brought together 5 industrial and 3 research partners in order to develop a safe microbial feed additive for poultry. The main aim was to establish a well-defined multi-component product combining various effective strains which should comply with the EU guidelines (Council Directive 87/153/EEC) for evaluation of probiotics for use in feedingstuffs, in terms of identity, efficacy and
safety. Numerous bacteria were isolated out of the gastrointestinal tract of healthy chickens and subjected to microbiological studies in order to obtain optimal strains for a competitive exclusion product. A polyphasic approach was carried out combining morphological, physiological and genotypic methods (e.g. morphology, protein profiling, analysis of metabolic end products, 16S rRNA gene analysis). 121 isolated strains were selected as representatives based on differences in whole cell protein patterns and screened for antagonistic properties against poultry pathogens. By using a co-cultivation assay, a reduced number of 90 strains exhibited the ability to inhibit *Salmonella enteritidis*. The 20 most effective strains were able to inhibit indicator pathogens such as *E. coli* serotypes, *S. choleraesuis*, *C. jejuni* and *C. perfringens*. Finally in regard to technological and functional aspects a multispecies product (Biomin® PoultryStar) was established consisting of 5 well-defined strains belonging to the genera *Enterococcus*, *Pediococcus*, *Lactobacillus* and *Bifidobacterium*. According to European safety requirements the candidates were subjected to a critical evaluation of the risks associated with the genetic transfer of antibiotic resistances from animals to humans via the food chain. On basis of a screening according to an opinion from the EU Scientific Committee on Animal Nutrition (SCAN, 2001) the strains were sensitive to the majority of clinically effective antibiotics. Using molecular studies (mating, polymerase chain reaction, plasmid preparation) single resistances were proven to be intrinsic (e.g. vanA) and not transferable. Positive effects of Biomin® PoultryStar have been shown in vivo with an efficacy trial (480 mixed sex Ross 308 broilers randomly allocated to 2 groups, 3 replications each). The control group received a standard diet, the test group received the product in the diet with an inclusion level of 5E+9 cfu/kg finishing feed. At the end of the trial chicks receiving Biomin® PoultryStar revealed a statistically significant (P<0.05) increase in their average body weight as well as in weight gain (~7.6%). Feed conversion was slightly improved and mortality (1.25% control vs. 0.42%) was reduced in the group receiving the additive. Overall fattening efficiency in this group was improved which was indicated by an increased European Production Efficiency Factor (356 vs. 318).

**Key Words:** competitive exclusion, European registration, safety assessment

### 191 Egg yolk antibody efficacy test I: The growth inhibition of *Clostridium perfringens* vegetative cells and spores in vitro.


Regardless of research aimed toward decreasing growth of food pathogens, *Clostridium perfringens* continues to remain a major cause of foodborne illness. The objective of this study is to test the efficacy of specific egg yolk antibodies (IgY) against the growth of *Clostridium perfringens* vegetative cells and spores in culture medium. *Clostridium perfringens* vegetative cells and spores prepared from ATCC were enumerated and normalized. The tubes were further divided into four groups containing either, *Clostridium perfringens* vegetative cells (1X10⁸ CFU) mixed with anti-*Clostridium perfringens* specific IgY (10 µg/ml); *Clostridium perfringens* spores (1X10⁵ CFU) mixed with anti-*Clostridium perfringens* specific IgY (10 µg/ml); *Clostridium perfringens* vegetative cells (1X10⁸ CFU); or *Clostridium perfringens* spores cells (1X10⁵ CFU).

Subsample of each group were incubated at 37°C for either 0, 2, 4, 8 or 24 h. Significant CFU reduction between controls and test groups against *Clostridium perfringens* vegetative cells (p < 0.05) and spores (p < 0.05) were observed. During 0 to 8 h of incubation, the number of vegetative cells increased by only 3.18 logs CFU/mL in test group, while cells increased by 3.72 logs CFU/mL in control group. At 24 h of incubation, a 2.1 log CFU/mL increase in the control group and 0.5 log CFU/mL decrease in the number of bacteria in the test group. Cell counts of *Clostridium perfringens* spores increased by 1.4 log CFU/mL and 5.47 log CFU/mL in test and control groups, respectively, during 0 to 8 h of incubation. This indicates a 10,000 fold reduction in number of bacteria in tubes containing specific IgY. At 24 h of incubation, there was over a 10 fold reduction in number of bacteria in tubes containing specific IgY. As a result, the growth of both *Clostridium perfringens* vegetative cells and spores in a culture medium was significantly inhibited by specific IgY. Our findings suggest the use of specific IgY as a natural food preservative to control the growth of *Clostridium perfringens* in food products.

**Key Words:** IgY, *Clostridium perfringens*, natural preservative

### 192 Rapid and specific real-time polymerase chain reaction method for detection of viable *Salmonella* species in poultry feed and feedstuff.

X. Li*, J. Caldwell, and J. Levine, North Carolina State University, Raleigh.

Traditional culture-based methods used to detect Salmonella are laborious and require a minimum of four days before isolates can be obtained and identified. The objective of this study was to develop a real-time polymerase chain reaction assay (qPCR) for routine analysis of viable Salmonella species in poultry feed and feedstuffs. Twenty-five grams of each sample obtained from a commercial poultry feed milling company at North Carolina was mixed with 225 ml of buffered peptone water (BPW) in a sterile plastic bag, stomached for 1 min, and incubated at 37°C for 18 to 24 h. The individual bag was thoroughly shaken before 1-ml samples were withdrawn and frozen at -20°C. The frozen samples were thawed and diluted 1:100 prior to conducting the qPCR assay. This method amplified a 119 bp PCR product originating from the invA gene of *Salmonella* chromosome DNA. *Salmonella* Heidelberg present at 10000 copies per PCR tube was used as a positive control. The PCR assay was performed in a Smart Cycler II System. Twenty-nine poultry feeds (starter, grower and finisher) and twenty-five feedstuffs (corn meal, soybean meal, and animal by-product) samples were evaluated by the qPCR method and compared to the standard Bacterial Analytical Manual (BAM) culture method for Salmonella detection. The qPCR method was rapid (obtained results within 45 min), simple (did not require DNA extraction or cell lysis), specific (only amplified Salmonella spp.), sensitive (detected 1 Salmonella cell in 25 grams of feed/feedstuff with background microflora 100000000 cfu per gram), accurate (yielded identical detection results as determined by the BAM method). Common PCR interference factors such as lipids, salts, proteins and the presence of a natural background microflora in feed and feedstuffs were circumvented by the use of DNA Hot Start TaqTM polymerase, pre-enrichment and appropriate sample dilution. This method can be used in the routine analysis of Salmonella spp. in feed and feedstuff with potential industry applications.

**Key Words:** real-time PCR, *Salmonella* detection, feed and feedstuff
193 **Destruction of Salmonella enteritidis and quality of table shell eggs using microwave commercial sterilization.** D. Lakins*, A. Echeverry, C. Alvarado, M. Brashears, and L. Thompson, Texas Tech University, Lubbock.

Currently, table eggs are the leading cause of foodborne illness caused by *Salmonella enteritidis*. The application of microwave commercial sterilization can cause the destruction of pathogenic microorganisms by both thermal and non-thermal effects. Therefore, the objective of this study was to determine if microwave commercial sterilization could be used to reduce loads of *Salmonella enteritidis* in shell eggs without causing a direct detrimental effect to the overall quality. A total of 414 shell eggs were used to determine the effect of microwave sterilization on quality. Destruction of *Salmonella enteritidis* was also determined by inoculating 12 eggs with a 10<sup>6</sup> *Salmonella enteritidis* cocktail and determining log recovery following the 10 sec microwave treatment. A trained sensory panel was used to evaluate the treated eggs (10 sec microwaved) and control eggs; eggs were observed for both raw and cooked (poached) attributes. The raw attributes that were evaluated included vitelline membrane strength, chalazae attachment, yolk color, and albumen color. There were no significant differences (P<0.05) between the microwave 10 sec treatment and the control for any of the raw attributes. The cooked attributes that were evaluated included hardness, egg flavor, yolk color and albumen color. There were no significant differences (P>0.05) between the microwaved 10 sec treatment and the control for any of the cooked attributes. For *Salmonella enteritidis* destruction, a 90% reduction was determined following the microwave treated (10 sec) shell eggs. Therefore, use of microwave commercial sterilization can be used on table in shell eggs to reduce *Salmonella enteritidis* within the eggs by up to 90% without causing detrimental effects to the overall quality of the raw and cooked eggs.

**Key Words:** microwave, in shell eggs, *Salmonella enteritidis*

194 **Effects of cool water washing of shell eggs on Haugh unit, vitelline membrane strength, aerobic bacteria, yeast, and mold.** A. B. Caudill*, P. A. Curtis<sup>1</sup>, D. R. Jones<sup>2</sup>, M. T. Musgrove<sup>2</sup>, K. E. Anderson<sup>3</sup>, and L. K. Kerth<sup>1</sup>, 1Auburn University, Auburn, Alabama, 2USDA Russell Research Center, Athens, Georgia, 3North Carolina State University, Raleigh.

Current egg washing practices utilize wash water temperatures averaging 49<sup>C</sup>, and have been found to increase internal egg temperature by 7-8<sup>C</sup>. These high temperatures create a more optimal environment for bacterial growth, including *Salmonella Enteritidis* (SE), if it is present. However, SE, the most common human pathogen associated with shell eggs and egg products, does not grow well at lower temperatures. This study’s objective was to determine if commercially washing eggs in cool water would aid in quickly reducing internal egg temperature, creating an environment less beneficial to bacteria and preserving egg quality. During three consecutive days eggs were washed at an off-line (Plant A) and an in-line (Plant B) commercial facility. Four dual tank wash water temperature schemes were used (WW = 49C, 49C; WC = 49C, 24C; CC = 24C, 24C; CW = 24C, 49C). Wash water pH ranged from 10.85 to 11.14 throughout the study. A 10 week storage study followed, in which vitelline membrane strength, Haugh unit, and presence of yeast, mold, and aerobic bacteria were monitored weekly. Haugh unit values and vitelline membrane strength declined over time; however, wash water temperature schemes did not significantly affect egg quality. There were no differences in yeast and mold found in the contents or on exterior shell surfaces of eggs from either plant. No significant differences in aerobic bacteria present in contents or on exterior shell surfaces of eggs for each temperature scheme from Plant A were found. The amount of aerobic bacteria found in contents and on exterior shell surfaces of eggs from Plant B was significantly lower for the WW temperature scheme; differences were within 1 log cfu/mL for contents (WW = 2.2; WC = 2.7; CC = 2.6; CW = 2.6) and slightly above 1 log cfu/mL for exterior shell surfaces (WW = 1.7; WC = 2.0; CC = 2.8; CW = 2.7). This study’s results indicate that commercial cool water washing did not affect interior egg quality or the microbial integrity of interior egg contents.

**Key Words:** shell eggs, cool wash, egg quality

195 **Influence of hen age and molting treatments on shell egg exterior, interior, and contents; microflora and Salmonella prevalence during a second production cycle.** V. Kretzschmar-McCluskey<sup>1</sup>, P. A. Curtis<sup>1</sup>, L. K. Kerth<sup>1</sup>, and O. A. Oyarzabal<sup>1</sup>, 1Auburn University, Auburn, Alabama, 2North Carolina State University, Raleigh.

*Salmonella* is one of the most frequently reported foodborne illnesses in the world, and *Salmonella Enteritidis* (SE) is the serotype most associated with eggs. The objective of this study was to determine if increasing hen age and three different molting treatments influenced the total microflora counts or the prevalence of *Salmonella* spp. on the exterior egg shell, within the interior shell, or in the contents. Eggs by Hy-Line W-98 and Bovans White layer strains were sampled approximately every 28 days from 70 to 114 wk of age, with the molting treatments enforced from wk 70 to 73. Layers were utilized from the 35th North Carolina Layer Performance and Management Test, and managed under identical husbandry practices. This study consisted of non-fasted, feed restricted, and non-molted treatments with the use of 135 eggs per layer strain, for a total of 270 eggs sampled per period. The exterior, interior shell, and contents were both spiral and spread plated onto Plate Count agar to calculate the total aerobic counts. Additional pre-enrichment, enrichment, conformational, and biochemical procedures were performed to test for the presence of *Salmonella* spp. Hen age and molting treatment significantly (P<0.05) affected the microbial loads on all three egg components. Exterior, interior, yolk, and albumen counts increased during the molt period to as much as 1 log unit higher than the highest countable plate (10<sup>7</sup>). Exterior, interior, and contents counts rose (P<0.05) during period 15, with an increase (P<0.05) in the interior also in period 14, and in contents in periods 14 and 17. There were a total of 360 egg pools and of those 7 were suspect positive *Salmonella* samples. All three components, including a separate yolk sample detected in period 13, and the three molting treatments had suspect positive samples.

**Key Words:** *Salmonella*, eggs, laying hens

196 **Impact of white and brown-egg layer strains and molt on size distribution, and egg quality during the second production cycle.** K. E. Anderson<sup>1</sup>, L. K. Kerth<sup>2</sup>, V. Kretzschmar-McCluskey<sup>2</sup>, and P. A. Curtis<sup>1</sup>, 1North Carolina State University, Raleigh, 2Auburn University, Auburn, Alabama.

The production characteristics of the commercially available layer strains vary, yet few studies continuously document these differences. In this study, 9 white egg (WES) and 3 brown egg strains (BES) were
equally represented and housed at a density of 413 cm². The feeding programs were segregated in order to meet the nutritional needs of the white and brown egg strains. At 66 wk the hens were divided into three groups: non-molted (NM) group; non-fasted molt (NF); and fasted molt (FR) for 4 wk. The remaining husbandry practices were the same for each group as those used in the 35th North Carolina Layer Performance and Management Test. Every 28 day period from 70 through 114 wk egg samples from the previous 24 h were collected from each replicate. The eggs were weighed and graded in accordance with USDA standards for shell eggs. Haugh units and other internal quality measurements were taken on egg samples collected every other period. Strain had the greatest influence on egg weight with the distribution of eggs from mediums and large to the extra large classification. In the WES the W-98 produced more (P<0.05) 89.1% extra large eggs while the W-36 and B-300 produced 69.4 and 65.1%, respectively. In the BES, egg weights were the heaviest (P< 0.05) for the Bovans Brown and Goldline at 67.7 and 67.8 g, respectively while the egg weight for the Hy-Line Brown was 66.5 g. This egg weight shifted the egg size distribution from large to extra large for the Bovans Strains. In both WES and BES, the NM control hens had the highest percentage of medium eggs while the two molt treatments were no different. WES molten by either method resulted in fewer Grade B and Cracked eggs than in the NM control group. In BES percent Grade A eggs for the NM, NF, and FR molt programs were 85.9, 88.3 and 90.5%, respectively. The shift in egg size was inversely related to the percent Grade B for the same molt treatments. There was no effect of molt treatment on cracks or loss eggs. Strain selection within the production operation can significantly affect the size of the eggs produced while molting influenced the egg quality.

Key Words: chicken, molt, egg quality

197 Feeding White Leghorn hens yeast beta-glucans to influence egg quality. N. McKilip¹, J. MacIsaac², and B. Rathgeber³. ¹Nova Scotia Agriculture College, Truro, NS, Canada, ²Atlantic Poultry Research Institute, Truro, NS, Canada, ³Agriculture & Agri-Food Canada, Truro, NS, Canada.

Poor egg shall quality remains to be a major source of economic loss to the poultry industry. A deficiency in calcium will adversely affect the egg structure. Partially purified soluble beta-glucan is a potent inhibitor of bone resorption by the inhibition of osteoclast activity. This potential to slow bone loss can allow for better utilization of calcium. In this experiment 480, 18-week-old White Leghorn hens of the Babcock variety were randomly assigned to 80 cages; 40 of these were administered the treatments beginning at 18 wks of age. The remaining 40 cages received the treatments beginning at 50 wks of age. Each of these two groups of birds were randomly assigned to one of four diets supplemented with either 0, 25, 50, or 250 g/tonne of refined yeast beta-glucan. Beginning at 22 wks for the first group and at 46 wks for the second group, 8 eggs per unit were collected every four weeks with the last collection at 78 wks of age. Albumen height, egg weight, and specific gravity of the eggs were measured at each collection. Daily egg production was recorded. At 66 wks 4 eggs per cage were collected and stored for 12 days and foaming volume, albumen pH, albumen height, and egg weight, were measured. No treatments effects were observed on the albumen height, egg weight, and specific gravity measurements or the number of soft shelled eggs. Foaming volume, albumen height, and egg weight were not influenced by dietary treatment. However, albumen pH was lower (P<0.05) for eggs from birds on the 250g/tonne treatment compared to the control and 50g/tonne treatments, but not different from 25g/tonne. Future studies will attempt to identify potential structural changes that may influence exterior and interior egg quality due to dietary inclusion of yeast beta-glucans.

Key Words: leghorn, yeast beta-glucan, shell quality


Functionality of eggs is of great concern to the egg industry. In a study done by Pyke and Johnson (1940) results concluded that the length of egg storage was a factor that might have indicated deterioration in egg quality in regard to cake baking. In this study, research was conducted over a six-week period to determine the storage effects of egg age on sponge cake volume. Eggs were collected from a layer study at Auburn University to test functionality. Eggs were then stored at room temperature for 0, 1, 2, 3, 4, & 5 weeks. On a weekly basis a pooled set of 18 eggs were broken out, homogenized and three replicates of sponge cakes were prepared according to the method of Norris and Cotterill (1986). Over the past four repetitions of the study, statistics have shown that there is a negative trend between the age of the egg and sponge cake volume.

Key Words: sponge cake, egg, functionality

199 The effect of egg storage time on custard functionality. A. Davis*, P. Curtis, and L. Kerth, Auburn University, Auburn, Alabama.

Eggs have many proteins that help produce certain characteristics in foods. These proteins include ovalbumin, conalbumin, and globulin which are the proteins used in coagulation. An egg custard is a good way to show the use of these proteins. However as eggs age their proteins degrade, which can lead to a change in the functionality of an egg. In this study storage time was used to determine if a loss of custard functionality occurred. Eggs from an Auburn University facility were stored at room temperature for six weeks (0, 1, 2, 3, 4, and 5). A modified egg custard recipe from the American Egg Board was used to show the interaction between egg storage and custard functionality. Coagulation of the custard was tested by determining the amount of weep produced after cooking. Weep is defined as the amount of moisture lost after cooking as the custards are refrigerated. Gelation of the custard was measured using gel bloom strength on the texture analyzer. In this study storage time provided a variation in the coagulation and gelation of eggs in custards.

Key Words: custard, functionality, storage
Behavior and Well-Being

200 Behavior and welfare of laying hens in conventional and modified battery cages. M. J. Jendral*, J. S. Church†, and J. J. R. Feddes‡, †University of Alberta, Edmonton, AB, Canada, ‡Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.

The welfare of White Leghorn hens housed in conventional (CON) and modified (MOD) battery cages was assessed by evaluating behavior during the laying period. CON (30x45cm) (n=84) and MOD (60x45cm) (n=84) each provided 450cm² of floor space for 3 hens. MOD included a perch (30x5cm) and a nest box (NB) (24x45cm), providing an additional 360cm² of nest area per bird. Location of lay was assessed for MOD on 2 consecutive d, every 4 wks, between 20 and 64 wks. Continuous video footage of 8 randomly selected cages per treatment was recorded at 35 and 60 wks, beginning at 0630 h. Focal sampling of each hen in the cage was conducted for 3 h, beginning as early as 0630 h, but extending at least 40 min beyond oviposition. Pre-lay, stereotyped, comfort, aggressive and resting behaviours, and hen location were recorded, and behavioural frequency (F), %-duration (PD) and mean duration (MD) were calculated. Data were analyzed using GLM for mixed effects. Treatment effects were significant at P≤0.05. NB use for oviposition was consistent throughout the study (m=94%). Behavioural observations indicate significantly higher PD of escape and bobbing activity in CON (P=0.05). F and PD of object pecking bouts were numerically higher in MOD, but occurred primarily in the NB. PD and MD of preening activity were significantly higher (P=0.03) in back and tail regions and numerically higher in belly and inside wing areas in MOD, and numerically higher in breast and outside wing regions in CON, suggestive of displacement preening in CON. F and PD of feather ruffling, head scratching and stretching were numerically higher in MOD. In CON, F and PD of aggressive pecking bouts and displacement, and feather pecking bouts were numerically and significantly higher (P=0.05), respectively. CON birds spent numerically more time standing and less time sitting and dozing. These findings suggest that hen welfare was improved in MOD, since hens preferred to oviposit in the NB, and CON hens experienced increased frustration and aggression, and reduced comfort and rest. Modifications to conventional battery cages improve hen welfare, while allowing producers to make use of existing capital.

Key Words: laying hen, behaviour, welfare

Good management practices are critical to maximize reproductive performance in broiler breeders. Yet we know little about what goes on in commercial facilities. Females commonly congregate on the slats to avoid harassment from males gathered mainly in the litter area. Male harassment may result in poor fertility and a high incidence of female injury and mortality. Increasing environmental complexity with cover panels may help alleviate this problem by attracting females to the litter area. Additionally cover panels may increase space use by males, resulting in greater mating opportunities, reduced mating interference and increased reproductive performance. We conducted a demonstration study on five commercial broiler breeder farms to determine the potential benefits of cover panels. Each farm had a control and panel treatment house with approximately 7000 females and 800 males. Flocks were studied until 51 weeks of age. Reproductive performance was measured by number of eggs laid/female and their hatchability. Male movement was measured by recording the location of ten randomly marked individuals in each house for ten weeks. Home range analysis was performed using minimum convex polygons as well core areas at 95% probability. Increased environmental complexity did not significantly impact female mortality (P > 0.05) or eggs laid (P > 0.05) but increased hatchability (P < 0.05) and decreased percent floor eggs (P < 0.05). Male home ranges measured by minimum convex polygon were larger for the cover panel treatment over the control (P < 0.05); difference between core areas was non-significant (P > 0.05). There was however a higher degree of variability (P = 0.05) between males’ core areas in the panel treatment, ranging from 34 to 100% usage of the total available space. These results suggest that cover panels have a positive impact on hatchability, perhaps due to increased mating opportunities and/or reduced females stress, and allow males a wider expression of use of space patterns. These results suggest that for broiler breeders environmental enrichment may not only be beneficial for the birds but may also be economically sound resulting in a win-win situation.

Key Words: broiler breeders, cover panels, performance


A new High-Throughput Modified Atmosphere Chamber (HT-MAC) was developed at the Agri-Tech Centre in Lethbridge, Alberta. The HT-MAC was field tested in Alberta at the Rose Dale Colony on March 17, 2005. The HT-MAC unit consists of a large plastic bin, approximately 1.83 m by 1.22 m by 1.22 m, with a hinged lid. A hole is cut in the lid and covered by an aluminum hood with a hinged front flap; birds are put into the bin by pushing open the flap and dropping them into the bin. Bin loads contained 436.2±27.0 (mean±SD) birds. The rate at which the cart was filled was 71.5±18.5 (mean±SD) birds/min. The bin has a PVC pipe mounted in each corner, with each pipe having small holes drilled along the length. These pipes are connected together on the bottom, and capped at the top. A hose is routed from this system to a quick-coupler mounted on the outside of the bin, and the gas supply is connected to this system via the quick-coupler when the bin is in use. The gas (CO2) is supplied from a liquid dewar; to obtain a high enough rate of gas, the CO2 is taken from the dewar as a liquid and run through a vaporizer to produce a gas at 3,450 birds/h at this location. The HT-MAC was developed at the Agri-Tech Centre in Lethbridge, Alberta. The HT-MAC unit consists of a large plastic bin, approximately 1.83 m by 1.22 m by 1.22 m, with a hinged lid. A hole is cut in the lid and covered by an aluminum hood with a hinged front flap; birds are put into the bin by pushing open the flap and dropping them into the bin. Bin loads contained 436.2±27.0 (mean±SD) birds. The rate at which the cart was filled was 71.5±18.5 (mean±SD) birds/min. The bin has a PVC pipe mounted in each corner, with each pipe having small holes drilled along the length. These pipes are connected together on the bottom, and capped at the top. A hose is routed from this system to a quick-coupler mounted on the outside of the bin, and the gas supply is connected to this system via the quick-coupler when the bin is in use. The gas (CO2) is supplied from a liquid dewar; to obtain a high enough rate of gas, the CO2 is taken from the dewar as a liquid and run through a vaporizer to produce the gas needed to fill the bin. The vaporizer is a modified hot water tank, filled with a water/antifreeze mixture and heated by propane. The CO2 runs through coils of copper tubing installed inside the tank. A regulator on the outlet of the vaporizer controls the gas rate. The bin is mounted within a u-shaped frame that attaches to a skid-steer. The skid-steer is used to move the bin around, and if necessary to lift it for dumping into a truck or onto a pile. Including 10 min to prime, fill and unload each bin and 436.2 birds in each bin we calculate a total culling rate of 3,450 birds/h at this location.

Key Words: layers, culling, euthanasia
203  Barley silage effects on laying hen behaviour.  S. G. Johannson*, K. V. Schwean-Lardner, and H. L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

Feather pecking is a common behavioural vice which can lead to a number of problems within a flock of chickens such as cannibalism and decreased welfare. Recognizing that nutrition can affect poultry behaviour, it was of interest to investigate the use of an alternate feed ingredient to reduce feather pecking in laying hens. Two experiments, each consisting of two treatments with four replications, were conducted to observe the effects of providing ad libitum access to barley silage on aggression and feather pecking behaviour in laying hens from 19-28 and 20-30 weeks of age, respectively. Each colony cage housed 20 hens and 2 roosters. Both bird treatments were provided ad libitum access to a nutritionally balanced laying diet and a large particle calcium source (Sure Shell) while treatment birds also had access to barley silage. Colony cages were used having previously been shown to elicit severe feather pecking. Solid partitions were placed between each cage to prevent social learning of feather pecking behaviour. Behavioural observations were collected via scan sampling on a bi-weekly basis. Silage intake was measured daily whereas mash and Sure Shell intakes were collected weekly. Feather scoring and blood collection, measuring heterophil to lymphocyte ratios, were completed at trial end. Treatment birds readily consumed silage with an average as is and dry matter intake for combined experiments of 45 and 14 g/b/d. Control birds ate more mash than the treatment birds but the total dry matter intake of the treatment birds was slightly higher (93.27 vs 89.68 g/b/d). Birds from both treatments ate approximately the same amounts of Sure Shell. Feeding silage significantly reduced both aggressive and feather pecking behaviours. Total feather scores of the treatment birds measured 17.3 and 17.9 vs control birds 13.5 and 16.7 for experiments one (P=0.06) and two (P=0.21) respectively. Treatment did not affect H:L ratios in hens (0.17 vs 0.16) however, males housed in the control cages (0.15 vs 0.09) elicited higher H:L ratios. Ad libitum feeding of silage reduced feather pecking and aggressive behaviour and may serve as a potential aid in improving bird well-being.

Key Words: feather pecking, barley silage, behaviour

204  The effect of daylength on the behaviour of broiler chickens.  K. Schwean-Lardner*1, H. L. Classen1, and B. I. Fancher2, 1University of Saskatchewan, Saskatoon, SK, Canada, 2Aviagen Inc., Huntsville, Alabama.

Behaviour can be an important component in assessing welfare in animals. An experiment was conducted to examine the effects of two levels of daylength on the behaviour of broiler chickens. Ross x Ross 308 males were exposed to photoperiod treatments of 14L:10D or 23L:1D from 7 to 32 d. Birds were housed in pens (N=15) with 2 rooms per lighting program, and given ad libitum access to feed and water. Using infrared digital video surveillance equipment, behaviour was recorded for 24 h at 25d of age. Data was then scan sampled at an interval of 10 min for the 24 h period. Behaviours recorded included resting, walking, standing, preening, leg or wing stretch, feeding, drinking, aggression, foraging, and dustbathing. Birds exposed to 14L:10D per day showed a clear separation between night and day in percentage of birds seen resting (P=0.052), walking (P=0.058), running, standing, feeding, drinking, foraging, and dustbathing. Birds exposed to 23L:1D, significant differences were noted between dark and light periods in resting, standing, feeding, and drinking, although the numbers were much closer than seen in 14L:10D birds. During the daylight phase, differences between the two lighting treatments were seen in resting (P=0.09), running, standing, drinking, foraging, and dustbathing. Over the entire day, birds raised on 14L:10D spent significantly more time running, standing, foraging and dustbathing. They also spent 58% more time walking than birds on 23L:1D. In conclusion, birds raised on 23L did not have clear separation between night and day for some behaviours, and comfort behaviours were performed less often. Daylength affected broiler behaviour both during the photophase as well as the total activity over a 24 h period of the day.

Key Words: broiler, behaviour, photoperiod

205  Effect of photoperiod on mobility and leg defects in broilers.  K. Schwean-Lardner*1, H. L. Classen1, and B. I. Fancher2, 1University of Saskatchewan, Saskatoon, SK, Canada, 2Aviagen Inc., Huntsville, Alabama.

Two experiments (E1 and E2) utilizing 4464 and 2976 broilers were conducted to determine the impact of photoperiod on the mobility and incidence of skeletal defects in broilers. In each experiment, two strains of commercial broilers (G) were housed sex-separately (S) and exposed to one of four lighting programs (23, 20, 17, or 14h; L) initiated at 7d of age. L treatments were replicated twice in each experiment and each S x G subclass was replicated 3 times within each replicate. No interactions were found between main effects and only L main effects are reported in this abstract. Mobility was assessed by gait scoring at 35 and 47d of age in E1, and at 34d of age in E2, with 40 birds per L x G x S grouping assessed at each age. Birds were visually assessed for ability to walk, within a scale of 0 (walking normal) to 5 (immobile). Combined mortality and morbidity necropsy results were summarized for skeletal defects over the 7-39d and 7-49d periods in E1, and from 7-38d in E2. Overall, gait scores were lower in all treatments than many previous reports, suggesting successful selection for improved skeletal quality. In E1, the relationship between average gait score and daylength at 35d was linear (0.73, 0.46, 0.45 and 0.39 for 23, 20, 17 and 14, respectively). At 47d, scores were higher for 23 (1.16) and 20 (1.06) as compared to 17 (0.71) and 14 (0.60), and again L effects were linear. At 34d in E2 L affected gait score with longer daylengths resulting in higher values (0.67a, 0.34b, 0.19c, 0.18c). Skeletal defects resulting in culled birds or mortality were similarly affected by L regardless of time period or experiment. The mean values for 23, 20, 17 and 14 were 1.54, 1.29, 0.61 and 0.48% for E1 7-39d, 3.24, 2.54, 0.83 and 0.54% E1 7-49d (linear) and 1.70, 1.10, 0.42 and 1.00% for E2. In conclusion, increasing the hours of daylength resulted in reduced mobility in broilers, likely due to increase in leg defects such as those noted in the mortality and morbidity data.

Key Words: broiler, photoperiod, mobility


The beak of birds is used for feeding, drinking, pecking, grasping, preening and other necessary functions. It is also utilized in aggressive and defensive activity that can result in injury and cannibalism. Consequently a practice in the industry, particularly in breeding stock, is to beak trim poultry in order to minimize the effects of aggressive
behavior. The beak encases the buccal cavity that contains the tongue, taste buds, salivary glands, blood vessels, nerves, receptors and other components. Beak trimming can impact the appropriate function of the bill and buccal cavity including mandibulation, sensing and discriminating among sizes and tastes of food items, producing adequate amounts of saliva in the mouth and esophagus, and maintaining the plumage of the body. The beak is a major component of the somatosensory and somatomotor system comparable to the same neural system that has been well understood in humans and other mammalian species. Therefore an emphasis will be placed upon a comparison of the neural pathways that have been mapped from the mandibular (mouth and jaw) region of mammals and poultry. Coverage of nociceptors, mechanoreceptors and thermoreceptors that reside in the beak and buccal cavity, afferent nerves of the fifth and seventh cranial nerves that serve the upper and lower mandibles, tongue and face region will be noted. The pathways where sensory information from the mouth is delivered to the brain, specifically to the principal trigeminal sensory nucleus in the brainstem will be shown followed by the three distinct forebrain areas that process sensory input from the beak. In addition, neural sites where information leaves the forebrain and is transmitted via efferent pathways to motor systems will be documented. The review will also include the methods used to beak trim poultry, extent of the bill recommended for trimming, age/s when trimming occurs and abnormalities, such as neuromas, that can occur particularly when excessive beak trimming is practiced. Finally key areas where further research needs to be undertaken will be outlined.

**Key Words:** trigeminal nerve, facial nerve, nociceptors

### 207 Relationship between body weight and beak characteristics in 1 d old layer chicks. A. G. Fahey1,2, R. M. Marchant-Forde2, and H. W. Cheng1, 1Purdue University, West Lafayette, Indiana, 2USDA, West Lafayette, Indiana.

The aim of this work was to determine if any relationship exists between body weights and beak characteristics in day old chick with a view to developing an automated system for standardizing infrared trimming. Three hundred and forty four day old layer chicks were enumerated using MCID Imaging Software. The width of the upper mandible was measured 2mm (W2mm), 3mm (W3mm), and 4mm (W4mm) from the tip of the beak. The lengths of the culmen, gonys, maxillary tomia (maxi), and the mandibular tomia (mand) were also measured. All parameters had non-normal distributions so non-parametric Spearman rank-order correlations were calculated between body weight and each beak dimension. The correlations are shown in Table 1 with P-values displayed in parentheses. Weak negative correlations were found for W2mm, W3mm, and W4mm, and weak positive correlations were present for culmen, gonys, maxi, and mand lengths. Significant P-values were also evident for W2mm, W3mm, culmen, gonys, and mand. However this may have been due to the relatively large sample size (n=344) as the actual correlations (r2) with body weight were really too low (all below 0.16) to be meaningful. In conclusion, the weight of a 1-day old chick is not a sufficient indicator of the size of its beak and as such should not be relied upon. Additional work is necessary to identify an accurate yet efficient way to separate chicks according to beak size to improve the accuracy of any subsequent beak trimming in terms of the relative amount of beak trimmed.

### Table 1. Relationship between weight and beak characteristics

<table>
<thead>
<tr>
<th></th>
<th>BW</th>
<th>W2mm</th>
<th>W3mm</th>
<th>W4mm</th>
<th>Culmen</th>
<th>Gonys</th>
<th>Maxi</th>
<th>Mand</th>
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<td>(0.011)</td>
<td>0.14</td>
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<td></td>
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<td>(0.007)</td>
<td>(0.004)</td>
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This work is the first in a series of studies examining the effects of infrared treatment on production and well-being. Seventy-two layer chicks were assigned to hot–blade trimming (HB) (1/3 beak), infrared treatment (IR) at 60 W to cause in a 1/3–1/2 reduction in beak length, or a control (C) treatment at 1 d old. Chicks were pair housed by treatment and beak photos and production indices (feed intake, waste & body weight (BW)) were obtained right after treatment and +2 d, +4 d and then weekly until 9 wks later. Changes in beaks were evaluated using MCID Imaging Software. All beaks were considered normally shaped at the onset of the study and no perceptible differences in shape occurred over time (P<0.05). Different trimming methods did however result in: varying proportions of trimming across treatment (P<0.01); different beak lengths over time (P<0.01) and; changes in upper to lower mandible length ratio (P<0.01). Just after treatment, HB birds had shorter beaks relative to the other two groups (P<0.05). C and IR birds remained analogous until the onset of tissue degeneration and erosion in the IR beaks 2 d to 2 wks after treatment. Thereafter, there was an increase in length in all treatments over time (P<0.01). Two weeks post treatment, beaks were longest in C, intermediate in HB (30% shorter than C, P<0.001) and shorter in IR birds (50% shorter than C, P<0.001). Finally, HB birds exhibited more deviations from a normal upper:lower mandible length ratio (P<0.05). Notable effects of treatment on production emerged by +2 d and persisted for 5 wks afterwards. Growth and feed intake were suppressed in HB & IR birds compared to C birds (P<0.05) with IR birds performing least well until the 4th wk of the study (P<0.05). Thereafter they performed numerically, though not statistically, better than the HB group. Feed waste was always lowest in the IR groups but alternated in the other two groups over time (P<0.05). The negative effects of trimming appeared greatest in the IR birds initially but these differences dissipated over time. Further work reports on the effects of IR treatment on morphology, behavior and other well-being indices.


The goal of this research was to examine the impact of infrared treatment at 1 d of age on behavior and feeding ability compared to hot-blade trimming. Seventy-two layer chicks were assigned to hot-blade trimming (HB) (1/3 beak), infrared treatment (IR) at 60 W (1/3–1/2 reduction in length), or a control (C) group at 1 d old. Chicks were pair housed by treatment and behavior was recorded on day 0-4 and weekly thereafter. A feeding test was used to determine treatment differences in feeding ability by assessing both feeding behavior and feeding rate (intake/peck). There was largely an effect of treatment
on the behavior post treatment (P<0.05). Specifically, C birds spent less time standing resting (P<0.01) and more time eating (P<0.01) and drinking (P<0.05) than IR birds. Furthermore, the number of pecks delivered at the drinker during imbibing was also suppressed by IR treatment (P<0.01). Aside from a tendency for HB to have shorter eating bouts than C (P=0.09), all other feeding indices in HB scored intermediary to those in C and IR with no perceptible differences. Treatment effects were most prominent in the initial 24-48 h post treatment with decreasing incidences of differences over time (P<0.05). During the feeding test, C birds took less time to approach the feeder and initiate feeding and had higher intake and feed wastage scores than HB or C during the first 3 wks after trimming (P<0.05). HB generally scored intermediary in these indices but there were few differences between HB and IR. C birds were the most efficient feeders (P<0.05) but there were no differences in among HB or IR (P>0.05). Both H & IR birds performed more head flicking than C (P<0.05) and HB birds also exhibited more bill wiping and wing flapping during the test (P<0.05). General behavior highlights an initial decrease in activity in IR birds that may indicate greater discomfort immediately post trimming. However, most other indices of behavior and feeding ability indicate few differences HB and IR in spite of more severe trimming in the IR birds. Further work reports on the comparative effects of HB and IR trimming 1/2 of beaks.


The aim of this work was to compare the effects of infrared treatment (IR) and hot-blade trimming (HB) at 1 day of age on beak length and production. As previously, 72 layer chicks were assigned to HB (1/2 beak), IR at 60 W (1/3-1/2 reduction in length), or a control (C) group at 1 d old. Chicks were pair housed by treatment and beak photos and production indices were obtained after treatment and at +1 d, +5 d and then weekly until 10 wks later. Changes in beaks were evaluated using MCID Imaging Software. Immediately after trimming HB beaks were between 40-45 % shorter than C or IR (P<0.001) and remained shorter than C beaks for the duration of the study (P<0.01). There were no differences in C and IR beaks until the onset of tissue degeneration in IR that occurred during the 2nd and 3rd wks post trimming (P<0.05). IR beaks were similar to HB beaks until wks 9 & 10 when a faster growth rate resulted in longer beaks in HB (P<0.01). IR beaks were shorter than C beaks from the time of tissue degeneration to the end of the study (P<0.01). By 10 wks, HB beaks were about 20% shorter, and IR beaks were 50% shorter, than C (P<0.01). The effects of treatment on BW emerged 5 d after trimming when IR and HB weighed 7% (P<0.05) and 17% (P<0.001) less than C (P<0.05). BW in HB was suppressed up to, and including, 9 wks post trimming relative to C birds (P<0.05), and was significantly lower than in the IR group between 2-4 wks (P<0.05). IR birds did not differ from C birds after wk 3 and by the final week of the study there were no longer any apparent differences in BW in any treatment. For the most part, FI was higher in C, intermediary in IR and lowest in HB birds until wk 9 post treatment (P<0.05). Similarly, waste was generally higher in C birds and least in the HB group (P<0.05). It appears that ½ HB trimming had a more pronounced impact on production and growth than IR trimming. Effects on beak length were similar until HB birds exhibited an increase in beak growth rate towards the end of the study. Furthermore, HB trimming seems to inhibit FI and BW to a greater extent than IR treatment with no perceptible benefits in beak length at 10 wks of age.

This experiment was conducted to determine the effects of supplemental methionine, lysine, choline, and sulfur on laying performance, metabolic parameters, and egg quality of hens fed diets containing sorghum (Sorghum vulgare) during the peak laying period. Lohman layers (n = 144), 30-wk of age as 6 replicate cages of 4 hens, were allocated randomly to receive basal diets containing either 22% corn (B) or 22% sorghum (BS) and diets BS plus 0.57% methionine, 0.66% lysine, 0.47% choline, or 0.05% sulfur for 98 d. Feed intake (FI) and egg production (EP) were recorded daily, egg weight (EW) was measured bi-weekly, and body weight (BW) was measured monthly. A sample of 12 eggs from each experimental group was collected every month to evaluate egg quality. At the end of the experiment, blood samples were collected for metabolite concentrations. Data were analyzed using one-way ANOVA as repeated measures and significant differences between the experimental groups were assessed using Duncan Multiple Range test. Partial replacement of corn with sorghum in the basal diet did not affect BW, EP, and FCR but increased FI by 5.7% and EW by 2.4%. The effects of additives on laying performance were variable. Except for serum total protein (STP) concentration, other metabolic parameters were not affected by partial replacement of corn with sorghum in the basal diet. Hens fed diet BS had lower STP concentration than hens fed diet B. Except for methionine supplementation, other supplements ameliorated depression in STP concentration. The additives did not affect other metabolic parameters.

Egg quality responses to the experimental diets were also variable. Partial replacement of corn with sorghum in the basal diet did not affect eggshell characteristics (both thickness and stiffness), whereas it had variable effects on inner egg quality parameters (increased yolk index, depressed yolk color, and unaltered albumen index and Haugh unit). In conclusion, laying hen diets could include low-tannin sorghum (0.26%) up to 22% without necessitating extra supplements to overcome compromised performance.

**Key Words:** sorghum, methionine, lysine

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We evaluated the influence of two soybean meal (SBM) sources and three levels of total lysine (LYS) in the diet on productive performance of Ross 308 broilers from 1 to 36 d of age. There were six treatments arranged factorially with two SBM sources (regular meal with 47.4% CP, and high quality meal with 49.5% CP) and three levels of LYS (105%, 115%, and 125% of NRC requirements in the starter diets, and 100%, 108% and 116% of NRC requirements in the finisher diets). Within each LYS level the amount of CP supplied by the high quality SBM (SBM–O) and the regular SBM (SBM–A) was similar and therefore, the percentage of SBM was lower in the SBM–O than in the SBM–A containing diets. Each treatment was replicated ten times (a cage with 10 chicks). The SBM–A was collected from a commercial supplier and was of Argentina origin. The SBM–O is marketed under the Soymax trademark and was obtained from Owensboro (Ohio) soybean crushing plant. Both starter (1 to 21 d of age) and finisher diets (22 to 36 d of age) were based on corn, soybean meal, and soy oil and contained 3,050 and 3,200 kcal ME/kg for starter and finisher diets, respectively. Average daily feed intake (ADF) and average daily gain (ADG) were recorded at 3, 10, 21, and 36 d of age. From 1 to 36 d of age, broilers fed SBM–O had better ADG (63.0 vs. 59.7 g/d; P < 0.001) and gain to feed ratio (G:F) (0.668 vs. 0.641 g/g; P < 0.001) than broilers fed SBM–A. ADG and G:F increased linearly as the lysine content of the diet increased (0.633, 0.660, and 0.671 g/g for G:F; P < 0.001). At 21 d of age broilers fed SBM–O grew faster than broilers fed SBM–A in diets supplying the lowest lysine level (105% of NRC) but no differences were detected for the higher lysine levels (P < 0.05). We conclude that SBM–O improves productive performance of broilers with respect to SBM–A indicating a better availability of the CP fraction. Also, lysine requirements of broilers from 1 to 21 are at least 25% higher than current NRC recommendations.

**Key Words:** soybean meal, total lysine concentration, broiler

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**W3** Inclusion levels of corn distillers grains with solubles and poultry byproduct meal in market turkey diets. S. L. Noll* and J. Brannon, *University of Minnesota, St. Paul.*

In the Midwestern U.S., animal protein and corn derived distillers grains with solubles (DDGS) are often priced favorably to enter diets at levels considered “excessive”. A feeding trial was conducted to examine different inclusion levels of poultry byproduct meal (PBM) and DDGS and their combined effect on market tom performance during 5-19 wks of age. Large White male turkey poults (Nicholas strain) were randomly assigned to pens (10/pen) at 5 wks age and fed one of the following diet treatments (T): 1. Corn and soybean meal control; 2. As T1 with PBM (8%); 3. As T1 with PBM (12%); 4. As T1 with DDGS (10%); 5. As T1 with DDGS (20%); 6. As T2 and T4; 7. As T2 and T5; 8. As T3 and T4; and, 9. As T3 and T5. Diets were formulated using digestible amino acids. Diet protein level was
established by using intact protein to meet the digestible thr at 100% of the NRC recommendation. All diets were supplemented as needed with lys and met to meet the NRC recommendations. The ratio of calcium: phosphorus was maintained at 2:1 to accommodate higher levels of phosphorus. Each diet was fed to 10 replicate pens. The experimental design was a completely randomized block design with a factorial arrangement of PBM and DDGS inclusion levels. At 19 wks of age, dietary treatment affected 19-wk body weight and feed efficiency (5-19 wks) (P < 0.001). The BW of the corn-soy control diet (T1) averaged 20.18 kg. Diets containing PBM (8 or 12%) or DDGS (10 or 20%) were not significantly different from the control. BW of turkeys fed diets containing PBM (8 or 12%) in combination with 20% DDGS was less than that of the control by 3.3%. A significant interaction existed for inclusion of PBM and DDGS (P < 0.02) for feed efficiency. Feed/gain of turkeys fed diets containing PBM (8 or 12%) or DDGS (10 or 20%) were not different from the control. However, the feed/gain increased for turkeys fed diets containing PBM (8 or 12%) in combination with 20% DDGS and were different from the control by 5 to 6 points. In summary, performance of turkeys fed 20% DDGS diets was not different from the control except when used in combination with high levels of PBM.

Key Words: turkey, distillers grains, poultry byproduct


The nitrogen-corrected apparent metabolizable energy (AMEn) and apparent ileal digestibility (AID) of amino acids in 3 cultivars of Australian sweet lupin (Lupinus angustifolius), 3 cultivars of white lupin (L. albus), 4 cultivars of peas (Pisum sativum) and 4 cultivars of fababean (Vicia faba) for broiler chickens were determined. For the purpose of comparison, a sample of soybean meal was also assayed. The assay diets were formulated by substituting the soybean meal and legumes for 50 and 25% (w/w), respectively, of a maize-soy basal diet. Legume seeds, with hulls, were crushed to pass through a 3-mm sieve in a hammer mill prior to inclusion into diets. All diets contained titanium oxide as an indigestible marker. The basal diet and the 15 assay diets were each fed to four pens of five male broilers from day 28 to 35 post-hatching. Total collection of excreta was carried out during the last 4 days for the determination of AMEn. On day 35, digesta from the lower half of the ileum was collected and apparent amino acid digestibility coefficients were calculated using marker ratios in the diet and digesta. Calculations were based on the assumption of additivity between the basal diet and test ingredient. Significant (P < 0.05) cultivar effects on AMEn were observed only for fababean. The average AMEn of sweet lupin, white lupin, peas, fababean and soybean meal were determined to be 1610, 2170, 2470, 2430 and 2650 kcal/kg DM, respectively. The AMEn of the two lupins were lower (P < 0.05) than those of other ingredients. No cultivar effects (P > 0.05) were observed for the AID of amino acids in any of the legumes. In general, the AID of amino acids in two lupins were similar to those in soybean meal. The AID of threonine, cysteine, proline and tyrosine were lower (P < 0.05) in peas and fababean compared to those in soybean meal. The mean AID coefficients of 17 amino acids in sweet lupin, white lupin, peas, fababean and soybean meal were 0.84, 0.87, 0.85, 0.83 and 0.80, respectively.

Key Words: apparent metabolizable energy, amino acid digestibility, broilers

W5 Effects of the level of canola meal, lysine and energy in the rations of broiler chickens. S. Gomez* and M. L. Angeles, National Center for Disciplinary Research in Animal Physiology, Ajuchitlan, Queretaro, Mexico.

The objective was to evaluate productive responses, carcass yield, tissue composition and accretion rates and the efficiency of protein deposition in the meat of broiler chickens fed diets with soybean meal (SBM) or canola meal (CM). In experiment 1 (Exp 1), 36 male broiler chickens from 43 to 56 days of age were assigned to 3 diets with increasing amounts of CM (0, 10 and 20%) and 2 levels of digestible lysine (0.85 and 0.95%) for a total of 6 treatments. In experiment 2 (Exp 2), 72 broiler chickens (half females and half males) from 28 to 42 days of age were assigned to 2 diets based on SBM or CM as the main protein ingredient and 3 energy levels (3.0, 3.1 and 3.2 Mcal ME/kg) for a total of 6 treatments. In both experiments, birds were allocated individually and the slaughter methodology was used to estimate the tissue deposition rate and the efficiency of protein deposition in the breast (Exp 1) or carcass (Exp 2). In Exp 1, no statistical differences were observed in any of the response variables evaluated. In Exp 2, feed intake (129.9 vs 121.8 g/d, 2.326; P < 0.05), energy intake (0.403 vs 0.378 Mcal/d, SEM=0.0072; P < 0.05) and protein intake (22.47 vs 21.44 g/d, SEM=0.395; P < 0.05) were improved with SBM. Feed efficiency (0.467 vs 0.521, SEM=0.023; P < 0.05) was greater with CM. Fat content (2.75 vs 2.18 %, SEM=0.201; P < 0.06) and fat deposition (0.360 vs 0.265 g/d, SEM=0.0353; P < 0.06) in the meat of the carcass were increased with SBM. Energy intake (0.362, 0.401 and 0.408 Mcal/d, SEM=0.0085; P < 0.01) and body weight gain (56.24, 63.46 and 66.30 g/d, SEM=3.437; P < 0.05) were increased linearly as the level of dietary energy increased. In summary, the results indicate that is feasible to replace up to a 100% of SBM by CM in rations of broilers without any detrimental effect on growth, carcass yield and composition and the accretion rate and efficiency of protein deposition in the meat of the carcasses.

Key Words: broiler chickens, canola meal, lysine-energy

W6 Effect of Betain® and salinomycin on oocyst production of broilers exposed to either Eimeria acervulina or E. tenella. J. C. Remus*1 and J. L. McNaughton2, 1Danisco Animal Nutrition, St. Louis, Missouri, 2Solution BioSciences, Inc., Salisbury, Maryland.

Previous trials have examined the impact of Betain®, natural betaine, on intestinal integrity and bird performance. This 2 x 2 x 2 factorial design examined 0 or 0.15% Betain (Bet), 0 or 60 g/t salinomycin (Sal) in the presence of either Eimeria acervulina (EA) or E. tenella (ET) challenge. Each treatment had 5 replicate battery pens containing 5 chicks per pen. Chicks were orally challenged at 12 days of age with 10,000 oocysts each of either EA or ET. From 18 to 21 days, daily collection of excreta was taken for oocyst measurement. Birds were weighed on day 21, lesion scores were measured on day 22. Probability was set at P < 0.05. At 21 days of age, birds supplemented with either Sal or Bet were heavier and shed less oocysts than control counterparts. Birds challenged with ET were lighter in weight and shed fewer oocysts than those given EA. Mortality-corrected FCR (mFCR) and liveability were improved with the use of Sal. Challenge with ET worsened mFCR compared to conversion of those birds given EA. Total intestinal lining (lesion) score was reduced (or improved) in birds given EA. Liveability were improved with the use of Sal. Challenge with ET worsened mcFCR compared to conversion of those birds given EA. Total intestinal lining (lesion) score was reduced (or improved) in birds given EA. Liveability were improved with the use of Sal. Challenge with ET worsened mcFCR compared to conversion of those birds given EA.
birds. No other interactions were present. Treatwise, the combination of Bet and Sal had the greatest improvement in lesion score for either EA or ET challenge. Body weight of ET-challenged chicks was improved with Bet + Sal versus other ET treatments. Overall, these results indicate that Betain and salinomycin in combination is likely to have the greatest impact on lesion scores and oocyst output.

Table 1.

<table>
<thead>
<tr>
<th>Main effect</th>
<th>Additive</th>
<th>Weight (g)</th>
<th>Cumulative mcFCR</th>
<th>Total lesion score</th>
<th>Oocyst (/day)</th>
<th>Mortality (%)</th>
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A,B: significant difference at P < 0.05 within that parameter

Key Words: betaine, coccidia, salinomycin

W7 Use of Bioplex-Sel-Plex trace minerals in commercial tom turkey diets from 0 to 19 weeks of age. C. Novak*, L. Li Hong1, A. P. McElroy1, and A. SeflIon2, Virginia Tech, Blacksburg, Alltech Inc., Nicholasville, Kentucky.

A study was conducted to test the effectiveness of low levels of organic minerals in place of a commercial trace mineral (TM) program on tom turkey performance from 0 to 19 wks of age. 1224 Hybrid poult received from a commercial hatchery and randomly assigned to one of four dietary trt (7 reps (pens)/trt). Experimental treatments consisted of: a positive control (PC), a negative control (trace minerals at 10% of PC - NC), and two regimens of Bioplex/Sel-Plex (1.5 lb/ton during starter and 1 lb/ton for grower and finisher - O1; 1.5 lb/ton for entire trial - O2). Bioplex/Sel-Plex treatments supplied TM at or below the level of NC. Commercial management practices were followed for the duration of the trial with pouls provided ad libitum access to feed and water (via Plassan drinkers). Body weight (BW), feed conversion (FCR), feed intake (FI) and fresh feces data was collected at fed changes (0, 49, 70, 84, 105 and 133 d of age), while bone breaking strengths (BBS) were collected at 49, 84 and 133 d of age. Litter TM concentration and breast yield were determined at 133 d. Overall, cumulative BW and gain, FCR and FI were not affected (P > 0.05) by dietary treatments with average BW and FCR of 16.72 kg and 2.41 g feed/g gain, respectively. Manure trace mineral content (manganese-Mn and zinc-Zn) was reduced (P < 0.05) feeding O1, O2 and NC compared to PC through out the trial. Copper excretion was significantly reduced similarly after 84 days of age. BBS of femur and tibia were only affected at 49 days of age with tibia and femurs from NC, O1 and O2 having reduced BBS compared to PC. Mn and Zn concentration in litter was reduced when feeding NC, O1 or O2. Breast yield at processing was improved (P < 0.05) feeding either O1 or O2 compared to PC. Overall, the data indicated the use of 10% commercial trace minerals or Bioplex/Sel-Plex in the diet of tom turkeys is adequate for growth and performance and the use of organic minerals may increase breast yield at slaughter.

Key Words: organic trace minerals, nutrition, turkeys

W8 Impact of wheat middlings, citric acid, and phytase on phosphorus utilization and growth performance of broiler chicks in the starter phase. T. O’Connor-Dennie* and J. L. Emmert, University of Arkansas, Fayetteville.

An experiment was conducted to investigate interactions among citric acid (CA), wheat middlings (WM), and phytase in P-deficient corn soybean meal diets and its impact on growth and P utilization during the starter phase. Male broilers were raised in battery cages and fed experimental diets from day 7 to 21. Each dietary treatment was fed to 6 replicate pens containing 5 chicks. Diets 1 through 4 consisted of a P-deficient diet with graded levels of supplemental P (0, 0.04, 0.08, or 0.12 %). Diets 5 through 15 were as diet 1 with phytase (300 or 600 FTU/kg), CA (3%) or WM (10%), alone or in combination. There was a linear response in growth and bone strength to supplemental P levels (P < 0.05), and adding phytase also improved growth and bone strength on low-P diets (P < 0.05). Adding CA increased gain and bone strength when compared to the negative control (P < 0.05); but did not restore it to the levels of the adequate diets. Combining phytase and CA improved growth and bone strength (P < 0.05). To assess bioavailable P release, standard curves were used with adjusted bone strength (ABS) (kg/mm2) and gain (g/c) as dependent variables and supplemental P consumption (g) as the independent variable. Phytase released at least 0.108 % P for ABS and gain. Citric acid released 0.056 % P and combining CA and phytase released at least 0.137 % P, which was higher than the amount released by phytase (P < 0.001). Combining all three supplements released 0.146 and 0.200 % P at 300 and 600 FTU/kg of phytase respectively, which was greater than P released by any supplement alone (P < 0.001). Furthermore, chicks fed diets containing 600 FTU/kg had a greater bioavailability of P compared to those fed 300 FTU/kg of phytase (P < 0.0001). These results suggest synergism between phytase, CA, and WM that can improve growth and bone strength, which is further enhanced by increasing phytase from 300 to 600 FTU/kg.

Key Words: citric acid, phytase, wheat middlings


This study was conducted to evaluate optimum dietary concentrations of metabolizable energy (ME) and crude protein (CP) for egg production performance of the pearl grey guinea fowl laying hens. In a 2 x 3 factorial arrangement, 360 Pearl Grey guinea fowl replacement pullets (22 wks of age) were randomly assigned to experimental diets with 2,800 and 2,900 kcal of ME /kg of diet each containing 14, 16 and 18% CP, respectively. Each dietary treatment was replicated 4 times, and feed and water were provided ad libitum. Experimental birds were raised in laying cages and received 16 hr light throughout the study period. The birds were observed for feed consumption (FC), hen-day egg production (HDEP), egg weight (EW), egg mass (EM), feed conversion ratio (FCR), internal egg quality (IEQ), shell thickness
Pearl grey guinea fowl, metabolizable energy, crude protein

In contrast to published water quality standards, negative effects of nitrate addition in the drinking water on broiler performance. Water treatments were mixed on a weekly basis. Water analysis was conducted on d 35 of Experiment 2 to determine blood protein for total nitrate was conducted on samples obtained each wk. Blood analysis was conducted on d 35 of Experiment 2 to determine blood nitrate levels. Water intake was not affected by the inclusion of nitrate.

Key Words: Pearl grey guinea fowl, metabolizable energy, crude protein


Standards for poultry drinking water state that there should be less than 10 ppm of nitrate. Two experiments were conducted to evaluate the effects of nitrate addition in the drinking water on broiler performance. Cobb 500 by-product male broiler chicks were housed in batteries equipped with a nipple water system. Chicks were fed a corn-soybean meal diet and were allowed ad libitum access to feed and water. Chick weight, feed intake, and water consumption were recorded weekly throughout the 35 d experiments. In Experiment 1, five replicate pens of ten birds were allotted to the water treatments which consisted of 0, 6.25, 25 and 100 ppm of nitrate. No performance parameters were significantly affected by the inclusion of nitrate. Therefore, in Experiment 2, five replicate pens of ten birds were allotted to the water treatments which consisted of 0, 200, 400 and 600 ppm of nitrate. Water treatments were mixed on a weekly basis. Water analysis for total nitrate was conducted on samples obtained each wk. Blood analysis was conducted on d 35 of Experiment 2 to determine blood nitrate levels. Water intake was not affected by the inclusion of nitrate in either experiment. The addition of 400 ppm of nitrate in the drinking water of broiler chickens significantly reduced chick weight gain during wk 4 and 5, respectively, and the gain:feed ratio during wk 5 in Experiment 2 compared to the chicks on the control city water. Nitrate levels of 600 ppm reduced all performance parameters evaluated compared to the control, although this effect was not significant. Blood nitrate levels at 35 days were significantly higher in the 400 and 600 ppm treatments over the control. Blood oxygen, total hemoglobin, CO hemoglobin, and methemoglobin levels were not significantly different between the treatments in Experiment 2. Based on these results, water nitrate levels up to 200 ppm did not impact broiler performance, however, levels greater than 200 ppm may reduce broiler performance. In contrast to published water quality standards, negative effects of water nitrate were only observed with levels that exceeded 200 ppm.

Key Words: broilers, water, nitrate


Quinoa is a high protein pseudo grain whose lysine content as a percent of protein is similar to soybean meal and it is produced in abundance in Bolivia and Peru. To date little is known of its feeding value for animals. It was hypothesized that quinoa could be substituted for corn on an isonitrogenous-isocaloric basis and support lay as well as corn-based diets. To test the hypothesis 15 twenty wk old SCWL were equally divided into three treatment groups according to the substitution of quinoa for corn in the grain fraction of the diet - 0, 50, 100%. The birds were maintained in individual cages and housed in environmentally controlled rooms with an ambient temperature of 18 C and a light dark cycle of 14L:10D. Egg production and egg weight were observed daily, feed consumption and shell thickness weekly and body weight every four weeks for 16 weeks. Though the feeds were similar in caloric content there was a noticeable decrease in feed consumption (P < 0.05) for the 100% quinoa (84.4 g/day) and 50% quinoa groups (89.7 g/day) as compared to the corn-based diet (98.7 g/day). The diminished feed intake did not affect egg numbers or egg weight but resulted in reduced final body weights (P < 0.05) for 100% quinoa (1348 g) compared to the corn control (1656 g). Though not significant the reduced feed intake appeared to affect shell thickness with reduced egg specific gravity for the 100% quinoa feeding (1.0995 vs. 1.0970). As hypothesized quinoa supported lay as well as corn substituting at either a 50% or 100% rate; however, it appears to be less palatable than corn as evidenced by lower feed intake which translated into reduced body weight and over a prolonged lay period may prove to have a negative impact on production.

Key Words: quinoa, production, egg


Degermed-dehulled corn (DDC) is produced by dry milling and results in the removal of 80% of the corn phytate phosphorus (P). An experiment was conducted to determine if feeding DDC to male turkey poult would support growth and performance as well as feeding normal corn (NC) for rearing turkeys to market age. Nicholas male turkey poult (288) were reared in a curtain-sided house with 16 pens (18 birds per pen) until market age with 4 pens per treatment. Treatments were in a factorial arrangement with two types of corn (NC & DDC) and two Ca and available P levels: 15% above (CPA) and 15% below (CPB) recommended NRC (1994) levels. Toms were fed typical starter, grower and finisher rations. Feed and water were provided ad libitium. Individual BW, feed consumption and feed conversion (FC) were determined at 3, 6, 9, 12, and 18 wk. Percent toe ash, Tibia breaking strength, AMEn, apparent nitrogen retention (ANR), and fecal P levels were measured at 3 and 6 wk. Data were analyzed using GLM and means were separated using LMEANS of SAS (P<0.05). Neither BW (18.3 ± 0.2 kg) nor FC (2.66 ± 0.04) were affected by corn type or Ca & P level at 18 wk. Poult fed CPA vs. CPB had higher toe ash (16.6 vs. 15.1 ± 0.5 %), increased bone breaking strength (10.7 vs. 9.99 ± 0.25 kg/mm2) and increased fecal P (2.4 vs. 1.4 ± 0.1 %) at 3 wk regardless of corn type. At 6 wk, CPA
W13 Relative biological availability of Ca and P in six sources of raw rock phosphates fed to broiler chickens. G. Diaz*1, A. Cuesta2, and G. Afanador3, 1 University of Guelpf, Guelph, ON, Canada, 2 Universidad de Ciencias Agrarias, Bogota, Cundinamarca, Colombia, 3 Universidad Nacional de Colombia, Bogota, Cundinamarca, Colombia.

Two experiments were carried out to determine the relative biological availability (RBA) of Ca and P in 6 sources of raw rock phosphate (RRP). The effect of fluorine on the percentage of tibia ash and on BW gain was also determined in a third trial. Experimental diets were sorghum and soybean meal based with no supplementary Ca and P. One d old Starbro chickens were fed the experimental diets for 21 d. Tibia ash was determined by combustion in a muffle furnace at 600°C. In the first experiment, Ca was fed at 0.2, 0.25, 0.3, 0.35 and 0.4% Ca with a P ratio of 1:2. In the second experiment, 0.1, 0.15, 0.2, 0.25 and 0.3% P was fed with 1% Ca. To assess the RBA of Ca, diets were supplemented with 0.25% and 0.35% of Ca from RRP. To assess the RBA of P, diets were supplemented with 0.1% and 0.2% of P from RRP. The mineral sources were calcium carbonate for Ca and monobasic sodium phosphate for P. To calculate the RBA, the percentage of tibia ash obtained from rock phosphate at any concentration of Ca or P were compared with the estimated concentration of the element in the equation to obtain an equal percentage of tibia ash from control sources. The ratios of the concentrations of the element in the rock to the element in the reference were then made to determine the RBA. The effect of F was determined by comparing the supplementation with 100, 300, 500, 700 and 900 ppm of F to a control fed 1% Ca and 0.4% P. The RBA of P was between 26 to 87%; the RRP from Pesca had the highest RBA at 84% when P addition was 0.1% and 87% when P addition was 0.2%. The Ca RBA was between 22 to 85%. The rock from Santander had the highest RBA of 85% when Ca addition was 0.35%. Other sources of RRP had RBA below 52% for both Ca and P. There was a negative linear response to increases of F on ash percentage (P < 0.01) and on BW gain (P < 0.01). Fluorine has a detrimental effect on bone-ash formation that may reduce the RBA of raw rock phosphates.

Key Words: calcium, fluorine


A twenty-eight day floor pen experiment was carried out using 1680 Cobb 500 male day old chicks to evaluate the impact of feeding different particle sizes of calcium carbonate on broiler performance and tibia ash. The experiment consisted of 8 treatments with 6 replications per treatment to test 8 different CaCO3 particle sizes. The eight treatments had 8 different CaCO3 particle sizes. The corn soybean basal contained 21.5% CP, 3025 kcal ME/kg, 0.78% Ca, 0.20% NPP with 500 FTU/kg of Danisco Phyzyme XP added. The average particle sizes of CaCO3 (along with % solubility) tested were 28 (74.4), 137 (56.4), 299 (47.0), 388 (53.0), 519 (46.7), 760 (45.3), 796 (72.2), and 1306 (43.4) microns. Significantly (P < 0.05) increased weight gains were obtained in chicks fed CaCO3 particle sizes between 137 and 388 microns compared to the gains obtained by feeding either the smallest (28) or largest particle (1306) sizes. An increased mg of ash per tibia was also obtained for the chicks fed CaCO3 particle sizes ranging from 137-388 as compared to the smallest (28) or largest particle (1306) sizes. An in vitro phytate P hydrolysis by a 3-phytase at pH 2.5 and 6.5 using the same 8 different particles sizes of CaCO3 at 9 g/kg diet was carried out to evaluate the effect of Ca particle size on phytase P hydrolysis at 15, 30, 60, and 120 min incubation at 37°C. The results indicate a significant (P < 0.05) interaction of Ca particle size and pH on phytate P hydrolysis with greater effect at pH 6.5. The main effect of particle size showed that the smallest particle size (28 microns) with more solubility (74.4%) had the lowest phytate P hydrolysis indicating the interference on the action of phytase on phytate hydrolysis due to Ca-phytate complex formation. In summary, both in vivo and in vitro studies indicate that a small calcium particle size (28 microns) limestone with a high solubility (>70.0%) limits phytase hydrolysis to provide available P for growth and bone ash formation.

Key Words: CaCO3 particle size, phytate hydrolysis, broiler

W15 Methionine requirements of alternative slow-growing genotypes. A. Fanatico*, P. Pillai, T. O’Connor-Dennie, and J. Emmert, University of Arkansas, Fayetteville.

In the U.S. synthetic methionine (MET) will be banned from organic poultry diets in the future. Slower-growing alternative genotypes may be useful in organic production; they are less heavily muscled and may be expected to have lower MET requirements. Six trials were conducted to determine the MET and sulfur amino acid (SAA) requirements of alternative genotypes during the starter (7 to 21 d), grower (28-42 d), and finisher (49-63 d) phases. In each trial, five graded levels of DL-MET were added to corn-peanut meal basal diets that were deficient in MET (MET requirement trials) or MET and cysteine (CYS; SAA requirement trials). Experimental diets were fed to three genotypes: slow-growing (S), medium-growing (M) and fast-growing (F; starter and grower phase only). Each dietary treatment was fed to five replicate pens containing five male chicks (starter period) or thirteen male chicks (grower and finisher phases). Growth data were fitted to a broken line (when appropriate) such that an objective inflection point could be established. For each genotype (with the exception of the S birds in experiment 4), weight gain and feed efficiency increased (P < 0.05) with addition of DL-MET in experiments 1, 2, 3, and 4. Broken-line analysis with weight gain regressed against digestible MET or SAA intake revealed MET requirements (for S, M, and F genotypes, respectively) of 0.33, 0.30, and 0.33% for the starter phase and 0.28, 0.29, and 0.28% for the grower phase. In the finisher phase, the estimated MET requirement for the S genotype was 0.25%; no (P > 0.05) weight gain or feed efficiency response occurred in the M genotype in response to DL-MET addition, indicating that the basal diet contained adequate MET (0.22%). For the starter and grower periods estimates of SAA requirements ranged from 0.57 to 0.60%, regardless of genotype; extreme variability prevented the estimation of SAA requirements during the finisher phase. These data indicate that the MET and SAA requirements of the various genotypes are similar during the starter and grower phases.

Key Words: slow-growing, methionine, organic
**W16** Influence of proteases on the apparent metabolizable energy (AME), ileal and total tract nitrogen digestibility and performance of broilers fed corn-soy diets. H. Schulze\(^1\), V. Ravindran\(^2\), and P. J. Moughan\(^1\), \(^1\)Danisco Animal Nutrition, Leiden, The Netherlands, \(^2\)Institute of Food, Nutrition and Human Health, Palmerston North, New Zealand, \(^3\)Riddet Centre, Massey University, Palmerston North, New Zealand.

The soybean meal has a lower energy value than would be predicted from its chemical composition. The energy and protein utilization in soybean meal may be improved by supplementation with exogenous proteases (PROT). The present study was conducted to evaluate the effects of 3 PROT on the performance, AME\(_a\) and ileal and total tract N digestibility of broilers fed corn-soy diets. Each of the 3 PROT was tested at 3 inclusion levels (PROT1, 50, 100 and 1000 mg/kg; PROT2, 75, 150 and 1500 mg/kg; PROT3, 75, 150 and 1500 mg/kg) and compared with the unsupplemented diet. Each of the 10 diets was randomly assigned to 15 individually-caged birds and fed from d 7 to 28. Total excreta collection was carried out from d 24 to 27. On day 28, all birds were euthanized and digesta contents from the lower half of the ileum collected and pooled to yield five replicates per treatment. PROT treatments had no effects on weight gain (P = 0.11) and feed intake (P = 0.20), but significantly (P < 0.05) increased feed/gain of broilers. All 3 inclusion levels of PROT1 improved (P < 0.05) feed/gain over the unsupplemented control, but for the other PROT enzymes the differences were significant (P < 0.05) only with PROT2 at 75 mg/kg and PROT3 at 150 mg/kg. Enzyme treatments significantly increased (P < 0.001) the AME\(_a\) values. At all three inclusion levels of PROT1, PROT2 at 1500 mg/kg and PROT3 at 150 and 1500 mg/kg the AME\(_a\) was improved (P < 0.05) over the unsupplemented control diet. Total tract N digestibility was significantly (P < 0.001) influenced by protease treatments. N digestibility was improved by all 3 inclusion levels of PROT1 and PROT2. Ileal N digestibility, in general, followed the same pattern as the excreta N digestibility, but the differences between the enzyme treatments only tended to be significant (P = 0.09). These data are suggestive of the potential of supplemental proteases in corn-soy based poultry diets. In the present study, PROT1 was particularly effective in improving performance, and, energy and nitrogen utilization of broilers fed corn-soy diets.

**Key Words:** protease, metabolizable energy, broiler


Two studies were conducted to investigate the relative bioavailability value (RBV) of Bioplex\(^*\) Zn (a chelated Zn proteinate) comparing with ZnSO4+7H2O for chicks and to determine the requirement of organic Zn for broiler chicks. A practical corn-soybean meal diet without Zn supplementation, containing 23 mg/kg Zn, was used as a basal diet. One-day-old male broiler chicks were used in both studies. Chicks were housed in starter cages with plastic-coated feeders in an environmentally controlled room. Regular tap water with no detectable Zn and feed were supplied on an ad libitum basis. In study 1, treatments consisted of feeding basal diet alone or with three supplemental levels of Zn (20, 40 and 80 mg/kg) either from Bioplex\(^*\) Zn or from analytical ZnSO4•7H2O. Six replicates cages of six chicks were randomly assigned to each of seven dietary treatments. Zinc supplementation increased (P < 0.01) weight gain. Total tibia Zn increased linearly when the first three levels of Zn were fed. There was no difference between two Zn sources. In study 2, treatments consisted of feeding basal diet alone or with four supplemental levels of Zn (5, 10, 20 and 40 mg/kg) either from Bioplex\(^*\) Zn or from ZnSO4+7H2O. Eight replicate cages of six chicks were randomly assigned to each of the nine dietary treatments. Zinc supplementation significantly increased (P < 0.01) feed intake. Weight gain increased linearly (P < 0.01) with the first three levels of Zn from Bioplex\(^*\) Zn and with the four levels of Zn from ZnSO4•7H2O. Broken-line analysis of the weight gain data indicated the inflection point occurred at 6.3 and 13.6 mg/kg of diet for Bioplex\(^*\) Zn and ZnSO4•7H2O, respectively. The RBV of Bioplex\(^*\) Zn was determined using slope ratios obtained from fitting regression weight gain and tibia Zn on supplemental Zn using data below the inflection points. The resulting RBV for Bioplex\(^*\) Zn were 183% and 157% for weight gain and tibia Zn, respectively. Using the corn-soybean meal basal diet (23 mg Zn/kg) fed in these studies, chicks required 13.6 mg of Zn/kg as zink sulfate and 6.3 mg Zn/kg as Bioplex \(^*\)Zn to maximize weight gain.

**Key Words:** bioplex, zinc proteinate, requirement

**W18** The effect of dietary phytase on digestible energy and growth performance in young chickens. V. Pirgozliev\(^*\), P. Mares\(^2\), T. Acamovic\(^1\), and M. R. Bedford\(^3\), \(^1\)ASRC, Scottish Agricultural College, Edinburgh, Scotland, United Kingdom, \(^2\)Mendel University of Agriculture and Forestry, Brno, Czech Republic, \(^3\)Syngenta Animal Nutrition Inc., Wiltshire, England, United Kingdom.

It has been suggested (Ravindran et al., 1999) that energy values based on digestible energy (DE) might more accurately predict the nutritive quality of poultry feeds compared to apparent metabolisable energy (AME) values. The aim of this experiment was to investigate the relationship between dietary DE, measured in the ileal digesta, dietary AME and growth performance of broiler chicks at 21d age, when fed diets containing different activities of a phytase (Quantum 2500D: Syngenta Animal Nutrition Inc.). Four hundred and eighty female Ross 308 broilers were reared in 32 floor pens. The birds were fed a nutritionally complete (12.79 MJ/kg ME, 231 g/kg CP), low in phytate (WG) and feed intake (FI) of birds fed phytase-supplemented diets. Although diets supplemented with 2500 FTU tended to have higher AME (15.73 vs 15.35 MJ/kg DM) and DE (14.14 vs. 13.82 MJ/kg DM) compared to the negative control, no relationship (P>0.05) was detected between the energy and growth performance of birds. The lack of relationship between AME and DE, and performance suggest that neither of these methods is sensitive enough to predict the feeding quality of phytase supplemented diets.

**Key Words:** phytase, broilers performance, AME, DE

The efficacy of a microbial phytase (Quantum™) in corn or sprayed directly on ground wheat (WP) was evaluated in a 14 d broiler study. The phytase activity of corn-based phytase (CBP) was determined to be 660 FTU/kg and incorporated into broiler diets. A total of 288 7-d old male broiler chickens were grouped by weight into 8 blocks of 6 cages. Six dietary treatments were randomly allotted to the cages within blocks. The corn-soybean meal-based diets consisted of a positive control (PC) adequate in P and Ca, low P and Ca (NC; no added inorganic phosphorus) NC supplemented with 0.55% CBP, NC + 5.5% CBP, NC + 55% CBP, and NC + WP, were formulated to contain 0, 0, 3630, 36300, 363000, and 3630 FTU/kg phytase activity respectively. Birds were fed the dietary treatments for 14 d. Excreta samples were collected between d 9 and 12, and on d 14 birds were weighed, euthanized and ileal digesta and left tibiae bones collected. Weight gain, feed efficiency tibia weight and percent tibia ash of birds fed 3630 FTU/kg of either CBP or WP were similar, and higher (P < 0.05) than those fed low P and Ca diets. There was no difference in feed efficiency of birds fed the PC diet or phytase-supplemented NC diet, however, tibia ash of birds fed the PC diets was higher than those fed supplemental phytase, whose performance surpassed the NC diets. Birds fed supplemental phytase had higher (P < 0.01) ileal and total tract P and Ca digestibility than those fed NC diet. It could be concluded from the study that efficacy of CBP compared favorably with WP and would minimize the need for supplemental P in broiler diets.

Key Words: phytase, corn phytase, broiler chicks

W20 Effect of plant-based feed alternatives on the growth performance and carcass composition of heavy hen turkeys. J. L. Maclsaac*1, S. MacPherson2, D. M. Anderson2, and B. Rathgeber1, 1Atlantic Poultry Research Institute, Truro, NS, Canada, 2Nova Scotia Agricultural College, Truro, NS, Canada, 3Agriculture & Agri-Food Canada, Truro, NS, Canada.

To determine the effect of plant-based diets on growth performance and carcass composition, a one-way analysis was conducted with dietary protein/energy source (poultry by-product meal/poultry grease (P), roasted soybeans/soy oil (RS), extruded soybeans/soy oil (ES), full-fat canola/canola oil (C)) as the main factor. Birds fed RS gained more weight (P ≤ 0.05) than those fed ES from 28-56 d (91, 98, 101, 65 g/bird/day; P, C, RS, ES). Birds fed RS and C had heavier (P ≤ 0.05) 56-d weights than those fed P and ES and birds fed P were heavier (P ≤ 0.05) than those fed PC (3474, 3691, 3791, 2809 g/bird; P, C, RS, ES). From 28-56 d, birds fed RS and C ate more (P ≤ 0.05) than those fed ES, and birds fed P ate more (P ≤ 0.05) than ES (4613, 4865, 5102, 3826 g/bird; P, C, RS, ES). At 69 d, birds fed RS and C had the heaviest (P ≤ 0.05) weights and birds fed RS were heavier (P ≤ 0.05) than those fed ES (3978, 3532, 4138 g/bird; P, C, RS, ES). From 56-69 d, birds fed ES had the lowest (P ≤ 0.05) daily weight gains (115, 126, 118, 102 g/bird/day; P, C, RS, ES) and birds fed ES ate the least (P ≤ 0.05) amount of feed (3440, 3683, 3601, 2972 g/bird; P, C, RS, ES). Diet had no effect (P ≥ 0.05) on feed conversion (1.76, 1.78, 1.81, 1.91 feed/gain; P, C, RS, ES). Diet had no effect (P ≥ 0.05) on carcass fat (30.4, 30.7, 25.5, 26.6%; P, C, RS, ES) or carcass protein (60.4, 62.3, 64.5, 63.1%; P, C, RS, ES) percent at 69 d of age. Roasted soybeans and full-fat canola in combination with their respective oils were effective replacements for animal by-products in turkey diets.

Key Words: turkeys, growth, carcass


The objective of this study was to investigate the effect of maternal dietary selenium supplementation from Sel-Plex® (a selenium yeast product) or selenite on tissue and plasma Se-dependent glutathione peroxidase (GSH-Px) activities of newly hatched and 14-day-old chicks. Six replicate pens of 10 broiler breeder hens (Cobb × Cobb) plus one rooster were randomly assigned to each of three dietary treatments. A low- Se basal diet, containing corn, cornstarch, soybean meal and torula yeast as the main ingredients, was fed alone or supplemented with 0.3 mg Se per kg diet provided by sodium selenite or by Sel-Plex®. Fertile eggs were collected after 24 weeks of feeding the experimental diets and incubated for 21 d. Upon hatching, 12 chicks per treatment were sacrificed to take liver, heart and brain samples. Another 90 chicks from each of the three treatments were grown in cages and were fed a low-Se torula yeast diet. After 14 d, 12 chicks per treatment were randomly selected for sampling. Blood samples were taken and plasma was obtained immediately by centrifugation. Chicks were then sacrificed to obtain brain, heart and liver samples. All samples were snap frozen in liquid nitrogen and stored at –80°C until assayed for GSH-Px activity. Compared with no supplementation, selenite supplementation of the breeder diet increased (P < 0.01) GSH-Px activity of brain, liver and heart from both day-old and 14-d old chicks, and Sel-Plex® supplementation of the hen diet further increased (P < 0.01) tissue GSH-Px activity. Sel-Plex® supplementation of the hen diet significantly (P < 0.01) increased plasma GSH-Px activity of the 14-d old chicks with no supplementation or supplementing sodium selenite. The results indicate Sel-Plex® is more effective than sodium selenite as a supplement in the breeder hen diet for elevating tissue GSH-Px activity in chicks at hatching and for maintaining the enzyme activity when chicks are challenged with low-Se diet.

Key Words: chick, selenium yeast, glutathione peroxidase

W22 Dried porcine solubles (DPS) and coccidiosis vaccines on the performance of broilers. P. H. D. Tomasi and J. L. Andriguetto*, Universidade Federal do Paraná, Curitiba, Paraná, Brazil.

The objectives of the present work were to compare the effect of two different vaccines against coccidiosis on the performance of broilers and to evaluate the interaction of dried porcine solubles, a source of peptides rich in glutamine, on the performance of the vaccinated broilers. Vaccines against coccidiosis tend to reduce performance due to the reaction on the mucosa of the lower digestive tract. A vaccine made of live attenuated oocysts (precocious strains - Paracox®- Schering Plough) was given to 1-day old chicks (active immunity), and a vaccine based on purified antigens, isolated from gametocytes of Eimeria (Coxabic®- Abic) was given to the breeders, and their chicks were used in the trials (passive immunity). DPS was supplied, for
the first 21 days, in an attempt to reduce the deleterious effects of the vaccines, as a source of highly available amino acids, in a 2 x 2 factorial design: T1(Paracox/DPS; n=420), T2 (Paracox only; n=420), T3 (Coxabic/DPS; n=420), T4 (Coxabic only; n=420). Animals received feed with equal levels of energy, protein, and aminoacids. Until 14 days of age, there was a significant (P < 0.05) reduction in weight gain of the birds receiving Paracox, if compared with birds receiving Coxabic. At 45 days, however, there was no significant difference in the final weight and feed conversion of the broilers receiving the two kinds of diet. The use of DPS increased (P < 0.05) the weight of chickens at 45 days of age. The feed conversion was improved by DPS (P < 0.05). Viability did not vary among treatments.

Key Words: broiler performance, DPS, coccidiosis vaccine

W23  Effects of reduced dietary phytate in phosphorus adequate practical-type diets fed to growing chicks. M. E. Persia*, R. Angel2, and W. W. Saylor1, 1University of Delaware, Newark, 2University of Maryland, College Park.

In experiment 1, dehulled-degermed corn-by-product was mixed with cornstarch, corn oil, cellulose and synthetic amino acids to create a corn product similar in analyzed proximate composition to the control corn, but lacking phytate (DDC). Two diets were prepared utilizing either DDC or intact corn, and low ash meat meal and alfalfa meal. The DDC and corn diets were formulated to contain 0.43% nonphytate P and 0.00 or 0.13% phytate, respectively. Both diets were pelleted to account for physical consistency. Three dietary treatments consisted of the corn and DDC diets fed ad libitum and the DDC diet pair-fed to the feed intake of the corn diet. The treatments were fed to 15 replicate groups of 4 straight run Ross 308 chicks from 5 to 20 d of age. Feed intake (607 vs. 642 g) and weight gain (377 g) were reduced in limit-fed chicks to dietary phytate in corn-soybean meal diets. Five dietary experiments utilized large amounts of phytase to reduce the exposure of chicks to dietary phytate in corn-soybean meal diets. Five dietary treatments were utilized: a control diet containing no phytate; diets containing E. coli phytase at 500, 7,500 and 15,000 U/kg and a diet containing 15,000 U/kg of a fungal phytase. All diets contained 0.45% nPP. Diets were fed to 9 replicate groups of 8 male Ross 708 chicks from 8 to 22 d of age. Feed intake increased 5 to 8% and weight gain increased 4 to 7% compared to control chicks (P < 0.05) when diets contained 7,500 and 15,000 U/kg of phytase activity, regardless of source. The addition of large amounts of phytase, presumably reducing dietary phytate content, resulted in increased feed intake and weight gain above the positive control diet.

Key Words: chick, phytase, phytate

W24  Study of effects saccharomyces cerevisiae on performance and biochemical parameters of broiler chicks during aflatoxicosis. A. Safamehr*1 and M. Shivaazad2, 1Maragheh Azad University, Maragheh, Iran, 2Tehran University, Karaj, Iran.

The amelioration of aflatoxicosis in broiler chicks was examined by the dietary addition of Saccharomyces cerevisiae (SCE). Saccharomyces cerevisiae incorporated into the diet at 1 g/Kg was evaluated for its ability to reduce the deleterious effects of 1 and 2 mg total aflatoxin Kg-1 diet on growing broiler chicks from 1 day to 42 days of age. In this study 480 day-old male chicks (Ross 308) were assigned to a completely randomized design to six treatment (1:control without aflatoxin, 2:contain 1g/kg SCE, 3:contain 1 ppm aflatoxins(AFs), 4: 1 ppm AFs + SCE (1g/kg), 5: 2 ppm aflatoxins, 6: aflatoxins2 ppm plus SCE (1 g/kg)) with four replicate each with 20 chicks. The AF treatments (3 and 5) significantly decreased food consumption and body-weight gain and increased food conversion ratio (p<0.05). Serum cholesterol, total protein and albumin decreased significantly (p<0.05) in diets contaminated with aflatoxin. Compared to controls, the addition of SCE to an AF-containing diet significantly reduced the deleterious effects of AF on cholesterol, albumin and total protein. The toxin fed group had higher activities of the enzymes LDH and AST and decreased ALP. The addition of SCE to an AF-containing diet did not produce any significant changes in activities of enzymes compared with the control. These results suggest that SCE reduced the adverse effects of AF and should be helpful in a solution to the aflatoxicosis problem in poultry.

Key Words: saccharomyces cerevisiae, aflatoxicosis, chicken


Campylobacter jejuni is the leading cause of bacterial foodborne illness in North America. Contaminated poultry is the primary risk factor for C. jejuni infection in humans. Thus, reducing the levels of C. jejuni colonization in poultry is a priority in the area of risk management and control in order to increase food safety. The high-efficiency feed additive, xylanase, is currently being used in the poultry industry to supplement feed and was recently shown to cause reduction in C. jejuni colonization. NRC–IBS has engineered and patented a superior xylanase supplement that is able to resist extreme temperatures during the pelleting process and, therefore, remains active in the chicken gastrointestinal tract after pelleting. We have compared the effects of commercial and NRC–IBS modified xylanase on C. jejuni colonization with the intent of developing a cost-effective high efficiency animal feed supplement that will also improve food safety by reducing the levels of C. jejuni colonization in poultry. Specific pathogen-free (spf) leghorns (0–28 d) were fed either NRC modified or commercially available xylanase. A total of 72 birds were housed in medium animal bio-containment units (n=6/unit) produced on site and housed in a controlled environment. The birds were separated based on the following treatments: NRC modified and commercial xylanase (equal enzyme units/kg diet) (n=18 birds each), heat-inactivated (100°C, 20 min) NRC modified and commercial xylanase (n=12 birds each), positive and negative controls (n=6 birds each). On day 6, all but the negative control birds were inoculated with 300 μL of 109 cfu/mL C. jejuni 11168CJ1. On day 28, cecal contents were removed and serially diluted to determine colonization levels. Preliminary results indicate C. jejuni colonization in the cecum was reduced by approximately 1 log with either active xylanase treatment. NRC–IBS modified xylanase offers an added advantage over the commercially available xylanase because it can be added to feed during the pelleting process.

Key Words: xylanase, Campylobacter jejuni, colonization
W26  
**C. jejuni as a secondary colonizer of poultry biofilms.**

Previous research in our lab has shown *C. jejuni* has poor attachment to processing materials and fails to form biofilms in monoculture. We concluded *C. jejuni* may be a secondary colonizer rather than primary. Therefore, we decided to investigate the ability of *C. jejuni* to incorporate into an established biofilm. The objectives of the research were to determine if *C. jejuni* biofilm formation is influenced by intraspecies and interspecies cell signals and assess the physical interactions between *C. jejuni* and resident biofilms. Bacteria were isolated from chicken carcass rinses and identified using Gram-staining, biochemical testing, and sequencing of the 16s rDNA gene. Interspecies cell signal influence on *C. jejuni* was done by culturing *C. jejuni* in supernatants from each isolate and assessing subsequent biofilm formation in a 96-well plate assay. The *V. harveyi* AI-2 assay was used to determine the level of interspecies cell signals in the supernatant and this was compared to level of biofilm formation by *C. jejuni*. Intraspecies cell signaling levels of *C. jejuni* were manipulated by adding antagonists and promoters of the LuxS cell cycle. To view physical interactions of *C. jejuni* with a resident biofilm, biofilms grown on glass coverslips were inoculated with GFP campylobacter isolates, counterstained with DAPI, and viewed periodically using confocal microscopy. Interspecies cell signaling had no influence on *C. jejuni* biofilm formation regardless of the level of AI-2 production. Similarly, manipulating LuxS signals did not influence biofilm formation. Reconstruction of confocal images showed an influence on *C. jejuni* attachment by specific bacterial populations. In monoculture, *C. jejuni* attached sparsely. However, with species such as *Enterococcus*, finding any *C. jejuni* attached was difficult. Given the prevalence of campylobacteriosis, yet the lack of genetic survival abilities, the finding any *C. jejuni* survival. However, our current research indicates *C. jejuni* may prefer to remain motile, which may be advantageous in terms of colonization and virulence.

**Key Words:** campylobacter, biofilm, poultry

W27  
**Molecular analysis of Salmonella serotypes at different stages of commercial turkey processing.**
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Salmonella is one of the predominant human foodborne pathogens affecting the poultry industry. A study was conducted to determine the homo- or heterogeneity of individual Salmonella isolates recovered at various stages of processing in a commercial turkey processing facility. The sampling sites were: 1) Pre-IOBW (IOBW; inside and outside bird wash), 2) Post-IOBW, 3) Post-chill, 4) Pre-scald, and 5) Post-scald, with n=23, 46, 24, 17, 54 samples evaluated per site, respectively. The 164 Salmonella isolates collected were stored on trypticase soy agar slants and were streaked onto BGA (novobiocin) plates and grown overnight at 37 C. A Salmonella colony from each plate was boiled for 15 min in TE buffer, chilled, and centrifuged at 1 min, 8,000 x g. The PCR primers used for amplification of RNA spacer region were conserved regions located between the 16s and 23s rRNA genes: Forward G1 (5′-GAA GTC GTA ACA AGG-3′) and reverse L1 (5′-CAA GGC ATC CAG ATG-3′). Polyacrylamide gel electrophoresis (PAGE) was carried out using a 5% polyacrylamide run for 180 min at 250 volts. Ethidium bromide was used to visualize the banding patterns. The analysis of the Salmonella serotypes genotype was expressed as a dendrogram with comparisons expressed as percentage similarity coefficients. Based on the different clusters, ten major banding patterns were observed and designated as genotypes A through J with the corresponding number of isolates ranging 3 to 60 and with percentage similarity coefficients ranging from 83.8 to 95.8 respectively. Genotypes, and corresponding serotypes, were distributed among treatments and results suggested that several Salmonella serotypes may be present at the different sampling sites in the turkey processing plant.

**Key Words:** Salmonella serotype, genotype, PCR

W28  
**Identification and Serotyping of Escherichia coli strains isolated from poultry carcasses in a public market in Mexico City.**
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*Escherichia coli* is one of the most common pathogens involved in gastrointestinal disorders in developing countries. Additionally it has been described that poultry meat is one of the most important sources of pathogens for human being. The aim of the present study was to analyze the predominant *E. coli* serotypes in poultry carcasses. Ten samples from broiler skin and 10 from gut were obtained from a public market in Mexico City. All samples were media on Macconkey-Lactose agar, and Blood agar and incubated at 18 hours at 37°C. Two lactose positive colonies were selected from each initial sample. Biochemical testing, and serotyping of *E. coli* were performed. Seventy *E. coli* strains from the 10 original colonies chosen were identified, 49 from gut and 21 from skin. There were 26 O groups found among the strains; the most common were O25 (10), OR (10) and O? (7); on the other hand, 10 different H antigens were detected and the most common were H2 (24), NM (23) and H4 (12). The most frequent serotype was O25:H4. Serogroups from skin and gut were different, except O3 and O25. Results suggest that contamination of the skin does not comes from gut, however, it could be important to look for virulence factors in these *E. coli* strains since they could represent a threat for consumers.

**Key Words:** Escherichia coli, poultry meat, serotyping

W29  
**The sensory acceptance of table eggs from quinoa-based diets under red and normal lighting.**
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Quinoa is a pseudo grain noted for its protein quantity and quality that is grown extensively on small-scale, self-sufficient farms in Bolivia and Peru. When quinoa, which is absent of xanthophyll, is fed to farmstead flocks the resulting egg yolks are a creamy white color. It was hypothesized that consumers in the USA would look unfavorably on the quinoa eggs because of unfamiliarity with white yolks. However, if they were unable to distinguish the yolk color, as is the case under sensory red light illumination, no detectable differences would be observed. To test these hypotheses two sensory panels were conducted to evaluate table eggs from hens whose dietary grain portion contained...
0, 50 or 100% quinoa producing yolks with a strong yellow, pale yellow or cream-white color respectively. In the first panel the sensory testing area was illuminated with red light and yolk color was indistinguishable and based on a nine point Hedonic scale the 50 panellists found no differences in appearance (6.7, 6.9, 7.2), overall acceptance (7.3, 7.2, 7.0), aroma (6.3, 6.0, 6.2), flavor (7.1, 7.0, 7.0), texture (7.1, 6.8, 7.1) and aftertaste (6.6, 6.4, 6.5). Because the second panel was conducted under normal light the 50 panellists were able to observe yolk color differences and as one might expect egg appearance was downgraded (P<0.05) (7.3, 6.3, 3.1), and the eggs were now perceived to have an objectionable aroma (P<0.05) (6.7, 6.5, 5.8), a less favorable flavor (P<0.05) (7.4, 6.8, 5.5), a poorer texture (7.3, 7.0, 6.1), a noticeable aftertaste (P<0.05) (6.8, 6.2, 5.4) and an overall reduction in acceptability (P<0.05) (6.8, 6.2, 5.4). As hypothesized, if panellists were unable to distinguish yolk color no differences existed in the sensory acceptance of quinoa-based eggs as compared to corn-based egg; however, when yolk color was distinguishable not only did appearance drop but also, aroma, smell, texture and aftertaste.

Key Words: quinoa, yolk, sensory

W30 Dietary lipid source and vitamin E effect on lipid oxidation stability of raw chicken parts. C. Narciso-Gaytán*, C. A. Bailey, A. R. Sams, and M. X. Sánchez-Plata, Texas A&M University, College Station.

The dietary effect of oils and fats and supra-nutritional levels of vitamin E on the lipid oxidation stability of cooked chicken patties was analyzed. Six hundred Cobb x Ross broilers were raised under commercial-like conditions, randomly assigned into 8 treatments with 3 repetitions. A 4x2 factorial arrangement was used, supplementing a basal corn-soybean meal diet with 5% animal/vegetable fat (AV), lard (LA), palm kernel (PK), or soybean oil (SB), and 33 or 400 mg/Kg of dl-α-tocopheryl acetate. Broilers were fed ad libitum during a 6-week period. Skinless breast and thigh muscle pieces were blast frozen and stored for ~6 months at -20°C. Muscle pieces were thawed out for 24 h under refrigeration, deboned, and trimmed of connective and fat tissue. Meat was ground twice using a 1/2" and 1/16" plate and manually formed into patties of 150 g each. Patties were cooked in a convection oven to an internal temperature of 74°C, cooled, placed on trays, wrapped with film and stored in boxes at 4.4°C for 0, 1, 3, and 6 days before analysis. TBARS (thiobarbituric reactant substances) analysis was performed to determine the lipid oxidation. The results showed no significant interaction between dietary oil/fat and level of vitamin E. However, significant differences were observed between dietary lipid treatments (P<0.05). SB showed the highest lipid oxidation in all of the sampling days for both breast and thigh meat patties. In breast meat patties, PK showed lower lipid oxidation at 0 and 6 days of storage when compared to the other treatments. For thigh meat patties, PK showed significantly lower lipid oxidation only at day 0. For all the treatments in both breast and thigh meat patties, 400 mg/Kg of vitamin E was significantly more effective at reducing the lipid oxidation of cooked chicken patties. In conclusion, dietary oil/fat and supra-nutritional levels of vitamin E directly influence the lipid oxidation stability of cooked chicken meat.

Key Words: dietary lipid, vitamin E, chicken meat lipid oxidation

W31 Dietary lipid source and vitamin E effect on lipid oxidation stability of cooked chicken patties. C. Narciso-Gaytán*, C. A. Bailey, A. R. Sams, and M. X. Sánchez-Plata, Texas A&M University, College Station.

The dietary effect of oils and fats and supra-nutritional levels of vitamin E on the lipid oxidation stability of cooked chicken patties was analyzed. Six hundred Cobb x Ross broilers were raised under commercial-like conditions, randomly assigned into 8 treatments with 3 repetitions. A 4x2 factorial arrangement was used, supplementing a basal corn-soybean meal diet with 5% animal/vegetable fat (AV), lard (LA), palm kernel (PK), or soybean oil (SB), and 33 or 400 mg/Kg of dl-α-tocopheryl acetate. Broilers were fed ad libitum during a 6-week period. Skinless breast and thigh muscle pieces were blast frozen and stored for ~6 months at -20°C. Muscle pieces were thawed out for 24 h under refrigeration, deboned, and trimmed of connective and fat tissue. Meat was ground twice using a 1/2" and 1/16" plate and manually formed into patties of 150 g each. Patties were cooked in a convection oven to an internal temperature of 74°C, cooled, placed on trays, wrapped with film and stored in boxes at 4.4°C for 0, 1, 3, and 6 days before analysis. TBARS (thiobarbituric reactant substances) analysis was performed to determine the lipid oxidation. The results showed no significant interaction between dietary oil/fat and level of vitamin E. However, significant differences were observed between dietary lipid treatments (P<0.05). SB showed the highest lipid oxidation in all of the sampling days for both breast and thigh meat patties. In breast meat patties, PK showed lower lipid oxidation at 0 and 6 days of storage when compared to the other treatments. For thigh meat patties, PK showed significantly lower lipid oxidation only at day 0. For all the treatments in both breast and thigh meat patties, 400 mg/Kg of vitamin E was significantly more effective at reducing the lipid oxidation of cooked chicken patties. In conclusion, dietary oil/fat and supra-nutritional levels of vitamin E directly influence the lipid oxidation stability of cooked chicken meat.

Key Words: dietary lipid, vitamin E, chicken meat lipid oxidation


Pre-rigor deboning and marination of broiler breast fillets are growing trends in the poultry industry. Marination can often enhance product attributes such as flavor, juiciness and texture. The purpose of this study was to evaluate the effectiveness of marination in improving meat quality attributes and uniformity of pre- and post-rigor deboned broiler breast fillets. A total of 400 broiler carcasses were processed using an in-line system and deboned at various times: 0.25, 1.25, 2.0, 2.5, 3.0, 3.5, 4.0, 6.0 and 24.0 h post-mortem (PM). A two stage chilling system was used for all treatments with exception of the 0.25 h which was deboned prior to chilling. Following chilling, carcasses and/or fillets were aged on ice. Breast fillets were marinated with 1% salt and 0.45% phosphate concentration. Consumer sensory evaluations for juiciness, tenderness, salt intensity, flavor intensity, and overall impression were obtained on all treatments using hedonic and just about right scales. Although there were slight differences in hedonic ratings for overall impression, texture and flavor of marinated breast fillets, all treatments could be categorized as ‘like slightly to like moderately.’ Using a JAR scale, only a small percentage of consumers
(<20%) considered any of the treatments as too tough. The scores for overall flavor or juiciness were not affected by the deboning times as the majority of the consumers considered them to be just about right. A majority of the consumers reported the potential for purchase of the product as ‘probably would buy’ to ‘maybe/maybe not.’ The results of this study indicate that marination of pre-rigor deboned meat (with 1% salt) is effective in producing product similar to marinated post-rigor deboned meat suggesting its effectiveness in improving meat quality attributes of early deboned meat.

Key Words: salt, consumer sensory analysis, marination

W33 Conjugated linoleic acid and fish oil in laying hen diets: Effects on egg tocopherols, total fat and fatty acids upon storage. G. Cherian*,1, M. G. Traber2, K. S. Ryu1, M. P. Goeger1, and S. Leonard2, 1Oregon State University, Corvallis, 2Linus Pauling Institute, Oregon State University, Corvallis.

Omega-3 and conjugated linoleic (CLA) fatty acids have received considerable attention for their health-enhancing properties. Increasing omega-3 fatty acids intakes have been recommended by nutritionists, but cost, consumer preference and seasonal availability limit the consumption of fish. Consuming low-fat ruminant foods also limit the intake of CLA. We sought to improve the omega-3 and CLA fatty acid pattern in eggs and simultaneously maintain egg vitamin E concentrations to prevent lipid peroxidation during storage. Therefore, the effects of incorporating CLA and fish oil in laying hen diets on chicken egg, CLA-omega-3 fatty acid and tocopherol contents during sixty-days storage were investigated. Hens were fed corn-soybean meal-based diet containing, 3% yellow grease (control), 2.75% yellow grease + 0.25% CLA (CLA), 2.5% yellow grease + 0.25% CLA + 0.25% fish oil (CLA-FO), or 2.75% yellow grease + 0.25% fish oil (FO), eggs were collected and stored at 4°C up to sixty days. On storage day 0, 20, 40 and 60, eggs (n=8) from each treatment were selected randomly, then tocopherol and total lipid concentrations, and fatty acid composition were measured. CLA and CLA-FO diets reduced α and γ- tocopherol contents at all days of storage compared with control eggs (P<0.05). Regardless of diet, egg storage for 40 days or longer depleted egg tocopherol contents (P<0.05). Feeding CLA-FO reduced egg total lipids (P<0.05); CLA diet increased egg saturated, omega-6 and CLA contents and decreased monounsaturated fatty acids. Egg omega-3 was highest in eggs from FO-fed hens and lowest in control hens (P<0.05). Storage for sixty days decreased omega-3 and CLA in eggs from CLA, CLA-FO and FO fed hens (P<0.05). No effect of dietary oils on egg cholesterol was observed (P>0.05). These data demonstrate that “healthy” eggs with increased omega-3 fatty acids and CLA can be generated by minor diet modifications and added tocopherol supplementation may be needed when omega-3 or CLA is included in the hen diet.

Key Words: eggs, tocopherol, conjugated linoleic/Omega-3 fatty Acid

W34 Effect of drinking water iron, nitrate, and manganese on broiler performance. B. D. Fairchild*, A. B. Batal, and C. W. Ritz, University of Georgia, Athens.

Many producers have problems with drinking water quality and are uncertain of the effect this will have on broiler performance and health. The maximum acceptable concentrations for Fe, NO3, and Mn for poultry drinking water are reported to be 0.3, 25, and 0.3 mg/L respectively. Previous work indicates that these contaminants alone do not have a significant impact on broiler performance at 600, 600 and 20 mg/L for Fe, NO3 and Mn, respectively. Two trials were conducted to examine the effects of combining these contaminants on broiler performance using the highest concentrations utilized in previous studies. Cobb 500 by-product male broiler chicks were housed in batteries equipped with a nipple water system. Chick weight, feed intake, and water consumption were recorded weekly throughout the 35 day trials. Water treatments were mixed and analyzed weekly. In Trial 1 water treatments consisted of Control (C), 600 mg/L Fe + 600 mg/L NO3 (FN), 600 mg/L Fe + 20 mg/L Mn (FM), and 20 mg/L Mn + 600 mg/L NO3 (MN). Water treatments in Trial 2 were identical to Trial 1 with the exception of treatment 4, 600 mg/L Fe + 600 mg/L NO3 + 20 mg/L Mn (FMN). Five replicate pens with 10 birds were used in for FN and FM, while 4 replicate pens were used for C, MN and FMN. In Trial 1, FN and FM birds consumed less water than C and MN birds. Birds in FN and FM had less weight gain in weeks 1 and 2 but experienced better weight gain in weeks 3 and 4. In Trial 2, FN and FM birds experienced less weight gain in weeks 3 and 4 respectively, but cumulative weight gain was not affected. Less water was consumed by FM birds as compared to other treatments. Less feed was consumed by FN and FM birds in weeks 2 and 3 but no differences were noted in final body weights. No differences in feed:gain ratio were noted in either trial. Combining Fe and Mn had negative effects on performance parameters measured while mixing Fe and NO3 were more variable. Previous work suggests that these single contaminants do not affect performance; the current study indicates certain combinations may yield negative effects.

Key Words: water quality, broilers, performance


An experiment was conducted to assess the prevalence and antibiotic resistance of Campylobacter jejuni (C. jejuni) in turkey house litter and transportation crates from commercial farms in North Carolina. A total of 76 farms from two turkey integrated companies were monitored utilizing samples collected at wk 1, 4, and 14 from farm house litter and transportation crates at the processing plant. C. jejuni was isolated and antimicrobial susceptibility was determined using Seni-Disc™discs. C. jejuni was isolated at a low rate in the litter for both companies at 1, 4, and 14 wks (company A 12.5%, 7.5%, 7.7% and company B 8.3%, 2.8%, 11.1%, respectively). Isolation rates from crates at the processing plant were higher (company A 45.0, 47.5%, 33.3%, and company B 38.9%, 48.6%, 25.7%, respectively). Isolates from house litter and transportation crates at all three sampling times and from both companies were resistant to enrofloxacin (15.0%, 100%, 100%), erythromycin (85.0%, 61.8%, 58.6%), gentamicin (55.0%, 26.5%, 13.8%), naladixic acid (37.5%, 26.5% 13.8%) and tetracycline (47.5%, 29.4%, 31.0%). No clear patterns were observed in relation to age of the birds or source of sample (litter/crates) and presence of Campylobacter. This study showed that C. jejuni is prevalent on turkey farms in house litter and transportation crates. Multiple drug resistant C. jejuni was prevalent in turkey flock at various stages of maturity. Both house litter and transportation crates may serve as reservoirs for infection of flocks. Thus, events which occur prior to slaughter, such as loading, transport, and holding in transportation crates may contribute to the
prevalence of *C. jejuni*. Further, multiple resistance may complicate approaches to control.

**Key Words:** *Campylobacter jejuni*, turkey farms, drug resistance litter

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**W36**  
**Impact of poultry litter on surface and groundwater in areas of hydric and non-hydric soil types: stable $^{15}$N isotopes of nitrate assessment.**  
C. M. Williams* 1, W. J. Showers, and G. D. Jennings, North Carolina State University, Raleigh.

Land application of poultry litter and resulting surface and groundwater impacts due to nitrate nitrogen are a concern in many areas of dense poultry production agriculture. This study investigated such impacts in a watershed located in North Carolina where poultry production is prevalent. The stable $^{15}$N isotopes of nitrate procedure was utilized. Results showed that $^{15}$N of groundwater nitrate was controlled by the types of soils in the poultry litter application fields. Hydric soils had enriched $^{15}$N nitrate compositions and reduced nitrate concentrations associated with denitrification. Partially hydric and non-hydric soils did not show elevated groundwater $^{15}$N nitrate compositions. The $^{15}$N composition of groundwater nitrate in litter application fields with non-hydric soils indicate the source of nitrate were a mixture of litter and fertilizer N. On a watershed scale, the $^{15}$N composition of stream water nitrate was not related to the distribution of poultry operations, but was related to the distribution of hydric soils in the basin. Nitrate concentrations in stream waters remained low through out the subbasin studied. The $^{15}$N composition of stream nitrate decreased downstream suggesting minimal impact on surface water quality from the surrounding poultry operations. The practice of placing poultry operations proximate to swampy land also places them in areas of abundant hydric soils. Denitrification proceeds quickly in such areas, which minimizes on-site nitrate transport and mitigates surface water quality impacts in these areas. This data suggest that water quality impacts from poultry production agriculture can be predicted from the distribution of hydric soils in a watershed.

**Key Words:** poultry litter, $^{15}$N natural abundance, watershed water quality

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**W37**  
**The use of a urease inhibitor on broiler litter.**  
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To determine the effect of a urease inhibitor on ammonia release from broiler litter, two experiments were conducted using an equilibrium chamber gas sampling technique. In both experiments, 22 male broilers were placed in each of 48 floor pens (10.28 birds / m²). All pens had built up litter and were in one climate controlled room with uniform airflow to each pen. The urease inhibitor used for these experiments was N-(n-butyl) thiophosphoric triamide (NBPT). Four treatments were used for these experiments: control (no urease inhibitor); 50 ml/pen of urease inhibitor solution applied at day 0; 50 ml/pen urease inhibitor solution applied at day 21; 50 ml/pen of urease inhibitor solution applied at day 0 and again at day 21. An equal volume of water was applied to the control pens. In experiment one three gas samples were taken on day 0, 21, and 42. No reduction in equilibrium ammonia concentration was observed from use of the urease inhibitor, perhaps due to the infrequent sampling. In experiment two, samples were taken 10 times (days 0, 7, 11, 21, 24, 27, 29, 31, 34, and 42). No clear positive effect of the urease inhibitor treatments was observed on equilibrium ammonia concentration prior to day 31. From day 31 to 42 the treated pens tended to have reduced concentration. Variability between pens was substantial thus this reduction was not significant. Litter moisture content tended to be dry (20-25% moisture) and it is possible the observed variability in equilibrium ammonia concentration was associated with litter moisture differences, with higher moisture content litter having greater potential for microbial activity. From these experiments it is unclear whether urease inhibitors would offer a reduction of ammonia emissions from broiler houses.

**Key Words:** urease inhibitor, ammonia release, broiler litter

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**W38**  
**Mannan oligosaccharides effects on litter bacteria levels.**  
K. S. Macklin* 1, J. P. Blake 1, B. A. McCrea 2, R. A. Norton 1, J. B. Hess 1, and S. F. Bilgili 1, 1Auburn University, Auburn, Alabama, 2University of California, Davis.

Four successive trials were performed in which litter bacterial levels were measured in birds fed one of three corn-wheat based diets: one supplemented with Bacintracin Methyline Disalclyate (BMD), one containing mannan oligosaccharide (MO) (Bio-mos, Alltech, Nicholasville, KY) and a control diet that had no additional supplementation (CON). Each diet was replicated in 10 pens containing 50 birds/pen. Birds for all four trials were raised on used litter to 6 weeks of age under standard management conditions. Litter samples were collected before chick placement and immediately after bird removal from three locations within each pen and mixed in a sterile bag. Samples were then serially diluted and plated on the following media: plate count agar (PCA) for determining total aerobic bacteria, reduced tryptic soy agar with 5% sheep red blood cells (RBA) to determine anaerobic bacterial numbers, and MacConkey agar (MA) for total enteric bacterial numbers. Media was then incubated at 37°C under appropriate conditions for 24 hours than counted. CFU/g counts were transformed using log10 and analyzed using General Linear Model with P<0.10. Trial 1 produced no differences (P>0.10) for the bacterial counts between the three diets. Counts at the end of Trial 2 showed significantly lower bacterial counts with MO on PCA (11.25) and RBA (9.93) than the CON (11.72 and 10.22) group, with the BMD group (11.41 and 10.15) producing intermediate results. MA produced no statistically significant differences between the three diets. Trial 3 produced no differences (P>0.10) for the bacterial counts between the three diets at the conclusion of the trial. At the end of trial 4, MO produced lower bacterial counts then either BMD or CON on all three media types. Given the results observed in these four trials, the use of MO and BMD as a feed supplement reduces total aerobic, anaerobic, and enteric litter bacterial counts

**Key Words:** mannan oligosaccharides, litter, bacteria

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**W39**  
**Microarray-based analysis for SNPs associated with high or low humoral immune response in the chicken.**  
T. Geng* 1, and E. J. Smith, Virginia Polytechnic Institute and State University, Blacksburg.

Natural immune response continues to be of importance in the poultry industry. Developing markers for humoral immune response to sheep
red blood cells (SRBC) offer the opportunity to identify and select birds for high or low natural immunity. Using nine birds from lines divergently selected for low (4) or high (5) anti-SRBC for over 40 generations, we screened for informative SNPs with microarrays from Illumina, Inc. As a result, 2,733 SNPs were successfully genotyped. A total of 191 informative SNPs were identified in the samples screened. Fifty seven of the informative SNPs appeared to be line-specific. Most of the line-specific SNPs are distributed over several chromosomes, including Chromosome 1 (8), 2 (9), 4 (6), 15 (4), 16 (4), and Z (11). Furthermore, 25 of them were located within (7 SNPs) or near (18 SNPs) previously reported immunity-related genes. In addition to the novel candidate markers, the results appear to validate 6 of 7 candidate markers previously identified by us through other genome analysis methods. These findings may provide a useful resource for identifying genes that control humoral immunity in Gallus gallus.

Key Words: single nucleotide polymorphism, humoral immune response, gallus gallus

W40 SLC11A1 and Prosaposin gene polymorphism associations with antibody kinetics in adult chickens. A. S. Ahmed1,2, J. R. Hasenstein2, and S. J. Lamont2,* 1College of Agriculture, Cairo University, Cairo, Egypt, 2Iowa State University, Ames.

Our goal was to increase knowledge of genes controlling antibody response kinetics in chickens. We identified single nucleotide polymorphisms (SNP) in two genes and examined their association with antibody response kinetics in hens. Two biological candidate genes were studied, natural resistance associated macrophage protein 1 (SLC11A1, or NRAMP) and Prosaposin (PSAP). An F2 population was produced by mating G0 highly inbred (< 99%) males of two MHC-congenic Fayoumi lines with G-B1 Leghorn hens. The F2 hens (n=158) were injected twice with SRBC, a T-dependent antigen, and whole fixed BA, a T-independent antigen. Blood samples were obtained preceding each immunization, at 7 d after primary, and at 4, 7, 10, 18, 32, and 63 d after secondary immunization, and used to measure agglutinating antibody titers. Secondary phase parameters of minimum (Ymin) and maximum (Ymax) titers, and time needed to achieve minimum (Tmin) and maximum (Tmax) were estimated from the seven post secondary immunization titers with a non-linear regression model. The equilibrium phase parameter was the mean titer of the last three collected samples. A 642 bp fragment of SLC11A1 had a T/G SNP at 314 bp between lines. A 647 bp fragment of PSAP had a G/A substitution at 25 bp between the lines. The F2 individuals were genotyped by using PCR-RFLP. General linear model tests were conducted for associations of genotypes with antibody response parameters and body weight at 0, 2, 6, 12, and 20 wk. The SLC11A1 gene SNP and body weight at 12 wk were significantly (P < 0.02) associated. The PSAP gene SNP was significantly associated with BA antibody level at 7 days after secondary immunization (P < 0.04), Ymin of BA (P < 0.04), and body weight at 20 wk (P < 0.05). The current study demonstrated that the SNP detected within the immune function genes affect antibody kinetics for BA, and may also have a role as effector or regulatory factors for body weight.

Key Words: antibody, SLC11A1, PSAP

W41 The complete sequence and analysis of the turkey (Meleagris gallopavo) mitochondrial genome. X Guan*, K. B. Gyenai, and E. J. Smith, Virginia Tech, Blacksburg.

The mitochondrial genome (mtGenome) is an extra-chromosomal and maternally inherited DNA molecule whose expression is essential in vertebrate biology for processes such as energy production, metabolism, cellular homeostasis, and apoptosis. These processes are important because they affect diseases like dilated cardiomyopathy, diabetes, cancer and Alzheimers in eukaryotes including human and model species such as the mouse. Despite this importance, the mtGenome has been very little-studied in birds, especially economically important poultry species. The turkey (Meleagris gallopavo), for example, the second most important poultry species, even lacks a complete mtGenome sequence. In this study, we used PCR-based methods involving 35 primer-pairs developed from mitochondrial DNA of the chicken and other species to generate and validate a complete turkey mtGenome sequence. The total length of the sequence was 16,968 bp. The sequence showed 85% nucleotide similarity with the chicken (Gallus gallus) mtGenome. As expected, annotation using bioinformatics tools revealed that the turkey mtGenome has 13 genes and 24 RNA (22 tRNA and 2 rRNA) sequences. The mtGenome sequence is a resource that will be useful in evaluating the role of the mitochondra in turkey biology as well as in defining genetic relatedness among turkey varieties, an interest of our group.

Key Words: turkey, mitochondrion genome, DNA sequence


Consumer interest in Heritage turkeys continue to grow and are rapidly becoming an important source of revenue for a different group of farmers, especially organic growers. The increasing demand for the heritage turkeys poses an important concern about the utility of the knowledge of the commercial turkey, the most-widely studied, in understanding their biology. Understanding the genetic relationships between commercial and non-commercial turkeys may help address this concern and to determine the usefulness of the heritage varieties in breeding programs that could involve introgression of novel genes important for economic traits including disease resistance. The objective of this research was to conduct molecular genetic analysis of relatedness among commercial and heritage domestic turkeys using microsatellite DNA markers and a gene-based SNP. A total of 10 microsatellite markers were used to genotype 25 birds from each of 5 heritage turkey varieties including Narragansett, Bourbon Red, Blue Slate, Spanish Black, and Royal Palm. A naturally-occurring ApaL I recognition site matching a SNP in cardiac troponin T was used as the basis for SNP-based phylogenetic analysis of the six populations by PCR-RFLP. Results of the microsatellite analysis showed that the Bourbon Red and Blue slate were closely related to the commercial strain, and the Royal palm and Spanish black were the least related. The SNP-based analysis showed a closer relationship between the Narragansett, Spanish Black, and the commercial turkey and between the Blue Slate, Bourbon Red, and Royal Palm. Though the two marker-types appear inconsistent, together, however, they provide for the first time, an opportunity to more fully define the relatedness among heritage and commercial turkeys.

Key Words: heritage turkeys, DNA markers, phylogenetic relatedness

A total of 1917 weight records obtained from a feed experiment consisting of 240 Ross broilers was used to estimate repeatability of body weight trait over a period of 8 weeks. The experiment was undertaken in the animal research unit of agriculture faculty of Birjand University of Birjand in Iran. In the model, fixed environmental effects of sex, week and ration were statistically significant (P<0.05). Restricted maximum likelihood (REML) & Henderson III (HIII) statistical methods were used to estimate variance components. The repeatability of body weight records were found to be 0.267 and 0.264 based upon REML and HIII methods, respectively.

**Key Words:** Ross broilers, repeatability, body weight

**W44** Correlation coefficients between some traits in commercial hen layers. A. Riasi* and H. Naeemipour, *Birjand University, Birjand, Iran.*

Correlation coefficients between some traits of commercial hen layers was studied using 192 Single Comb White Leghorn hens from 100 to 112 wk of age. The age, specific gravity of eggs (GR), shell thickness (SHT), shell weight (SHW), shell weight to egg weight (SHW/EW), yolk colour index (YCI), feed conversion rate (FCR), feed consumption (FC), egg production (EP), packed-cell volume (PCV), triglyceride (TG), total cholesterol (Chl), HDL cholesterol (HDL), and LDL cholesterol were studied. The SAS software (1990) was used for statistical calculations. Results show that the correlation coefficients between some traits were positive and the other ones were negative. The highest significant correlations were found between age and TG (0.67) (P<0.01), age and SHT (-0.63) (P<0.01), age and YCI (-0.31) (P<0.05), age and Chl (0.49) (P<0.01), FC and EP (0.55) (P<0.01), FC and PCV (0.29) (P<0.05), FC and LDL (0.26) (P<0.05), FC and Chl (-0.34) (P<0.01), EP and FCR (-0.85) (P<0.01), EP and HDL (-0.30) (P<0.05), LDL and TG (-0.37) (P<0.01), LDL and Chl (-0.88) (P<0.01), SHW and SHW/EW (0.69) (P<0.01). The correlation coefficients between SHW and SHT, FCR and PCV, age and PCV were not significant (P>0.05). It is concluded that some physiological characteristics of hen layers are able to be estimated by common traits.

**Key Words:** correlation coefficient, traits, hen layer


The gastrointestinal tract of a turkey poult harbors a dense and metabolically active microbial community. During the poult production phase, antibiotics are used as an intervention tool to control gastrointestinal disease. However, the effects of antibiotics on the gastrointestinal microbial community are poorly understood. The early development of gastrointestinal microflora affects both the immune system and performance. Traditionally, culture plating methods have been used to characterize microbial populations in the gastrointestinal tract of turkey poults. Unfortunately, these techniques are limited in their ability to detect only cultivable microorganisms. The objective of this study was to assess the microbial diversity and succession of the bacterial community in the gastrointestinal tract of turkey poults with and without penicillin using denaturing gradient gel electrophoresis (DGGE). Three penicillin applications; penicillin in feed, penicillin in water, and penicillin in feed and water along with a control of no penicillin, were examined in this study. The gastrointestinal tract of three representative birds from each of 25 houses representing 14 sites were dissected, sampling the duodenum, jejunum, and ileum. Genomic DNA was extracted, amplified using PCR, and then visualized by DGGE. MANOVA results indicated that replicates within each treatment group possess similar microbial communities, while microbial communities differ significantly between treatments (p<0.001). MANOVA results also identified bacteria which were prominent in each treatment group. Bacteria correlated with good performance and the use of penicillin were identified by DNA sequencing as *Lactobacillus spp.* Overall, DGGE has been an effective tool to monitor the microbial diversity and succession in response to antibiotic treatments.

**Key Words:** DGGE, turkey poult

**W46** Vitrification of the inner perivitelline layer of chicken eggs for use in the sperm:egg interaction assay. D. C. Bongalhordo*1,2, A. S. Flores1, V. Severo1, V. C. Gonzalez1, B. R. Curcio2, M. C. Macedo Jr.2, and J. C. Deschamps2, *1Biology Institute, Federal University, Pelotas, RS, Brazil, 2Biotechnology Center, Federal University of Pelotas, Pelotas, RS, Brazil.*

The sperm:egg interaction assay is a good predictor of the fertilizing potential of semen. The ability of chicken sperm to interact with the egg can be measured by counting the number of holes in the inner perivitelline layer (IPVL) of a fresh egg. However, IPVL is viable for a short period of time and must be prepared within 24 hours of the test. Preservation of IPVL for long periods of time in liquid nitrogen would facilitate the sperm:egg interaction assay. This work aimed to develop a protocol for IPVL vitrification. IPVL squares from the same egg were washed with mDPBS/BSA, equilibrated for 1 minute in vitrification solution 1 (VS1 - 1.4 M DMSO and 1.8 M EG) and transferred to VS2 (2.8 M DMSO, 3.6 M EG, 0.6 M sacarose, and 1% X-1000). After 1 minute in VS2, they were envased in 0.5 ml straws (each straw contained from 4 to 8 IPVL squares cut from the same egg, immersed in VS2 solution), refrigerated in nitrogen vapour for 1 min, and then immersed in liquid nitrogen. For thawing, the straws were removed from liquid nitrogen, and gently agitated in the air for 15 seconds. Both ends of the straws were cut and the straw content was placed in thawing solution 1 (TS1 - 0.5 M sacarose and 0.4% BSA in PBS). The number of membranes recovered was counted, and they were consecutively transferred to TS2 (0.25 M sacarose and 0.4% BSA in PBS), and TS3 (0.125 M sacarose and 0.4% BSA in PBS). The IPVL squares remained in each TS for 1 minute, with gentle agitation of the plate in order to spread the membranes. At last, the IPVL squares were placed in 1% NaCl solution and were ready to be used in the sperm:egg interaction assay. There were no statistical differences (Wilcoxon Signed Rank test, P > 0.05) in the number of holes made by the same sample of sperm in fresh and vitrified membranes (respectively, 159.5 ± 17.7 and 146.0 ± 17.7 holes/mm2 of IPVL, mean and standard error, n = 123) and the percentage of intact membrane’s recovery after the freezing-thawing process was 80%.

**Key Words:** vitrification, IPVL, sperm:egg interaction
W47 Some observations on molting female Japanese quail. K. Arora* and V. Vatsalya, Fort Valley State University, Fort Valley, Georgia.

Molting is the natural process in birds of shedding and renewing feathers. Photoperiod, season of the year, feed and water restrictions, and other stress factors are considered contributing factors. During our growth studies with laying female birds (age=125 d; room temperature=72 °F; LD 16:8), we noticed in mid-November that some birds were shedding feathers dorsally and around the neck and losing weight. The birds were weighed regularly and divided in two groups: molting (n=18) and non-molting (n=15). Blood was collected from the wing vein for determining PCV, glucose, and total plasma protein values. Some birds from both groups were euthanized for evaluation of the status of reproductive organs and the maturation of ovarian follicles. Total plasma proteins were determined by using lab refractometer (T2-Ne Atago Co), glucose using a glucometer (Elite XL), and PCV using microhematocrit tubes. Besides shedding feathers, loss in body weight (115 vs. 132g) and cessation in egg production, the molting birds had a relative increase in glucose (284 vs. 243 mg/dl) and PCV (48 vs. 42 %) values, and decrease in total plasma proteins (3.78 vs. 5.96 g/dl). In the molting birds, the weights of the oviducts were drastically reduced (1.6 vs. 4.82 g). The ovaries were also regressed and devoid of maturing follicles. There was evidence of resorption of old follicles in some birds. During the molting period, the females were hard to distinguish from males with respect to breast feather colors. The birds recovering from molting resumed egg production and returned to normal blood values. Our observations indicate that the above mentioned changes in the molting birds resulted from the disruption of gonadotropin and gonadal hormone secretions. The data is also being analyzed with respect to the dynamics of circulating leukocytes and hormones. Accordingly, the molting process is likely to impact reproductive, endocrine, blood, and growth studies in birds.

Key Words: female Japanese quail, molting, oviducts


Leptin is a potent hormone that can regulate feed intake and energy balance in domesticated and wild birds. It can act centrally, through activation of hypothalamic nuclei and the sympathetic nervous system, or directly on peripheral tissues. Studies in mammals suggest that leptin also can be a potent modulator of the skeleton. It is not known if this function of leptin and its neuroendocrine circuitry exists in poultry. To explore this mechanism for linking nutritional status, energy balance and skeletal quality, a bone explant culture model was used to test effects of chicken leptin (cLEP) and the sympathetic neurotransmitter, norepinephrine (NE), on the growth of embryonic chick bones. Contralateral pairs of tibiotarsi bones were dissected from day 10 chick embryos and incubated individually with cLEP (1 μM), NE (10 μM) or transforming growth factor-β (TGFβ;10 ng/ml-control for tissue viability). After 5 days in culture, measurements were taken of the length of proximal condyles and width of the mineralized band at the diaphyseal-epiphyseal junction as estimates of longitudinal growth and chondrocyte maturation respectively. cLEP treatment resulted in an increase in condyle length (CO 3.96±0.06 mm; cLEP 4.21±0.07 mm;p=0.0003) as well as the mineralized band (CO 318±35 μm; cLEP 640±77 μm; p=0.006). Similar effects were observed with NE treatment on length (CO 4.65±0.08 mm;NE 5.04±0.11 mm;p=0.006) and mineralization (CO 514±57 μm; NE 680±52;p=0.04). In contrast, TGFβ had no effect on length and reduced mineralization (CO 510±81 μm; TGFβ 260±52 μm;p=0.0003), consistent with its role as an inhibitor of proliferation and maturation. Immunohistochemical and quantitative real time PCR analysis for the expression of Type X Collagen, a marker of chondrocyte maturation, further supported these results. For example, NE treatment resulted in a ~2-fold increase in Type X expression (f=2-ΔΔCt;f=2.13±0.29). In addition, analysis of BrdU incorporation suggest a positive effect of leptin and NE on chondrocyte proliferation. These results provide compelling evidence that leptin and its effectors may function to regulate skeletal growth and homeostasis in poultry.

Key Words: lepton, norepinephrine, skeleton

W49 Pituitary levels of a putative gonadotropin inhibiting hormone receptor mRNA fluctuate during a reproductive cycle in the chicken. G. Y. Bedecarrats*, M. Shimizu, and M. Zeini, University of Guelph, Guelph, ON, Canada.

Although gonadotropin inhibiting hormone (GnIH) has been shown to inhibit the release of luteinizing hormone in several species, its effect on the reproductive axis in chickens has been controversial. Recently, two putative chicken GnIH receptors have been identified (RFamide-related peptide receptor, RFRPR, and neuropeptide FF receptor, NPFFR). However, whether their expression pattern changes during a reproductive cycle is not known. Thus, the objective of this study was to detect and quantify RFRPR mRNA in pituitaries and brain tissues from hens and roosters at various reproductive stages. Pituitaries, diencephalon, brain stem, cerebrum and cerebellum were collected from White Leghorn females at 4 different reproductive stages (immature, peak of lay, mid-lay, and end-of-lay) and from males at 3 reproductive stages (immature, 4 weeks and 40 weeks post-photostimulation). The presence of GFRPR mRNA was first detected by RT-PCR using primers designed to amplify the full length receptor. After PCR, RFRPR could be visualized in all tissues examined. To further determine if RFRPR gene expression was dependant on the reproductive status of the animals, levels of mRNA were quantified in individual pituitary glands and hypothalami by semi-quantitative real time PCR using primers spanning intron 2. In both males and females, mRNA levels in the pituitary gland were significantly higher in immature birds than in photostimulated birds (p<0.05). However, this difference was no longer significant towards the end of the laying period in hens. In the diencephalon, no significant changes were observed between reproductive stages, although levels tended to decrease after photostimulation in females. Interestingly, levels in the pituitary gland were consistently lower than in the diencephalon (p<0.05). In conclusion, GnIH receptor mRNA levels in the pituitary gland fluctuate during a reproductive cycle in both male and female chickens with the lowest levels observed around sexual maturity.

Key Words: gonadotropin, chicken, receptor

W50 Characterization of structure and tissue distribution of chicken GPR39. I. Yamamoto*, M. Numao, and M. Tanaka, Nippon Veterinary and Life Science University, Musashino, Tokyo, Japan.

GPR39 belongs to the subfamily of G protein-coupled receptors containing 7 transmembrane domains, and shows high homology to ghrelin receptor, GHSR (McKee et al., 1997). GPR39 has recently
been characterized as a specific receptor for a novel anorexic peptide hormone, Obestatin, isolated from rat stomach (Zhang et al., 2005). Obestatin is generated from the proprotein for ghrelin by a prolylcleavage and shows opposing action to ghrelin in weight regulation. The chicken ghrelin propeptide contains an amino acid sequence homologous to that of rat obestatin, suggesting that obestatin is produced in chicken tissues. In this study, we performed cDNA cloning for chicken GPR39 and characterized expression profiles of its mRNA in chicken tissues.

Total RNA was extracted from chicken tissues and GPR39 cDNA was cloned by RT-PCR using primers designed from the putative GPR39 gene sequence appeared in chicken genome database. The cDNAs for 3′- and 5′- regions were cloned by RACE. Realtime PCR analysis for GPR39 mRNA expression was carried out using primers derived from Exon 2 (sense) and Exon 3 (antisense) of GPR39 gene. Values for GPR39 mRNA were normalized to values for ribosomal protein S17 mRNA.

Chicken GPR39 cDNA was cloned from duodenum. The cDNA was about 3.0 kb in length and encoded 462 amino acids. The amino acid sequence showed significant homology to human (62.6%), mouse (62.6%) and rat (65.3%) GPR39. Realtime PCR analysis revealed that chicken GPR39 mRNA was expressed in all the tissues examined with highest levels in the duodenum where the expression level was rapidly increased during post-hatch period. These findings suggest that obestatin might be generated as a ligand for GPR39 in chicken.

Key Words: GPR39, obestatin, cDNA

W51 Comparison of antimicrobial sensitivity of Escherichia coli strains isolated from broilers in United States of America and Mexico. C. Rosario*, Universidad Nacional Autónoma de Mexico, Mexico, D.F., Mexico.

Since 1950, control measures for E. coli-associated diseases have depended mostly on the prophylactic and therapeutic use of certain antibiotics. However, this practice has provided a selective pressure for antimicrobial resistance genes and as a result, many bacteria associated with chickens and poultry meat are now resistant to antimicrobial agents. The purpose of the present work was to determine the resistance patterns of several E. coli strains isolated from broilers in USA and Mexico and compare these patterns. For this reason 76 E. coli strains isolated from young broilers and Mexico and 70 strains from cull chicks in USA were analyzed to determine the sensitivity to different antimicrobial agents. Results showed higher resistance levels among Mexican strains than those seen in USA isolates (Table 1). Moreover, the multi-resistant patterns were more frequent and complex among the Mexican strains. These findings are interesting since avian strains are considered a potential source of genes that encode for antimicrobial resistance and virulence factors for humans. In addition, a relationship between virulence and resistance to antibiotics has been established recently, since resistance and virulence are both adaptive mechanisms acquired to enhance survival under stressful conditions.

Table 1. Antimicrobial Resistance among Mexican and American Strains of Escherichia coli

<table>
<thead>
<tr>
<th>Antimicrobial Agent</th>
<th>Mexican Strains</th>
<th>American Strains</th>
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<tbody>
<tr>
<td>Amikacin</td>
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<td>0</td>
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<tr>
<td>Ciprofloxacin</td>
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<td>0</td>
</tr>
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<td>0</td>
</tr>
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<td>Nitrofurantoin</td>
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<td>0</td>
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<td>6</td>
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<td>9</td>
</tr>
<tr>
<td>Gentamicin</td>
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<td>77</td>
</tr>
<tr>
<td>Kanamicin</td>
<td>24</td>
<td>53</td>
</tr>
</tbody>
</table>

Key Words: Escherichia coli, antimicrobial resistance, broilers

W52 Differences among turkey (Meleagris gallopavo) varieties for the incidence and severity of toxin-induced dilated cardiomyopathy. K. B Gyenai* and E. J. Smith, Virginia Tech, Blacksburg.

Round heart disease, which is characterized by dilation of the left ventricles, is reported to cause as much as five percent mortality in commercial turkey pouls. Its etiology, however, remains little understood. Using a toxin-induced model earlier described by others, we investigated differences among genetically distinct turkey varieties in the incidence and severity of RHD. The turkey varieties compared included Blue Slate (BS), Bourbon Red (BR), Narragansett (N), Royal Palm (RP), Spanish Black (SB), and commercial birds. The birds were fed either a standard commercial starter diet (control) or a starter-diet containing 700 ppm furazolidone (treatment) ad libitum to 33 days-of-age. The incidence and severity of RHD in control and treatment birds were evaluated based on percent mortality and echocardiography using left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic dimension (LVESD), and fractional shortening as primary indicators. As a result, mortality within the varieties ranged from 40 to 70%, with the lowest in the BR and the highest in the commercial turkeys, respectively. Similarly, the commercial and N birds had the highest LVEDD and LVESD measurements while the BR was the lowest, though not significantly different from those for RP. These data suggest for the first time, the response of turkeys to furazolidone-induced RHD may have a genetic basis.

Key Words: round heart disease, turkeys, genetics

W53 Effect of mannanoligosaccharides and enzymes on antibody titers against Newcastle. M. C. Oliveira*,1, D. E. Faria Filho2, D. F. Figueredo2, R. A. Graevens2, R. H. Marques2, and V. M. B. Moraes2, 1University of Rio Verde, Rio Verde, GO, Brazil, 2State University of São Paulo, Jaboticabal, SP, Brazil.

Mannans are components of pathogen-associated molecular patterns and considered as stranger compounds to the host, resulting in increased immune response. This study evaluated the effect of
including mannanoligosaccharides (MOS) and/or enzymes in broiler diets on antibody titers against Newcastle disease. A total of 750 one-day-old Cobb chicks were distributed into a completely randomized experimental design in a 2 x 2 + 1 factorial scheme with two levels of MOS (0 and 0.1% until 21 days and 0.05% from 22 to 42 days of age), two levels of enzymes (0 and 0.05%), and a positive control diet with 125 ppm of colistin sulfate and 10 ppm of virginiamycin as growth promoting agents. Complement levels on day 133 were higher in the positive control compared to the negative control (P < 0.02) and the BioPlex/SelPlex treatments were intermediate. Collectively the data indicate that the anti-Gal system has the sensitivity to detect nutritional influences on immunity and these observations further extend its utility to the study of trace minerals.

Key Words: organic trace minerals, immunity, nutrition

**W55 Methods in heat-stabilization of gallus domesticus Immunoglobulin Y (IgY).** E. A. Bobeck*, D. L. Trott, M. E. Cook, and M. Yang, University of Wisconsin, Madison.

Post-pellet application of heat-labile protein (i.e. enzymes, antibodies, and peptides) has become the industry standard in recent years; however, heat-stabilization of these proteins would permit pre-pellet application. Development of a pilot steam conditioning system which models industry steam conditioning was necessary to create a laboratory model for testing encapsulation strategies and heat stability of proteins prior to large-scale production. Egg yolk antibody is an example of a protein increasingly being used in animal feeds. The objective of this project was to attempt to improve the heat stability of egg yolk proteins and to test a steam conditioning chamber engineered to model commercial conditioning prior to feed pellet manufacture. Ligand-specific whole egg liquid was mixed with no carbohydrate, 12% trehalose or 6% sorbitol plus 6% corn starch. Egg preparations were spray dried at 90°C. The antibody powder was added to broiler feed and subjected to 10s of steam conditioning at 82°C, then pelleted. Antibody was extracted from the feed and antibody ligand binding activity following encapsulation and heat treatment was assessed by a ligand-specific enzyme-linked immunosorbent assay (ELISA). Loss of optical density (OD) reading following heat processing relative to pre-processing was 87% for the control, 45% for trehalose and 84% for the sorbitol plus starch-treated egg products. In the trial involving an engineered pilot conditioner, ligand-specific egg yolk was mixed with 0 or 24% trehalose, freeze dried, and then mixed into feed. Feed samples were conditioned at 85C for up to 60s and then removed from the chamber. Ligand binding activity was assessed using ELISA. Loss of OD reading was similar between the two treatments at 10s (ca, 20%), 45 and 25% at 30s and 50 and 37% at 60s for the control and 24% trehalose treated egg yolk antibody, respectively. At this time, a direct comparison of antibody loss under commercial heat treatment of feeds is not readily piloted in a bench scaled conditioner, however, trehalose does appear to offer some heat stability to egg antibody in both the commercial and piloted conditioners.

Key Words: antibody heat stability, trehalose, IgY

**W56 Influence of pediciococcus-based probiotic on coccidiosis in broiler chickens.** S.-H. Lee1, H. Lillehoj*2, D.-W. Park1, R. Dalloul1, Y.-H. Hong1, and J. Lin2, 1Animal and Natural Resources Institute, ARS, USDA, Beltsville, Maryland, 2ImaginT Technology, Frederick, Maryland.

Coccidiosis is the major parasitic disease of poultry and is caused by the apicomplexan parasites Eimeria. Drugs and live vaccines are the two main control measures of the disease; however, due to increasing concerns with prophylactic drug use and high cost of vaccines, alternative control methods are needed. Recent evidence that various dietary and live microbial supplements can influence host...
immunity against enteric diseases prompted us to investigate the role of a Pediococcus-based probiotic on coccidiosis in broiler chickens. In the present study, we examined body weight gains, oocyst shedding, and antibody responses of broilers fed the commercial probiotic MitoGrow® (MG). Day-old chicks were fed either a standard broiler diet (control) or one of two probiotic diets supplemented with 0.1% (MG 0.1) or 0.2% (MG 0.2) of MitoGrow, and orally challenged with 5,000 or 10,000 sporulated oocysts of Eimeria acervulina (EA) or with 5,000 Eimeria tenella (ET) oocysts at 2 weeks of age. In EA-infected birds, 0.1% MitoGrow improved (P < 0.05) weight gain as compared to the other two groups, and reduced (P < 0.05) oocyst shedding in birds infected with 5,000 EA oocysts. In ET-infected birds, MitoGrow also reduced oocyst shedding and was more effective at the 0.1% level while there was no significant effect on weight gain. In those birds, Eimeria-specific antibody levels were higher (P < 0.05) in the MitoGrow-fed groups compared to the control group especially in MG 0.1 birds. These results demonstrate that this Pediococcus acidilactici-based probiotic effectively enhances the resistance of birds and partially protects against the negative growth effects associated with coccidiosis, particularly when supplemented at 0.1% of the diet.

Key Words: pediococcus, broiler, coccidiosis
Metabolism and Nutrition: Nutrition A - Protein/Amino Acids and Feeds

211 Amino acid requirements in laying hens fed two different energy levels. M. L. Locatelli1, A. Lemme1, D. Hochler1, P. J. A. Wijtten2, J. Van Wichen2, J. K. W. M. Sparla2, and D. J. Langhout2, 1Degussa Corp., Kennesaw, Georgia, 2Provimi P.V., Rotterdam, The Netherlands.

Recent literature data on amino acid (AA) and energy needs and their relationship on performance of modern type laying hens are scarce. The effects of different dietary balanced protein intake levels (550, 600, 650 and 700 mg apparent fecal digestible (AFD) Lys/hen/d) at two different dietary energy intake levels (298 and 313 kcal/hen/d for maintenance (M) and above maintenance (AM)) were determined during peak of production (24-39 weeks of age) in ISA-Brown laying hens. All diets fed the following minimum AFD essential AA ratios to AFD Lys content: Met, 50; Met+Cys, 93; Thr, 66; Trp, 19; Ile, 79 and Val, 86. Six replicates of 12 individually housed hens by treatment were used. Water access was unlimited but feed was restricted to 105 and 112 g/h/d for M and AM energy level intake groups. Restricting the energy intake of laying hens to minimize weight gain, hardly affected egg production parameters but improved feed efficiency (Ps 0.05). Average weight gain of the low-energy-intake groups (M) was 19 g/h over the entire experimental period and was significantly lower than the high-energy-intake groups (AM, 71 g/hen). Increasing the daily AA intake up to 650 mg Lys/hen/d maximized laying %. Hen weight significantly increased between 550 and 650 mg AFD Lys intake, reaching a plateau above 650 mg AFD Lys. This indicates that a daily AFD Lys intake below 650 mg is not sufficient to reach the maximum body protein accretion. Daily egg mass production and feed conversion, however, improved linearly up to the highest AFD Lys level (700 mg). Energy intake level did not affect performance response to daily AA intake. It can be concluded that the balanced protein requirement for maximum daily egg mass production and optimum feed conversion is probably higher than 700 mg AFD Lys/hen/d. Moreover, feed (energy) restriction enables steering of the body weight growth of laying hens during peak of production, and improves feed efficiency.

Key Words: laying hens, amino acids, energy

212 Effects of reducing dietary protein on performance of White Leghorn layers during the second production cycle. H. M. Yakout1, D. Hoehler2, and C. Novak1, 1Virginia Tech, Blacksburg, 2Degussa Corporation, Kennesaw, Georgia.

The use of low protein diets can have potential benefits on reducing nitrogen emissions as well as potential cost savings by reducing high cost protein sources. An experiment was conducted with 384 Hy-Line W-36 hens which were randomly assigned to one of four dietary treatment groups. Corn-soy based diets varying in dietary protein supplemented with commercially available amino acids as follows: [1] 18% CP + Met ($129.33/ton), [2] 16% CP + Met and Lys ($126.99/ton), [3] 15% CP + Met, Lys and Thr ($128.90/ton), and [4] 13% CP + Met, Lys Thr and Trp ($138.16/ton) were fed from 38 to 50 wks of age. Cage was considered the experimental unit (4 hens/cage), and each treatment was replicated 24 times. Overall, hens had similar feed consumption (FI) in diet 1, 2, 3, & 4 of 94.24, 93.79, 93.21 and 93.61 g/h/d, respectively. Egg production (EP) ranged from 83.53 to 72.99% for all dietary treatment with the highest producers fed diet 3 and the lowest for diet 4. Egg weights (EW) performed similarly to EP as they were decreased (P ≤ 0.01) from 62.23 g to 57.98 g as dietary protein decreased from 18% to 13%, respectively. Egg mass (EM) was higher (P ≤ 0.0001) when hens consumed diet 1 (51.74 g), 2 (50.70 g), or 3 (49.65 g) compared to diets 4 (42.69 g). Decreasing dietary protein significantly (P ≤ 0.007) reduced daily albumen percent, while numerically increased dry shell percentage. Feed consumption (FI), specific gravity (SG), dry yolk, dry shell and yolk solids were not significantly affected by dietary treatments. Dietary treatments 1, 2 and 3 were statistically similar when evaluating production performance and egg components as compared with diet 4. Based on the information gathered in this trial, feeding the 15% CP diet with supplemental Met, Lys and Thr matched the EP and EM of the high protein diet, and in turn should reduce N excretion. The use of such a diet in the field has the potential to save the poultry industry as much as $0.43/ton based on the current study. Additional in house or field studies are needed to validate these findings.

Key Words: reduced dietary protein, second production cycle, layers


There are two sources of methionine (Met) activity used in commercial feed formulation: DL-2-hydroxy-4-(methylthio) butanoic acid (HMTBA) most commonly available as an 88% solution with 12% water, and DL-methionine, (DLM, 99% powder). Controversy and confusion exists with respect to their relative bioefficacy (RBE). We review the use of a non-linear common plateau asymptotic regression technique (NLCPAR) that has been used to compare the two Met sources with particular emphasis on the validity of the basic assumptions of that model. The controversy is at least in part due to the misapplication of this regression technique to estimate the RBE of HMTBA and DLM. The NLCPAR model is a bioassay with key assumptions that HMTBA is a dilution of DLM, and that each follows dose response curves of the same form and approach a common plateau. Since both provide Met activity it seemed reasonable to accept these assumptions; however, specifically testing them demonstrated that the assumption of a common dose response is not supported by
In conducting nutritional experiments using chickens, scientists are limited in determining the urinary excretion of nutrients due to difficulty of separating urine from the feces. Our main objective was to improve the colostomy procedure for urine collection in broilers and both urine and eggs collection for broiler breeder hens. Ketamine HCl, 10-30 mg/kg i.m. in combination with Xylazine, 2-6 mg/kg i.m. was used to anesthetize broilers (4 weeks old) and broiler breeder hens (25 weeks old). The colostomy technique involved: a) transecting the distal colon at approximately 1/2 - 2 cm from the proximal cloaca and ligating distal colonic segment with 3-0 absorbable surgical suture, b) ligating the mesentery at the skin level to prevent continued bleeding of colostomy stoma, and c) placing three sutures using a triangulation technique that consisted of seromuscular aspect of the transected proximal colonic segment and the skin, and d) finally, suturing all exteriorized edges of the transected proximal colonic segment after mucosal eversion to the skin with simple interrupted sutures using absorbable suture. For the purpose of urine and or egg collection the appropriate size of drainable pouch with a curved tail closure was used. The feces were collected on a tray. The colostomized broilers could be kept for several days and colostomized broiler breeder hens were kept for several months to collect urine, eggs (for breeder hens), and feces separately without the problem of cross contamination.

**Key Words:** colostomy, broiler, broiler breeder hens

### 215 A critical analysis of methods to determine nutritional requirements.

G. M. Pesti*, University of Georgia, Athens.

Research papers published in Poultry Science use a variety of methods for evaluating experiments designed to determine nutritional requirements. Growth trials result in a set of ordered pairs of data. Often, point-by-point comparisons are made between treatments by analysis of variance. This approach ignores that body weight (as well as other response variables) is a continuum. Point-by-point analyses harvests much less than the total amount of information from the data. Regression models are more effective at gleaning information from data, but the concept of “requirements”, is poorly defined by many regression models. Response data from a study of the lysine requirements of young broilers was used to compare methods of determining requirements. In this study multiple range tests were compared to quadratic polynomials (QP), broken line models with linear (BLQ) or quadratic (BLQ) ascending portions, the saturation kinetics (SK) and a logistic (LM) and a compartmental (CM) model. The sum of total residuals was used to compare the models. The BLQ and LM were the best fit models (total sum of residuals of 0.1g each), followed by the QP (0.3g), SK (-0.5g), BLL and CM models (0.7g each). A plot of the residuals versus the nutrient intake level showed clearly that the BLQ and SK models fitted the data best in the important region where the ascending portion meets the plateau. While the BLQ model clearly defined the concept of nutritional requirements, the SK, LM and CM models more clearly conceptualize the law of diminishing marginal productivity and economic theory.

**Key Words:** requirements, models

### 216 Mean separation procedures used in *Poultry Science.*

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Research papers published in *Poultry Science* were studied to determine the frequency and appropriateness of use of procedures to test for significant differences between treatment means. Excluding papers from symposia, 255 papers and research notes were published in *Poultry Science* in 2004, of which 198 or 77.6% reported differences between means of 3 or more treatments. Mean separation was accomplished with the following procedures: Duncan’s multiple range test, 46 papers; least significant difference, 32; Tukey’s, 25; t test, 24; contrasts, 21; least squares, 21; paired t test, 12; and other, 20. Eleven papers showed separation of means in tables or figures but did not specify a method. Use of more than one procedure in a single paper resulted in a total of 201 procedures used in 187 papers that specified methods. Some methods were not used appropriately. Examples of inappropriate use of Duncan’s multiple range test, for example, included use with factorial designs (8 instances), application to designs with graded levels of treatments where regression techniques could have been used (3), use in experiments designed with internal structure such that treatments could have been analyzed with orthogonal contrasts (6), and in cases where the only comparisons discussed were between individual treatments and a control (4). Despite numerous papers and textbooks that discuss the proper use of mean separation procedures, many papers in *Poultry Science* report results that were not analyzed by methods most likely to find significant and meaningful differences in the data under study.

**Key Words:** multiple range tests, mean separation, statistical analysis

### 217 Effect of different levels of protein and sulfur amino acids on mature broiler breeder hens performance, carcass and reproductive morphology.

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An experiment was conducted to investigate the use of supplemental sulfur amino acids and reduce protein level in diets for broiler breeder hens. Eight hundred Hubbard Classic females (27WK) were...
individually weighed. Eight hens with one male were transferred to breeding pens. Hens were randomly sorted into 25 treatment groups. Treatments involved feeding different levels of CP (17.5, 16.0, 14.5, 13.0 and 11.5%) and sulfur amino acids (0.69, 0.66, 0.63, 0.60 and 0.57%). Hens were weighed weekly. Egg production, egg weight and settable eggs were recorded every day. Fertility was determined by candling at 7 days incubator. Hatchability was estimated on 21st day of incubation. All chicks were weighed at hatch. At the end of the trial (50WK) 2 hens per pen were dissected. Birds fed 14.5% CP had the highest egg production. Settable eggs from birds fed 11.5 and 16.0% CP were higher than other groups (p<0.05). Birds fed 11.5% CP had lower BW than other groups. Eggs from birds fed 11.5 and 13.0% CP, and 0.57 and 0.60% sulfur amino acids were significantly smaller than other treatments and resulted in reduced chick weight at hatching. CP and sulfur amino acid level had no effect on fertility and hatchability, however the number of chicks produced by birds fed 16% CP and 0.57% sulfur amino acids were higher than for other groups (p<0.05). The lowest liver weight and highest fat pad weight was seen in hens fed 17.5% CP. Birds fed 0.69% sulfur amino acids had lowest fat pad. Birds fed high levels of sulfur amino acids had heavier Pectoralis minor weights. Birds fed higher levels of CP had heavier oviducts; mainly because they were heavier in BW (no proportionate differences). The numbers of large yellow follicle were higher for birds fed higher levels for acids intake. These data suggest that 20.3 (11.5%) g/b/d CP intake and 832 (0.57%) mg/b/d sulfur amino acids intake is adequate for mature broiler breeder hens.

Key Words: broiler breeder, protein, sulfur amino acid

218 Maintenance nitrogen requirement of adult female ostriches (Struthio camelus). D. C. Bennett*, A. Kaneko, and Y. Karasawa, Shinshu University, Minamiminowa-mura, Nagano-ken, Japan.

Successful ostrich farming requires knowledge of the nutritional needs of the birds. While much information is available on the nutritional value of various feed ingredients fed to ostriches, there is little known about their specific nutrient requirements. In this study, we measured the maintenance nitrogen requirements (MNR) of ostriches by nitrogen balance. We predicted, based on allometric analysis of nitrogen requirements of various species of birds, that ostriches would have a MNR of 20.9 g N/d and an endogenous nitrogen loss (ENL) of 3.9 g N/d. Three adult female ostriches fed five pelleted diets containing 0.6 to 2.3% N (4-15% CP), 18 kJ/g gross energy (11.4 kJ/g ME) and 15% crude fiber. Ostriches were fed each diet in random order, and each dietary trial consisted of a 10-day adaptation period, followed by a 5-day total excreta collection period. Body mass (108 ± 2.4 kg) and metabolizable energy intake (19.9 ± 0.4 MJ/d) were unaffected by dietary nitrogen levels. Similarly, nitrogen balance was unrelated to metabolizable energy intake. After correcting for excreta nitrogen losses during drying, MNR was calculated to be 16 g N/d (100 g CP/d) and ENL as 9.9 g N/g. Failure to correct for the 10.9 ± 4.1% N losses during drying would under predict the “true” MNR by 37% and ENL by 48%. Our estimate for MNR of ostriches predicts a dietary requirement of 5.8% protein. Our estimate of ENL was 2.5 times that predicted, possibly reflecting the high fiber content of their diet.

Key Words: ostrich, protein requirement, nitrogen requirement

219 The amino acid requirements for production and fertility of broiler breeder hens at peak production. M. de Beer* and C. N. Coon, University of Arkansas, Fayetteville.

A total of 640, 30-week old Cobb-Vantress broiler breeders with similar body weight (3450 ± 218g) were selected to determine the production requirement of dietary digestible arginine, cystine, isoleucine, lysine, methionine, threonine, tryptophan, and valine in a 70 day feeding study. The average hen day egg productions for the start of the trial and for the 10 week period were 82% and 63%, respectively. Breeders were given a corn-soy basal diet plus crystalline amino acids with eight graded levels of arginine, cystine, isoleucine, lysine, methionine, threonine, tryptophan, and valine representing 40% to 120% of the highest suggested requirement between NRC (1994) and Fisher (1998). All other amino acids were maintained at 100% of their suggested requirement level. Diets were supplemented with glutamic acid to fulfill the total crude protein requirement. The breeders were fed 154 g of feed (467 kcal ME) daily. Each level of each amino acid was represented by ten birds. All breeders were inseminated weekly with 5×10⁷ sperm cells. Every egg was recorded, weighed and set for fertility determinations. The total egg mass output added to total wt gain/loss was defined as product. The feed consumption divided by the product was defined as feed/product ratio. The digestible arginine, cystine, isoleucine, lysine, methionine, threonine, tryptophan, and valine requirements for product and feed/product ratio were determined to be 1002.25 mg/d and 1007.76 mg/d; 463.13 mg/d and 465.12 mg/d, 828.12 mg/d and 806.14 mg/d, 855.95 mg/d and 829.64 mg/d, 454.20 mg/d and 427.50 mg/d, 629.38 mg/d and 612.75 mg/d, 245.81 mg/d and 237.80 mg/d, 783.28 mg/d and 782.13 mg/d, respectively. A significant decrease in fertility was noted with increasing levels of isoleucine and lysine.

Key Words: amino acid requirements, peak performance, fertility

220 Effect of sunn hemp seed inclusion in broiler starter diets on live performance attributes. J. B. Hess*1, V. A. Drouet1, and J. A. Mosjidis2, 1Auburn University, Auburn, Alabama, 2Auburn University, Auburn, Alabama.

Seeds of Crotalaria spp. Contain pyrrolizidine alkaloids that are toxic to a range of animal species. Sunn hemp (C. juncea L.), a relative of showy crotalaria (C. spectabilis Roth.) known to be toxic to chickens, has only a small amount of those toxins. This trial examined live performance responses of mixed-sex broilers raised to 21 days of age on one of three treatments to determine whether sunn hemp seeds of showy crotalaria were detrimental to young broilers. The birds were housed in Petersime battery brooders with eight replicates per treatment (a total of 240 birds). A mash starter feed was fed to 21 days with or without whole sunn hemp seed. Treatments included a control, a contamination level (0.5% sunn hemp seed) and an ingredient inclusion level (5% sunn hemp seed). Body weights, feed consumption and feed conversion were be measured by pen at 21 days. Mortality was monitored and was posted to determine cause. Broilers did not consume sunn hemp seeds at the same rate as the rest of the diet. For this reason, sunn hemp consumption was not accomplished at the exact levels stated. Body weights were reduced in birds fed 5% sunn hemp (801.3 vs 849.9 g), but not in birds fed 0.5% (858.0 vs 849.9 g) as compared to the control. Period gains showed a similar pattern. Feed consumption was reduced in birds fed 5% sunn hemp (1.072 vs 1.123 kg/bird), while feed conversion ratio was poorer (1.374 vs 1.322). No
significant mortality differences were measured between treatments and no unusual pathologies were noted in the birds during posting.

Key Words: sunn hemp, Crotalaria, broiler

221 Determination of the metabolisable energy of sweet potato tuber meal and its utilization by growing pullets. O. Ladokun*, F. Aderemi, and O. Tewe, 1Lead City University, Ibadan, Oyo State, Nigeria, 2Boven University, Iwo, Osun State, Nigeria, 3University Of Ibadan, Ibadan, Oyo State, Nigeria.

The nutritive value of sweet potato tuber meal (SPM) as replacement for maize in the diet of growing pullets was evaluated. The trials were conducted using the completely randomized experimental design. A preliminary 10 day study was conducted with thirty pullet chicks to determine the metabolisable energy (ME) of SPM. The result revealed that SPM has an ME of 3.50kcal/g. In the feeding trial which lasted 49 days, SPM was used to replace maize at 0, 50 and 100% levels. A total of ninety day-old Yaffa pullet chicks with an average initial weight of 55.51g were used for the study. Digestibility of dry matter for chicks on the control diet was significantly (P<0.05) higher than for chicks on the sweet potato based diets. Chicks fed maize-based (control) and the partially replaced maize diet had weights, which were significantly (P<0.05) higher than those on the completely replaced maize diet. Pullets chicks fed the control diet consumed significantly (P<0.05) higher feed than the birds on the sweet potato based diets. The economy of production of pullet chicks revealed that partially replaced maize diet appeared to be more economically efficient, thereby justifying the replacement.

Key Words: metabolisable energy, sweet potato, pullet chicks

222 Dietary energy needs of broilers from 2.0 to 4.0 kg as influenced by ambient temperature. W. A. Dozier*, J. L. Purswell1, A. Corzo2, M. T. Kidd2, and S. L. Branton1, 1USDA-ARS Poultry Research Unit, Mississippi State, Mississippi, 2Mississippi State University, Mississippi State.

Two trials were conducted to evaluate potential interactive effects of dietary AME x ambient temperature from 36 to 60 d of age on growth and meat yield responses of broiler chickens. Nineteen-hundred and twenty Ross x UY Hubbard broilers were randomly distributed to 32 floor pens (30 males and 30 females; 0.09 birds/m²) at 36 d of age. Treatment structure was a 4 x 2 factorial arrangement. The main effect of AME (16 replicate pens; 8 replicate pens/trial) was diets formulated to 3,175, 3,220, 3,265, and 3,310 kcal/kg. Temperature effect (2 replicate rooms; 1 replicate room/trial) consisted of two regimens. Regimen 1 was set at 21.1°C from 36 to 38 d, 20.2°C from 39 to 42 d, 18.9°C from 43 to 46 d, 17.8°C from 47 to 50 d, 15.6°C from 51 to 54 d, and 12.8°C from 55 to 60 d. Regimen 2 was set at 21.1°C from 36 to 60 d of age. From 36 to 60 d, gradient increases of dietary AME decreased (P<0.001) feed consumption and improved (P<0.001) feed conversion linearly. Reducing ambient temperature improved (P<0.10) BW (4.07 vs. 3.82 kg), feed consumption, feed conversion, and reduced (P<0.02) mortality. Dietary AME x temperature interactions (P<0.02) were observed for BW, BW gain, feed consumption, and feed conversion. BW and BW gain increased with increments of dietary AME when subjected to Regimen 2 but not with Regimen 1. With increasing dietary AME, the slope for feed conversion was more pronounced with Regimen 2 than Regimen 1 (−0.07 vs. −0.04). This indicates that for each 45 kcal/kg increase in AME that feed conversion would be improved by 7 points with Regimen 2, and 4 points with Regimen 1. Treatments did not affect the absolute and relative amounts of abdominal fat and total breast meat. Results indicate that these broilers had a higher dietary AME need when subjected to increased temperature. Decreasing ambient temperature below than currently being used in commercial practice from 51 to 60 d led to improved growth performance.

Key Words: broiler, dietary energy, temperature

223 The effect of different levels of virginiamycin and energy on performance and blood components in broiler chicks. F. Ahmadi*, Azad University of Sanandaj, Sanandaj, Kurdistan, Iran.

This experiment was carried out to study the effect of different levels (2800, 2900Kcal/Kgdiet) of energy and virginiamycin (0,10,20,30mg/kgdiet) on performance and component of blood serum of broiler chicks. In completely randomized design and in 2*4 factorial arrangement, four hundred and eighty (480) broiler chicks (Ross) were divided into 24 groups, 20 chicks per group. Feed consumption, bodyweight and mortality of each and in 2*4 factorial arrangement, four hundred and eighty (480) broiler chicks (Ross) were divided into 24 groups, 20 chicks per group. Feed consumption, bodyweight and mortality of each pen were determined at 21, 42 and 56 days of experimental period. At the end of experimental period from each pen one male and female were selected, slaughtered and blood samples were collected at slaughtering time. After separation of serum, calcium, phosphorous, magnesium and triglyceride were measured by using the relevant methods Also percentage of small intestine, abdominal fat, liver and etc. were measured. The results indicated that different levels of energy had not significant effect on bodyweight, feed conversion ratio and blood serum components, but its effect on feed consumption at the 21st day of age was significant (p<0.05). Virginiamycin did not significant effect on the average feed consumption and blood serum components, although these criteria had increasing trend with increasing the levels of virginiamycin. Virginiamycin had significant (0-21days)effect on average bodyweight and feed conversion ratio(p<0.05).Interaction between energy and virginiamycin (body weight from 0 to 21 and 21 to 42 days)were significant (p<0.05).Interaction between virginiamycin and different levels of energy had not significant effect on abdominal fat percentage, liver percentage, and blood serum components. Interaction between virginiamycin and sex on intestine percentage was significant(p<0.05).Interaction between virginiamycin, energy and sex had not significant effect on plasma components including calcium, phosphorous, magnesium and triglyceride.

Key Words: virginiamycin, bloodserum, broiler

224 True metabolizable energy in meat and bone meal from Iran. H. Jammohammad1, H. Nassiri Moghaddam2, J. Pourreza3, M. Danesh Mesgran, and A. Goli2, 1University of Tabriz, Tabriz, East Azarbaijan, Iran, 2University of Ferdowsi, Mashhad, Iran, 3Esfan University of Technology, Esfahan, Iran, 4University of Manitoba, Winnipeg, MB, Canada

Meat and bone meal (MBM) is an ingredient of farm animal diets, particularly in poultry and Pig. Evaluation of available energy in meat and bone meal, like other ingredients, is necessary for diet formulation.
Metabolizable energy of MBM depends on raw material source and processing condition, is variable. In Iran, MBM are produced from slaughter wastes of beef, lamb, goat and or camel. The product is used mostly in poultry diets but there are not any data of its true metabolizable energy (TME) content. The objective of present study was to determine TMEn in MBM samples from Iran. Six composed samples were taken randomly from a large rendering plant in east of Iran and kept at -20°C until chemical analysis. Gross energy (GE) by Parr adiabatic calorimeter bomb and DM and CP (6.25 *N) were determined according to AOAC (1990) methods. True metabolizable energy (TME) in the samples was determined by Sibblald’s precision fed assay, using thirty five intact leghorn roosters (1989). Endogenous energy loss (EEL) was measured in one group of five roosters which fasted 48 hours. The obtained data were subjected to one way analysis by GLM procedures of SAS (2002). Comparison of means was done by Duncan test. Mean EEL and EEL corrected to zero nitrogen balance were 14.6 and 7 kcal/48 h. True dry matter digestibility, gross energy efficient (TME/GE), TME and TMEn values were significantly different among sample (0.05). Mean (and range) of TME and TMEn were 3183 (2692 to 3884) and 2993 (2473 to 3253) kcal/kg respectively. The results showed that available energy content of MBM from Iran’s animal rendering plants is high, but like the results of other reports, TMEn values is relatively variable.

Key Words: TMEn, meat and bone meal

Metabolism and Nutrition: Nutrition B - Enzymes and Manufacturing

225 Variability in feed value of Australian wheat-, triticale- and sorghum-based diets supplemented with and without enzymes for broilers. T. A. Scott*, University of Sydney, Camden, NSW, Australia.

Our definition of feed value now includes measurements of variation in nutrient intake that have been directly correlated with growth. Within cereal grains, variation in intake can be in excess of 20% and is not related to energy or protein levels of the diets. In the present study, 45 grains (34 wheat, 8 triticale and 3 sorghum) were ground and included (750 g/kg) in mash diets (wheat and triticale diets had a different basal diet from sorghum-based diets); all diets contained 1% acid insoluble ash marker. The diets were then split and one portion supplemented with 0.5 g/kg xylanase and phytase (Danisco Animal Nutrition, UK). The 90 diets (45 cereal-based diets with or without enzyme) were each full fed to one cage of six male broilers (Cobb 500) in four consecutive bioassays from 4 to 17 d of age. At 16 d a 6 h excreta collection was frozen, freeze-dried, ground and analysed to determine the AME (kcal/kg diet). Feed intake, growth and mortality were recorded from 4 to 17 d and used to calculate feed conversion ratios. Fifteen of the 34 wheat samples had been previously tested in another bioassay; diets contained no enzyme(s) and birds were five-weeks of age; AME was determined by total collection. The present study supports earlier work that demonstrated measurements of feed value must not ignore the variation in intake, growth and efficiency. Variation in feed intake of wheat-based diets (~20%) was positively correlated (r=0.70) with body weight; while correlations between intake and AME were positive (r=0.30). Variation in performance of triticale samples was similar to wheat, while no enzyme response was observed for sorghum-based diets due to low levels of soluble non starch polysaccharides. The 15 wheat samples measured in two different bioassays had significant positive correlations for measures of performance, but no relationship for measures of AME. This indicates that factors within these common grains consistently influenced performance in a similar manner, but not AME. Further work is required to understand the cause of variation or limitation in intake and how this can be minimized.

Key Words: AME, cereals, feed intake

226 Should oligosaccharides be considered as antinutritive factors and target substrates for enzyme use in broiler chicken diets? B. A. Slominski1, X. Meng1, L. D. Campbell1, W. Guenter1, and O. Jones2, 1University of Manitoba, Winnipeg, MB, Canada, 2Canadian Bio-Systems Inc., Calgary, AB, Canada.

Removal of oligosaccharides has been indicated to be beneficial for poultry as an increase by 20% in the TME of SBM was noted following ethanol extraction. Interpretation of the data, however, is confounded by the fact that ethanol extraction would result in the removal of many other components of the meal. Specific removal of oligosaccharides by using α-galactosidase enzyme has been investigated in our laboratory. In many studies, very low digestibility of oligosaccharides in enzyme supplemented diets was observed. Factors capable of causing enzyme inactivation were evaluated and the low pH in the upper gut was considered to be the most significant. Recently, a new preparation of α-galactosidase has been evaluated for its ability to improve the rate of oligosaccharide hydrolysis. Incubation of 5g of SBM with enzyme for 90 min at 40°C resulted in a significant reduction in oligosaccharide content (from 68.8 to 42.4 mg/g) at an enzyme to substrate ratio of 1:175 and almost complete oligosaccharide hydrolysis (from 68.8 to 4.5 mg/g) at an enzyme to substrate ratio of 1:35. In studies with broiler chickens (5-18 d) using wheat/SBM/canola meal diets, the total tract digestibility of oligosaccharides averaged 27.2% for a control diet, and 32.1 and 57.4%, respectively, for 0.01% (1:175 enzyme to substrate ratio) and 0.05% (1:35 enzyme to substrate ratio) α-galactosidase supplemented diets. Despite the fact that the hydrolysis of oligosaccharides was substantial at the 0.05% enzyme level, it was not reflected in any improvement in growth performance with weight gain and feed conversion values of 439.7 g/14 days and 1.53 being identical to those of 447.4 and 1.52 for the control diet, respectively. It would appear evident that the oligosaccharides raffinose and stachyose do not pose a nutritional concern and that the use of α-galactosidase enzyme to enhance their digestibility may not be beneficial.

Key Words: oligosaccharides, α-galactosidase, broilers
227 Enzyme for corn-soybean meal diet: Target substrates and enzyme efficacy in broiler chickens. B. A. Slominski*1, X. Meng1, D. Boros1, L. D. Campbell1, W. Guenter1, W. Jia1, and O. Jones2, 1University of Manitoba, Winnipeg, Canada, 2Canadian Bio-Systems Inc., Calgary, Canada.

In enzyme development studies factors investigated included: a potential deficiency in key digestive enzymes in young chickens, antinutritive properties of oligosaccharides and poor utilization of fiber components. No positive effects of dietary amylase and protease additions in broilers fed a corn/SBM diet were noted. Weight gain (WG) and feed efficiency (FE) averaged 91.6, 95.5, 97.1g and 1.41, 1.38, 1.38 for the control and the amylase or amylase plus protease supplemented diets, respectively, in week one, and 235.9, 242.8, 240.0g and 1.43, 1.40, and 1.41 in week two of the experiment. This data was corroborated by similar ileal starch (96.8, 96.8, 96.9%) and protein (83.9, 80.1, 79.6%) digestibility values indicating that a digestive enzyme deficiency in young chickens may not be as pronounced as originally thought. Specific removal of oligosaccharides by using α-galactosidase enzyme was investigated and, although a significant oligosaccharide hydrolysis in the chicken gut was achieved, no improvement in growth performance was noted. A study was also carried out to target the NSP of SBM. Significant NSP depolymerization was achieved in vitro using a multicarbohydrase enzyme and a series of experiments were conducted to determine its efficacy in broilers fed corn-SBM diets. On average, WG and FE improved by 3.9% (450 vs 468 g/14 days) and by 3.2% (1.44 vs 1.39), respectively. However, the effect of enzyme addition was only significant (P<0.05) for WG in two trials and for FE in four trials. As determined in three trials, there was an effect of enzyme addition on total tract DM (71.5 vs 73.3%), and NSP (5.7 vs 15.2%) digestibilities, pepsin P utilization (21.1 vs 39.2%) and AMEn content (2963 vs 3047 kcal/kg diet). Ileal protein digestibility increased from 79.6 to 84.0%. It can be concluded that the use of a multicarbohydrase component would improve the overall efficacy of dietary enzymes in corn-SBM diets.

Key Words: corn-SBM diet, enzyme, broilers

228 Improving soybean meal digestion during the full first cycle of lay. A. E. Seffon* 1 and S. Leeson1, 1Alltech, Inc., Guelph, ON, Canada, 2University of Guelph, Guelph, ON, Canada.

Vegpro® (Alltech, Inc., Nicholasville, KY) is an enzyme combination specifically designed to enhance the digestibility of plant based protein supplements, and has been found to improve the digestibility of plant protein supplements by 7% for energy, protein and amino acids. This long-term layer trial was undertaken to test the efficacy of Vegpro when fed to layers, from 19 to 72 weeks of age. Four treatment groups with 80 individually housed, 19 week old Shaver Whites were used. The test rations were formulated to the same nutrient specifications as the control (C) treatment except that the ingredient profile of the soybean meal was raised by 7% (L), 10.5% (M) and 14% (H) for metabolizable energy, crude protein, and amino acids. The rations followed the Shaver White recommendations. The lay period was divided into 13, 28 day periods. There were no differences among treatments until the 8th period when feed consumption of treatment H was less than treatment L (P<0.05), there were no other differences in feed intake. This difference mirrored the lower hen egg production of treatment H in the 9th period when it was lower (P<0.05) than treatment C and M and lower than (P<0.05) treatments C, L and M in periods 10 and 11. There were no other differences in egg production, mortality, feed intake, egg weight, shell deformation or albumen height. These results support the ability of Vegpro to improve digestibility of soybean energy, protein and amino acids by at least 7% in layers.

Key Words: layer, Vegpro, enzymes

229 The effect of enzymes on degradation of corn DDGS using in vitro assay. S. Dalsgaard*1 and M. Hruby2, 1Danisco Innovations, Brabrand, Denmark, 2Danisco Animal Nutrition, St. Louis, Missouri.

Corn Distiller Dried Grains with Solubles (DDGS) availability as a feed ingredient has been increasing with an unprecedented growth in ethanol or ethyl alcohol production. Traditionally, by-products of ethanol production have been used mainly in ruminant diets but most of the plants today are capable of producing DDGS, which can be used also at higher inclusions in monogastric animal feeds. The available scientific literature suggests that DDGS inclusion between 5-20% in pig and poultry diets can be achievable without a negative effect on performance. DDGS contain concentrated levels of remaining compounds found in corn after removal of most of the starch. It has been shown to be rich in protein, fat, phosphorus, and fibres. In the past, exogenous or feed enzymes have shown to improve nutritive value and reduce variability of many feed ingredients. DDGS could potentially be another ingredient benefiting from a targeted exogenous enzyme action.

Fourteen DDGS samples were collected in the US and in vitro screening was conducted in order to determine; 1) the level of nutrients in DDGS, 2) the type and level of potential substrates for enzyme action, and 3) the enzyme(s) match for the substrate. The results suggested that digestibility of two compounds, pentosans and phytate P, could potentially be improved with an addition of exogenous enzyme. Different enzymes (two types of endo-xylanases and one 6-phytase) have been tested for their capability to degrade pentosans and phytate P respectively. The in vitro method consisted of a two-step procedure and its goal was to mimic the broiler’s gastrointestinal tract: 1) 45-min pepsin (pH 4.3) and 2) 60-min pancreatic incubation (pH 7-7.3), both at 40°C (104°F), followed by a determination of soluble xylan and phosphate. The results showed an effect of xylanase addition on fibre hydrolysis. Phytase and xylanase combination improved the level of soluble phosphate significantly. The evaluation showed that specific feed enzymes could contribute to DDGS’ nutritive value improvement. However, the enzyme application will need to be targeted to account for the nutrient and antinutrient variability in different DDGS sources.

Key Words: DDGS, pentosans, xylanase

230 Effect of formulating of B-Mannanase (Hemicell Feed Enzyme) into turkey tom diets varying in amino acid density. M. E. Jackson*, J. Mitchell2, and G. F. Mathis3, 1ChemGen Corp, Gaithersburg, Maryland, 2Akey Inc, Lewisburg, Ohio, 3Southern Poultry Research, Athens, Georgia.

B-mannan, a polysaccharide found in soybean meal and other plant proteins, exhibits powerful anti-nutritive effects in monogastrics. The enzyme B-mannanase (Hemicell) has been shown to improve performance and live weight uniformity in turkeys. It has been estimated that this enzyme results in an uplift of approximately 120 Kcal/kg ME. Turkey producers may elect to assign Hemicell a lesser
energy benefit with the aim of reducing feed costs and improving performance. An experiment was conducted to test Hemicell at 2 AA planes in commercial corn-soybean based diets. Four dietary treatments consisted of two AA planes (commercial and high after 9 weeks of age (increased lysine and methionine levels by approximately 0.07 and 0.05%, respectively)) with and without Hemicell formulated in at a reduced matrix of 55 Kcal/Kg uplift. Treatments were assigned to 8 replicate pens with 11 Hybrid male turkeys per pen. Body weight was determined at 0, 6, 9, 12, 15, and 20 weeks of age and feed consumption was determined between these ages. Individual weights were determined at 9 and 20 weeks of age. Hemicell formulated into diets resulted in improvements in weight gain and feed conversion in both amino acid planes at all ages tested. There were no significant effects of increasing the AA density. At 20 weeks of age, formulating in Hemicell improved weight gain by 3.7% and FC by 5.5 points (both P<0.05) at the commercial AA plane. At the high AA plane, effects were positive but not significant. Body weight % CV was significantly improved when Hemicell was formulated into diets at 9 and 20 weeks of age (P<0.05) but was unaffected by AA density. The experiment revealed that when formulated in turkey diets with an ME uplift of 55 Kcal/kg, Hemicell improves turkey performance and live weight uniformity.

Key Words: hemicell, turkeys, metabolizable energy


Acute phase proteins (APP) are an aspect of the innate immune system and some APP accumulate in blood to high levels in response to various forms of stress. The APP called α-1-acid glycoprotein (AGP) is known to be very responsive in birds and is readily measured by a radial immunodiffusion assays. The level of AGP in broilers was monitored in a series of cage and pen trials, and in turkeys from a pen trial. All experiments used commercial type corn/soybean diets. The AGP level was significantly elevated in broilers after infection with three Eimeria species, and also by the exclusion of the antibiotic (BMD) from the diet. In trials with broilers at 21 and 42 days, as well as turkeys at market weight, the addition of β-mannanase to the corn/soybean diets significantly reduced the blood AGP level while also providing significantly increased growth performance as shown by a decrease in weight adjusted feed conversion. The innate immune system is activated by molecular patterns commonly found in pathogens, and high molecular weight mannan is one of the patterns that induce a strong response. A possible mechanism for the observed β-mannanase mediated reduction of AGP will be discussed. Measuring APP provides a convenient tool to monitor stress in birds and the levels measured were predictive for the growth performance in these studies.

Key Words: Hemicell® β-mannanase, α-1-acid glycoprotein (AGP), innate immune system


The influence of including additional fiber into low–fiber diets on total tract apparent retention of nutrients (TTAR) was evaluated in nine–d–old chicks. There were six dietary treatments and five replicates (a cage with 14 chicks) per treatment. The control diet (diet A) was based on rice, soy protein concentrate, fish meal, yellow grease, and 3% sepiolite and contained 3,100 kcal ME/kg, 1.31% total lysine, and 1.5% crude fiber. Diets B, C, and D were similar to diet A but sepiolite was substituted (wt/wt) by oat hulls (OH), sugar beet pulp (SBP), or microcrystalline cellulose (CEL). Diets E and F were identical to diets B and C but the fiber sources were ground to pass through a 0.5–mm screen instead of a 2.0–mm screen. All diets contained 2% celite as a source of acid–insoluble ash and were fed as mash. At 9 d of age fecal samples were collected and fecal digestibility of soluble ash (SA), DM, organic matter (OM), ether extract (EE), and N retention, and AMEn of the diets were determined. Treatment means were analyzed by adequate non–orthogonal contrasts to study the effects of fiber inclusion and fiber particle size. Fiber inclusion increased AMEn of the diet (3,098 vs. 3,135 kcal/kg; P < 0.05) and TTAR of most nutrients (DM, SA, and EE; P < 0.001). Oat hulls and SBP were more effective in improving nutrient utilization than CEL (P < 0.1). Also, OH inclusion was more effective than SBP inclusion in improving AMEn (3,196 vs. 3,129 kcal/kg) and nutrient digestibility (P < 0.001). In general, a reduction of particle size of the fiber source improved digestibility of most nutrients except for EE. We conclude that the inclusion of additional fiber improves nutrient utilization in young chicks fed low–fiber diets (1.5% CF) and that OH inclusion is more beneficial in this respect than SBP or CEL inclusion.

Key Words: particle size, fiber inclusion, digestibility

233 The effects of sucrose or electrolyte supplements and corn particle grind size on Ross broilers during stress and during post-stress recovery. W. S. Virden*, A. C. DeLeon, A. Corzo, and M. T. Kidd, Mississippi State University, Mississippi State.

The detrimental effects of physiological stress on broilers are well known. However, little research exists to delineate the effects of different nutritional regimes on the stress response in broilers. Hence, an experiment was conducted to examine the effects of sucrose and electrolyte water supplements on broilers during stress, as well as particle grind size during post-stress recovery. Ross x 308 male broilers (420) were placed in 35 floor pens, and given common starter diets from d 1 to 20. From d 21 to 24, chicks were given ad libitum access to one of four dietary treatments: 1) control (7 replicate pens); 2) control diet containing 5 mg of CS/kg diet (14 replicate pens); 3) as 2 + a sugar-water solution (0.15 g of sucrose/ml) (7 replicate pens); 4) as 2 + electrolyte-water solution (0.45 g of K, 0.04 g of Na, and 0.0005 g Mg/ml) (7 replicate pens). On d 25, broilers were given ad libitum access to a pellet control diet, except 7 replicate pens that received CS, which were given the control diet with 30 % of corn replaced as roller mill corn post pelleting. Performance parameters were measured on d 25 and d 46, and carcass parameters were measured on d 47. During the stress period, BW gain was higher (P<0.05) for broilers receiving the control diet than broilers receiving treatments 2 or 3. However, BW gain did not differ between treatments 1 and 4. Feed intake was higher (P<0.05) in broilers given treatments 2 and 4 than those fed control. However, broilers given treatment 3 had lower (P<0.01) feed intake than those given all other treatments. Broilers fed treatment 1 had lower (P<0.01) feed conversion than broilers given treatments 2 and 4, but not 3. Water intake was lower (P<0.05) for broilers receiving control than for all treatments given CS. From d 26 to 46, BW gain and feed intake did not differ between treatments. However, post-stress feed conversion was lower (P<0.05) for broilers under stress compared to those in the control.
fed electrolytes or sugar-water solution during stress, than the control. Adding roller mill corn to the recovery diet did not affect performance. Carcass parameters did not differ among treatments.

**Key Words:** broiler, stress, electrolyte

234  **Efficacy of germination time and use of a preservative (potassium di-formate) on feeding value of wheat for broilers.**  
C. M. Tomkinson and T. A. Scott*, *University of Sydney, Camdne, NSW, Australia.*

Germination of seeds changes the physiochemical profile of seeds and may improve nutrient availability, reduce ANFs as well as improve the health of broiler chickens. The same conditions also provide ideal opportunities for microorganism growth and potential contamination of diets. This trial evaluated the effect of germination time (0, 21 or 42 h of controlled (moisture, darkness, 20°C temperatures; followed by 48 h drying (40°C). To minimise microbial contamination, the extended (42 h) germination treatment was treated with or without potassium di-formate (3 g/kg grain; BASF, Australia). The diets (grain inclusion was 750g/kg) were formulated to meet or exceed the nutritional requirements of Cobb (500) male broiler chicks from 0 to 21 d of age; diets contained 1% acid insoluble ash marker. Diets were split and one portion supplemented with xylanase and phytase (0.5 g/kg diet; Dansico Animal Nutrition, UK). The 8 diets were full fed to 6 cages of 6 male broilers from 0 to 21 d. Based on an 8 h excreta collection at 19 d, AME of diets were determined. At 21 d one broiler per pen was killed and measurements of intestinal tract and viscosity of digesta determined. An unexpected outcome was that germination (42 h) was suppressed with potassium di-formate, whereas germination was achieved with grains soaked for 21 or 42 h. There were no significant effects of germination on growth and performance of broiler chicks. It was apparent from measurements of digesta viscosity that germination activated endogenous cereal xylanase and that reductions in viscosity increased with longer germination (particularly with potassium di-formate inclusion). These marginal results may relate to conditions applied during germination and/or drying that altered palatability of the wheat. The observation here that potassium di-formate suppressed germination, but still allowed endogenous enzyme activity to proceed may be a useful way of minimising respiration losses of nutrients, particularly energy, during germination.

**Key Words:** germination, wheat, broilers

236  **Evaluation of limit feeding low-energy diets for a varying number of days in a non-feed withdrawal laying hen molt program.**  
P. L. Utterback*, E. J. Kim, C. M. King, K. W. Koelkebeck, and C. M. Parsons, *University of Illinois, Urbana.*

An experiment was conducted using 504 Hy-Line W-36 hens (69 wk of age) to evaluate three low-energy non-feed withdrawal molt diets fed for a varying number of days. Treatment 1 consisted of feed withdrawal for 10 d followed by feeding a 16% CP corn-soybean meal diet for 18 d. Treatment 2 consumed a 94% corn (Corn) diet for 35 d. Treatments 3, 4, and 5 received a 47% corn:47% soybean hulls diet (Corn:SH) for either 21, 28, or 35 days. Treatments 6 and 7 were fed a 71% wheat middlings:23% corn diet (WM:Corn) for either 21 or 28 days. At the end of the various molt periods, all hens were fed a 16% corn-soybean meal layer diet and production performance was measured for Weeks 1 to 28. Hens on the feed withdrawal treatment ceased egg production by Day 8. Treatments receiving the Corn:SH diet did reach 0% egg production by Day 10 but laid sporadically throughout the remainder each of their individual molt periods. However, treatments receiving the WM:corn diet never reached 0% production. Body weight loss for hens on the feed withdrawal treatment was 25.2% on Day 10 of the molt period. On Day 21 of the molt period hens on the Corn:SH 21 and WM:Corn 21 treatments lost 13 and 2% of their original body weight, respectively. Hens on the Corn:SH 28 and WM:corn 28 treatments lost 21 and 8% of their initial body weight. And, the hens fed the Corn and the Corn:SH 35 for 35 d lost 17 and 28% of their original body weight, respectively. Hen-day egg production was different (P < 0.05) for Weeks 1 to 28, with the Corn treatment being statistically lower than all treatments except the Corn:SH 35 and WM:corn 28 treatments. No consistent differences were observed among treatments for mortality, egg weight, egg specific gravity, and feed efficiency during the post-molt production period. When compared to a 10-d fast, this research indicates that a diet containing a combination of corn and soybean hulls fed for a varying number of days is an effective non-feed withdrawal method for molting laying hens.

**Key Words:** molt, laying hens, molt period
The effects of diet composition on development of digestive organs and apparent ileal digestibility (AID) of nutrients were studied in 21 d old broilers. There were twelve treatments arranged factorially with two cereals (corn and rice), two processing methods (HP) (raw and cooked at 90°C from 50 min), and three fiber sources [none, 3% oat hulls (OH), and 3% soybean hulls (SH)]. Each treatment was replicated three times (a cage with 16 chicks). The control diets were based on cereal (60% of either corn or rice), soy protein concentrate, soy oil, and 1% celite, and the crude fiber content was 2.4% (corn diet) and 1.5% (rice diet). Relative weights (RW) of proventriculus (0.78 vs. 0.75% BW) and gizzard (3.28 vs. 2.84% BW) were higher for broilers fed corn than for broilers fed rice ($P < 0.001$). HP of corn reduced gizzard RW ($P < 0.05$) whereas HP of rice did not have any effect. Oat hulls increased gizzard RW (3.37 vs. 2.96% BW; $P < 0.001$) whereas SH increased proventriculus RW (0.78 vs. 0.74% BW; $P < 0.001$). An interaction cereal × HP was observed; HP improved AID of DM and gross energy in the corn diets but had the opposite effects in the rice diets ($P < 0.01$). Hulls inclusion improved AID of DM and gross energy ($P < 0.05$) and the benefits observed were more pronounced with OH than with SH ($P < 0.1$). We concluded that the inclusion of an insoluble fiber source to low–fiber diets stimulates gizzard function and improves nutrient utilization. Therefore, it is recommended to include a minimal amount of insoluble fiber in diets for young broilers.

Key Words: fiber inclusion, ileal digestibility, broiler
gain or mortality. These results demonstrated that the OAB treatment significantly reduced horizontal spread of SAL to uninfected birds and reduced environmental SAL contamination.

*ACTIVATE is a registered trademark of Novus International, Inc.

**Key Words:** organic acids, ACTIVATE, Salmonella

240 Control of caecal Salmonella by dietary FOS in probiotic treated broiler chickens.  J. R. Chambers*1, J. Gong1, B. Sanei2, C. Gyles3, M. A. Hayes1, and S. Sharif1, 1Food Research Program, AAFC, Guelph, ON, Canada, 2Ontario Ministry of Agriculture and Food, Guelph, ON, Canada, 3OVC, University of Guelph, Guelph, ON, Canada.

To test the potential of dietary fructooligosaccharides (FOS, 0.5% by wt) to reduce caecal Salmonella counts, broiler chicks were challenged with NaLR Salmonella, either typhimurium or heidelberg, in two trials (set 1). In each trial, hatched chicks were gavaged with either no probiotics (control), a defined probiotic (8 or less known organisms) or a non-defined probiotic (numerous organisms not all known). Next day, caeca from 1 chick per treatment, 6 total, were sampled to be tested for Salmonella (none detected) before the remaining 132 chicks were gavaged with 104 cfu of Salmonella in 0.5 ml suspension. Chicks were provided a crumbled, broiler started ration and distilled H2O, half receiving FOS. They were confined in 6 small pens with litter floors and solid walls. This plan was repeated with two other probiotics in two trials (set 2). At 1, 2 and 4 weeks post-challenge, caecal contents of 7 chicks per treatment were cultured on BGS agar plates with nalidixic acid. Samples with no colonies had material previously preenriched in Selenite Cystine broth cultured to distinguish between low level positive and negative status. Salmonella counts were analysed using Proc GLM of SAS with probiotic, prebiotic, age and trial (serotype) interaction (P<0.01). Small reductions (0.7 logs) of Salmonella existed if FOS fed broilers were treated with the non-defined probiotic. Corresponding values in set 2 were non-significant (P>0.05). In set 1 the FOS effect was predominant at 1 wk post-challenge leading to a significant interaction (P<0.01) between probiotic and age. Results suggest FOS reduces caecal Salmonella by small amounts. Moreover, it may need to be used with specific probiotics to realize benefits.

**Key Words:** fecal contamination, inside-outside bird washer, Campylobacter


A study was conducted to determine the effect of visible external or internal fecal contamination on the microbiology of broiler carcasses. In each of three trials, 12 uneviscerated carcasses were obtained from a commercial processing plant, placed on a shackle line and eviscerated on commercial equipment in a pilot plant. One g of cecal contents was placed on either the exterior breast area to mimic outside contamination (OC), inside the carcass (IC), or not applied (Control). All carcasses were held 10 min prior to washing. Carcasses were replaced on the shackle line and passed through a commercial inside-outside bird washer (IOBW) set at 80 PSI (552 kPa), 5 s dwell time, using approximately 47 gal (178 L) per min of tap water at ambient temperature. Whole carcass rinses (WCR) were conducted and coliforms, E. coli, and Campylobacter counts were determined and are reported as log cfu/ml rinse. Coliform counts for OC (5.0) were significantly (P<0.05) greater than IC (4.5), which were significantly greater than Control (3.7). E. coli counts from OC (4.9) were significantly greater than IC (4.2), which were greater than Control (3.6). Campylobacter counts for OC (3.6) were significantly greater than IC (2.6), which were greater than Control (2.2). Visible contamination was observed on post-wash OC carcasses, but not in or on post-wash IC carcasses. In this study, post-wash carcasses with internal contamination had fewer bacteria than carcasses with external contamination. However, washing did not reduce bacteria from internally contaminated carcasses to control levels.

**Key Words:** fecal contamination, inside-outside bird washer, Campylobacter

242 Inhibition of Campylobacter and Salmonella on whole chicken carcasses using a novel intervention technology.  T. W. Thompson*, C. Z. Alvarado, and M. M. Brashears, Texas Tech University, Lubbock.

A study was conducted to determine the effectiveness of Protectatm pc intervention on the reduction of Campylobacter and Salmonella on poultry carcasses. Protectatm pc intervention was compared to ambient water (CONTROL), and no rinsing (UNTREATED CONTROL). A total of 90 carcasses where used to evaluate the reduction of either Campylobacter or Salmonella. Each group had 3 replications with 5 carcasses being used in each of the 3 treatments. In the pathogen processing lab at Texas Tech University, a cocktail mixture of 4 strains of Campylobacter spp. and Salmonella spp. were prepared and added to chicken carcasses by dipping to yield a population of approximately 7.5 log10 cfu/g of rinse from the carcasses. Bacteria were allowed to attach for 30 min prior to application of interventions or sampling. The USDA poultry rinse method was used to sample the chickens. Standard FDA-BAM methods were used to enumerate Campylobacter spp. on the carcasses. The CONTROL and UNTREATED CONTROL samples contained 7.23 and 7.46 log10 cfu/ml of Campylobacter spp. after treatments, and the CONTROL and UNTREATED CONTROL samples contained 3.19 and 7.49 log10 cfu/ml of Salmonella spp. after treatments. The Protectatm pc treated carcasses yielded 6.32 and 7.02 log10 cfu/ml reduction for Campylobacter spp intervention on the reduction of Campylobacter spp. after interventions. The Protectatm pc treatments had a 1.7 log10 cfu/ml reduction for Campylobacter spp intervention on the reduction of Campylobacter spp. respectively. The Protectatm pc treatments had a 1.7 log10 cfu/ml reduction for Salmonella spp intervention on the reduction of Campylobacter spp; when compared to the UNTREATED CONTROL. Treatments with ambient water did not result in a significant reduction of Campylobacter spp. or Salmonella spp. on the carcasses. While there were still pathogens remaining after all treatments, the reductions with Protectatm pc can help reduce to total number of bacteria on broiler carcasses.

**Key Words:** Campylobacter, Salmonella, poultry
243 Recovery of bacteria from broiler carcasses after immersion chilling in different volumes of water, Part 2. J. K. Northcutt*1, J. A. Cason1, K. D. Ingram1, D. P. Smith1, R. J. Buhr2, and A. Hinton, Jr.1, 1USDA-ARS, Athens, Georgia, 2The University of Georgia, Athens.

In a previous study, the levels of bacteria recovered from broiler carcass halves after immersion chilling in a low volume of water (2.1 L/kg) were greater than the levels of bacteria recovered from halves after immersion chilling in a high volume of water (16.8 L/kg). A second study was conducted to determine if the recovery of bacteria from chilled broiler carcass halves would be different if a commercial immersion chilling volume was used (3.3 L/kg) compared to double that volume (6.7 L/kg). For this study, pre-chill broiler carcasses were removed from a commercial processing line, cut into left and right halves, and one half of each pair was individually chilled in a bag containing either 3.3 L/kg or 6.7 L/kg distilled water. Bags containing halves were submersed in a secondary chill tank containing approximately 150 L of an air-agitated ice-water mix (0.6°C). After 45 min, halves were removed, allowed to drip for 5 min, and rinsed with 100 mL of sterile water for 1 min. Rinses were analyzed for total aerobic bacteria (APC), Escherichia coli (EC), Enterobacteriaceae (EN) and Campylobacter (CP). When the numbers of bacteria in the half-carcass rinses (HCR) were compared, counts recovered from halves chilled in 3.3 L/kg of water were the same as those recovered from the halves chilled with 6.7 L/kg of water (P > 0.05). Levels found in the HCR ranged from 4.0 to 4.2 log10 cfu/mL for APC, 3.3 to 3.5 log10 cfu/mL for EC, 3.6 to 3.8 log10 cfu/mL for EN and 2.4 to 2.6 log10 cfu/mL for CP. Data were also analyzed using a paired comparison t-test, and this analysis also showed that there was no difference (P > 0.05) in the numbers of APC, EC, EN or CP recovered from paired-halves chilled in different volumes of water. The present study shows that doubling the amount of water that is traditionally used during immersion chilling (6.7 L/kg) will not improve the removal of bacteria from the surfaces of chilled carcasses.

Key Words: poultry, immersion chilling, chiller water

244 Coliforms, E. coli, Campylobacter, and Salmonellae in a counterflow broiler scalding with a dip tank. J. A. Cason* and A. Hinton, Jr., Russell Research Center, Athens, Georgia.

Suspended bacteria were enumerated in scald water and carcass rinse samples from a commercial broiler processing plant with a multiple-tank, counterflow scalding machine. After five-week old broilers had been processed for eight hours, water samples were taken on six days from each of three scald tanks and from a dip tank located between defeathering machines. Coliforms, E. coli, and Campylobacter were enumerated and the Most Probable Number (MPN) of Salmonellae was determined in water samples and in rinses of carcasses removed from the processing line immediately after defeathering. Mean coliform concentrations in Tanks 1, 2, and 3 were 4.6, 2.5, and 1.6 log10 (cfu/mL), respectively. E. coli concentrations followed the same pattern with means of 4.4, 2.1, and 1.4 in Tanks 1, 2, and 3, respectively, with significant differences (P<0.05) in the concentrations of both coliforms and E. coli between the tanks. Mean Campylobacter concentration in four positive samples from Tank 1 was 4.0 log10 (cfu/mL), but only one water sample from Tank 2 and none from Tank 3 were Campylobacter positive. Coliforms and E. coli were found in dip tank samples in only two instances, with no isolations of Campylobacter or Salmonellae. Mean numbers of coliforms, E. coli, and Campylobacter in carcass rinses were 3.1, 2.7, and 3.3 log10 (cfu/mL). Salmonellae were isolated from five of six water samples from Tank 1 with a mean MPN of 13.3/100mL, but were isolated from only three of six water samples from Tank 2 and two of six from Tank 3. Salmonellae were isolated from half (18/36) of all carcass rinses. Most bacteria suspended in scald water were found in the first tank, with no Campylobacter or Salmonellae found in the dip tank. Counterflow, multiple-tank scalders appear to reduce the opportunity for cross-contamination during scalding.

Key Words: scalding, bacteria, Salmonella


Internal contamination of eggs by Salmonella enteritidis has been a significant source of human illness for several decades and is the focus of a recently proposed FDA regulatory plan. Salmonella heidelberg has also been identified as an egg-transmitted human pathogen. The deposition of Salmonella strains inside eggs is a consequence of reproductive tissue colonization in infected laying hens, but the relationship between colonization of specific regions of the reproductive tract and deposition in different locations within eggs is not well documented. In the present study, groups of laying hens were experimentally infected with large oral doses of S. heidelberg, S. enteritidis phage type 13a, or S. enteritidis phage type 14b. For all of these strains, the overall frequency of ovarian colonization (34%) was significantly higher than the frequency of isolation from either the upper (23%) or lower (18%) regions of the oviduct. No significant differences were observed in the frequency of Salmonella isolation from egg yolk or albumen (4.0% and 3.3%, respectively). Some significant differences between strains were observed in the frequency of isolation from eggs, but not in the frequency or patterns of isolation from reproductive organs. Accordingly, although the ability of these Salmonella strains to colonize different regions of the reproductive tract in laying hens was reflected in deposition in both yolk and albumen, there was no indication that any specific affinity of individual strains for particular regions of this tract produced distinctive patterns of deposition in eggs.

Key Words: Salmonella, reproductive tract, eggs

246 Prevalence of Salmonella, Campylobacter and Listeria on the surface of vacuum loaders in shell egg processing plants. D. R. Jones* and M. T. Musgrove, USDA-ARS, Egg Safety and Quality Research Unit, Athens, Georgia.

Previous studies have examined the effectiveness of sanitation programs in shell egg processing facilities. The results showed vacuum loaders to be a reservoir of high levels of aerobic bacteria and Enterobacteriaceae. This study was conducted to determine the prevalence of Salmonella, Campylobacter and Listeria on the surface of the suction cups from the vacuum loaders. Two shell egg processing facilities were sampled (one offline, one mixed operation) on three occasions each (weekly). One third of the suction cups (20 per visit) were randomly selected for sampling each visit with the aid of a random number table. Cups were removed from the vacuum loader and placed in a sterile sample bag
with 50 mL of sterile phosphate buffered saline. Cups were rinsed for one minute before being returned to the vacuum loader. Rinnsates were transported on ice to the laboratory for analysis. Total aerobic populations and Enterobacteriaceae were enumerated. Appropriate methodology was utilized to determine the prevalence of Salmonella, Campylobacter and Listeria. Aerobic population and Enterobacteriaceae levels were similar to those determined in the previous sanitation studies (5.5 and 2.3 log cfu/mL, respectively). There was no Campylobacter found on the vacuum loaders. Less than 10% of the samples were positive for Salmonella. There was a very high incidence of Listeria found on the suction cup surfaces. Biochemical tests confirmed presumptive isolates to be L. innocua and L. monocytogenes. These results indicate that additional research is needed to improve the cleaning and sanitation procedures for suction cups on vacuum loaders to reduce the incidence of these pathogens in the shell egg processing environment.

Key Words: egg processing, vacuum loaders, pathogens

247 Enterobacteriaceae and related organisms isolated from shell eggs washed in cooler wash water. M. T. Musgrove* and D. R. Jones, Egg Safety and Quality Research Unit, USDA-ARS, Athens, Georgia.

Processing guidelines in 7 CFR part 56 dictate that shell eggs be washed in water at 32-49 C. As they pass through dual commercial washers, egg temperatures often rise to levels conducive to bacterial growth. A commercial study was conducted to determine if washing eggs with cooler water would allow for reduced temperatures but preserve microbiological quality. An in-line and off-line facility were each sampled on 3 times. Wash water treatments were: HH = 49C, 49C; HC = 49C, 24 C; and CC = 24 C, 24 C. On each visit, 4 3-egg pools per treatment were sampled by crushing shells and membranes with 30 mL of phosphate buffered saline. Enterobacteriaceae were detected by pour-plating shell/membrane homogenates with violet red bile glucose agar and incubated at 37 C for 24 h. Five isolates per positive sample were randomly selected, streaked three times to ensure purity, and identified to genus level using biochemical testing. Shell surface temperatures for the 3 treatments (HH, HC, CC) averaged 26.2, 22.7, 21.2 C for in-line eggs and 20.2, 18.6, and 17.2 C for off-line eggs. Escherichia coli were the most frequently identified genera from either facility, regardless of treatment. Citrobacter, Klebsiella, Leclercia, Proteus, Salmonella, and Serratia were also recovered from both facilities. Other Enterobacteriaceae recovered from the in-line facility included Buttiauxella, Erwinia, Haemophilus, Klyuyvera, Morganella, Providencia, and Yersinia. Only Enterobacteriaceae were identified from off-line eggs though related species were recovered from the in-line eggs (Aeromonaceae and Pseudomonas cepacia). Differences in Aeromonaceae (Aeromonas, Listonella, Vibrio) prevalence were observed by treatment: 31.8, 25.7, and 47.1% for HH, HC, and CC, respectively. Higher proportions of Salmonella were presumptively identified from HC (36.5%) and CC (20.0%) than from HH washed eggs (5.0%). The 3-5 C reduction in shell surface temperature resulting from using cooler wash water temperatures may not be worth the observed decrease in microbiological quality.

Key Words: shell eggs, processing, Enterobacteriaceae

248 Microbiological survey of seven types retail shell eggs. M. T. Musgrove* and D. R. Jones, Egg Safety and Quality Research Unit, USDA-ARS, Athens, Georgia.

A variety of shell eggs are available at retail, marketed to accommodate consumer preferences for esthetic, nutritional, or microbiological/safety perceptions and needs. In light of imminent changes to egg washing and packing regulations, any microbiological information on retail eggs processed under current guidelines will be useful for future comparison. A microbiological survey was conducted of eggs purchased in Athens, GA grocery and health food stores. Seven types of grade A large eggs were included in the study: (1) traditionally processed; (2) nutritionally enhanced; (3) in-shell pasteurized; (4) vegetarian fed; (5) free-range/fermile; (6) cage free; and (7) kosher. Eggs were transported back to the laboratory in cartons and ten of each type were aseptically sampled by a shell/membrane crush method. Egg contents were also collected. Aerobic plate, Yeast/mold, and Enterobacteriaceae counts were determined for individual egg shells/membranes and content samples by plating on plate count, dichloran rose bengal chloramphenicol, and violet red bile glucose agar, respectively, using appropriate incubation times and temperatures. For each egg type, three 3-egg pools of shell/membrane homogenates and three 3-egg content pools were enriched for the detection of Salmonella, Campylobacter, and Listeria. Accepted methods of pre-enrichment, enrichment, selective plating, and confirmation were employed for each pathogen population. All microbial counts are reported as log cfu/mL for egg types 1-7. Aerobic egg shell/membrane counts by egg type were 1.2, 2.6, 1.5, 0.6, 1.4, 1.4, and 2.2, respectively. Yeast/mold counts were 0.1, 0.1, 0.3, 0.1, 0.2, 0.0, and 0.0, respectively, while Enterobacteriaceae counts were determined to be 0.3, 0.1, 0.3, 0.0, 0.2, 0.1, and 0.0, respectively. None of these populations was detected in any of the egg content samples. Salmonella, Campylobacter, and Listeria were absent from shell/membrane homogenate and content pools for all egg types sampled. These results indicate that shell eggs available in the retail market have acceptable microbiological quality and safety characteristics.

Key Words: shell eggs, microbiology, retail

249 Albumen quality and functionality from eggs produced by hens from five layer strains over two production cycles. P. A. Curtis*1, L. K. Kerth2, and K. E. Anderson3, 1Auburn University, Auburn, Alabama, 2North Carolina State University, Raleigh.

Egg processors who break eggs to create a variety of egg products, want large eggs that consistently produce high quality egg products. Consistency is the major problem with eggs, particularly in the albumen. It is well known that as the hen ages a number of changes occur in the egg. Bird age has been reported to have an impact on egg size and composition. Egg weights generally increase as the bird ages. Egg weights are also influenced by strain. In order to study such problems, strains of layer hens bred for the egg breaking industry were evaluated looking at the quality and functional characteristics of eggs over a complete two year cycle which included a molt. Eggs from five strains of birds from the 35th North Carolina Layer Management Test were analyzed over a 24 period laying cycle for albumen quality. The strains utilized were the Hy-Line W-36, Hy-Line W-98, Hy-Line CV-20, ISA White, and Bovans White. These strains were selected based upon their egg weight, availability, and market share. Strain performance was monitored under identical rearing and environmental
conditions throughout the test. The hens were provided nutrients to meet the needs of all the hens based upon compilation of the breeder recommendations. The eggs from these strains were collected every 28 days from the previous 24 hrs production. Once collected the quality and compositional properties of the eggs such as pH, solids, whipping height, Haugh units and angel food cakes were evaluated. Angel food cake volumes had greater variation in the first laying cycle (first 12 months) than in the second laying cycle (second 12 month period). None of the other quality measurements analyzed were a good predictor of cake volume. Egg weights were also influenced by strain. The strains with the highest (P<0.05) egg weights were the W-98, and ISA White at 61.2 and 61.0 g, respectively. The lowest egg weights were associated with the W-36 hen’s eggs weighing 57.1 g during the first cycle.

Key Words: egg quality, albumen functionality

250 Functionality and quality of whole eggs and yolk from five different layer strains over two production cycles. L. K. Kerth*1, P. A. Curtis1, and K. E. Anderson2, 1Auburn University, Auburn, Alabama, 2North Carolina State University, Raleigh.

Breeders in the modern commercial environment have been developing and selecting layer strains for the production of large egg sizes to enhance yield. However, the impact of such breeding programs on egg composition has not been evaluated. To date the research that has been conducted only looks at a few characteristics and does not look at those characteristics over a complete laying cycle or as the hen ages. Therefore, in this study five commercial layer strains were selected based upon their egg weight, availability, and market share and were monitored for a complete two year laying cycle (17-114 weeks of age) including a molt. The five strains that were utilized in this study are Hy-Line W-36, Hy-Line W-98, Hy-Line CV-20, Bovans White and ISA White. Eggs were collected every 28 days from the 35th North Carolina Layer Performance and Management Test in which the strains were maintained under identical husbandry and environmental conditions throughout the study. After collection, the quality, functional, and compositional properties of the eggs were determined. During the first production cycle (17-66 weeks of age) the functionality of the whole egg as tested by sponge cake volume was very erratic (P<0.05) between the strains. However, the volume of the sponge cakes became much more consistent among the strains (P>0.05) during the second cycle (70-114 weeks of age). Egg weights and whole egg solids were also significantly (P<0.05) influenced during both cycles by strain. Emulsion strength of mayonnaise was impacted by hen age and strain during both production cycles. Yolk solids had no difference (P>0.05) among the five strains during the first cycle, but there was a significant difference (P<0.05) during the second. Vitelline membrane strength was also impacted over the complete laying cycle by hen age and strain (P<0.05). Both hen age and strain appeared to influence the functional properties of the eggs produced.

Key Words: egg quality, yolk functionality, whole egg functionality

251 Are thermal manipulations to improve thermotolerance during chick's embryogenesis only a question of fine tuning? S. Yahav*, Institute of Animal Science ARO the Volcani Center, Bet Dagan, Israel.

Thermal manipulations during chick’s embryogenesis are based on the following hypothesis: a. during embryogenesis, inducing long lasting physiological memory, based on epigenetic adaptation, is achievable; b. the meaning of long lasting memory can be defined, most probably, as alteration in the thermoregulatory hypothalamic threshold response to changes in the environment; c. thermal manipulations during the sensitive periods of embryogenesis, using specific level and duration of heat exposure will achieve the improvement of thermotolerance acquisition during life span. It was previously well documented that thermal manipulations during the 1st week post-hatch reach the targeted aim of improved thermotolerance. However, technical problems to adopt these manipulations in chicks, coupled with the hypothesis that during embryogenesis thermal manipulations maybe more efficient for the improvement of thermotolerance, targeted the chick embryogenesis as a promising period for manipulations. Thermal manipulations during 8 to 10, and 16 to 18 d of embryogenesis were conducted using 6 h exposure to 39.5C on each day. These treatments didn’t affect hatchability or development upon hatch or later on. Challenging the treated chicks with hot conditions for 3 d demonstrated a better thermotolerance (significantly lower body temperature coupled with lower thyroid hormones concentration) and stress resistance of the manipulated embryos at 16 to 18 d of embryogenesis. However, challenging the chickens at marketing day (42 d of age) did not show any thermotolerance efficiency/advantage of the manipulated chickens. Moreover, these chickens lost their relatively lower body temperature with age, meaning, they lost their efficiency to better cope with heat challenge. These results raise the following questions: a. is it possible that there is no way to induce long lasting thermoregulatory memory by thermal manipulations during embryogenesis? or b. is it only a question of thermal manipulation fine tuning? Further research is needed to shed light on this topic, although there are evidences that fine tuning may achieve the targeted goal.

Key Words: embryogenesis, thermotolerance, thermal manipulations

252 Incubator temperature and oxygen concentration affect the physiology of selected muscles of broiler embryos at the plateau stage in oxygen consumption. V. L. Christensen*, D. T. Ort, M. M. Mann, M. J. Wineland, P. E. Mozdziak, S. L. Funderburk, J. L. Grimes, and E. R. Oviedo, North Carolina State University, Raleigh.

An apparent paradox in energy budgets of avian eggs and metabolism occurs at the plateau stage in incubation as heat output increases, but oxygen utilization does not. When confronted with life-threatening situations, embryonic organ growth and function may be antagonistic. Temperature manipulations have been shown to affect the posthatch phenotype through muscle alteration. Little is known of the effect of oxygen on embryonic muscle physiology. The objective of the current study was to test the effect of incubation temperature and fractional oxygen concentration at the plateau stage in development on muscle physiology. Eggs from two strains of broilers (high and low eggshell conductance (G) strains) were incubated normally for 18 d. At that
time they were transferred to four incubation cabinets to operate at 36, 37, 38 and 39° C in trial 1 or with 17, 19, 21 or 23% oxygen in trial 2. At external pipping and at hatching randomly selected embryos or chicks were weighed and sampled for pipping, breast and thigh muscle glycogen and lactate. Blood samples were collected to test for the enzyme activities of creatine kinase (CK) and lactate dehydrogenase (LDH). Increasing temperature decreased (P < 0.0001) breast, thigh and pipping muscle glycogen at the plateau stage, but it did not affect CK or LDH. At hatching temperature and strain interacted (P < 0.01) such that the high G strain was less sensitive to increases in temperature than the low G, but it did not affect CK or LDH. Oxygen had divergent effects on muscle lactate and glycogen. Increasing oxygen concentrations decreased (P < 0.01) glycogen concentrations in some muscles but increased it in others with no consequent effects on CK or LDH. It is concluded that temperature greater than 37°C and oxygen concentrations less that 21% in the incubator atmosphere at the plateau stage in embryo development affect muscle physiology.

Key Words: embryo, muscle physiology, temperature

253 Incubator temperature and oxygen concentration affect the growth of selected muscles of broiler embryos at the plateau stage in oxygen consumption. V. L. Christensen*, M. J. Wineland, E. R. Oviedo, S. L. Funderburk, D. T. Ort, J. L. Grimes, P. E. Mozdzia, and M. M. Mann, North Carolina State University, Raleigh.

Temperature is the major regulatory factor in egg incubation and embryo development because of its effect on general growth and the coincidental impact on tissue formation. Prior research indicated that temperature manipulations affected the posthatch phenotype through the alteration of muscle (Malty and Strickland, 2004). Little is known of the effect of oxygen on muscle cell expression, but it is thought that oxygen may be a primary determinant of the growth of the embryo. The impact of temperature and oxygen on embryo muscle development is highly important because of the proliferating pool of precursor muscle cells available late in incubation. The objective of this study was to test the effects of incubation temperature and oxygen concentration on the development of muscles during incubation. Eggs from two strains of broilers (high and low eggshell conductance (G) strains) were incubated normally for 18 d. At that time they were set in four incubation cabinets calibrated to operate at 36, 37, 38 and 39°C in trial 1 or with 17, 19, 21 or 23% oxygen in trial 2. At external pipping and at hatching randomly selected embryos or chicks were weighed and sampled for pipping, breast and thigh muscle weights. Increasing temperature depressed (P < 0.0001) BW, pipping and thigh muscle weights but not breast muscle weight. Increased fractional concentrations of oxygen depressed (P < 0.01) pipping muscle weights but increased (P < 0.0001) thigh muscle weights with no effect on breast muscle weight. Oxygen interacted with strain as 19% increased (P < 0.01) thigh muscle weight in the low G line but it required 23% oxygen to increase the weight in the high G line. It is concluded that temperature and oxygen have divergent effects the growth of muscles.

Key Words: embryo, muscle growth, temperature

254 Determining true fertility of clear eggs identified at 7 days incubation histologically. K. L. Knight and T. A. Scott*, University of Sydney, Camden, NSW, Australia.

In order to best differentiate infertility from very early embryo mortality it is important that we can clearly classify true fertility, particularly for those eggs identified as clear with candling. This study determined the effectiveness of using Propidium Iodide (PI) (Sigma P4170, St. Louis MI, 63103), a fluorescent DNA-specific red stain, in identification of true fertility of eggs identified as clear at 7 d candling. True fertility is determined by the presence of cell nuclei that uptake the stain and illuminates the nuclei. Propidium iodide acts by intercalating between base pairs of DNA. The cells of fertile eggs are diploid and it is estimated that at the time of oviposition, embryos may contain up to 70,000 cells. Briefly, the procedure requires a portion of the shell at the large end of refrigerated 7-d candled clear eggs to be removed and the outer perivitellic membrane moved to expose the germinal disk. Germinal disks were visually screened for signs of early embryonic development; those germinal disks showing no development were transferred to a microscope slide. Propidium iodide was used to stain the germinal disk at a concentration of 5 µg PI/mL 0.9% NaCl solution. For each slide, 5 µL of the dilute PI was used and a coverslip placed on top. Based on 4,800 eggs (single age flock) from each of two storage times (3 and 7 d at 18°C) 8.3% were classified macrascopically as infertile, 4.25% as early dead. Approximately 50% (347) of the 798 eggs identified as “clear” were fixed, stained and histologically examined; of these 41 were reclassified as fertile with embryo mortality occurring before oviposition or during storage; this was equal to almost 12% of eggs classified as “clear” and estimated to be 1% of total eggs candled. Incidence of eggs re-classified as fertile with PI staining were numerically higher with 7 d as compared to 3 d of storage before incubation. This study has provided a definitive tool to assess true fertility from eggs incubated to 7 d of age.

Key Words: true fertility, stains, embryo

255 Effect of cooling and developmental age on quail embryo heart rate. B. C. Wentworth*, University of Wisconsin, Madison.

Managers of avian incubation have known for many years that it is very important to keep the temperature at a constant appropriate level. We have known that avian embryo development varies with respect to incubation temperature. The objective of this study was to report the effect of cooling and developmental age on quail embryo heart rate. The heart rates of 302 Wisconsin white egg line Japanese quail (Coturnix coturnix japonica) embryos were recorded from day four of incubation to day 15 of incubation. The heart rate was determined with an infra red heart rate sensor in an instrument called “Buddy”. The instrument would not detect heart rate before day four. Respiration after day 15 compromised the heart rate recording. The heart rate of 210 ± 23 beats/min on day four increased with a significant (P<0.001) linear trend to 371 ± 28 beats/min on day ten with a NS decrease (367 ± 17 beats/min) on day 15. Cooling the embryos at room temperature (22°C) for five min. resulted in an average heart rate decrease of 16 ± .69 beats/min. The decrease in heart rate with cooling of four day-old embryos was 11 ± .73 beats/min with a significant (P<0.01) numerical decrease in heart rate (13 ± .64 beats/min.) at day eight to (18 ± .72 beats/min). On day 13 of development there was a rate plateau until day 15. Among the 302 embryos recorded there was NS dam and sire affect on heart rate from day four to 15, or on the heart rate decrease with cooling for five min. These results demonstrate that a short period of cooling has a dramatic effect on slowing the heart rate of quail embryos.

Key Words: embryo, heart rate, temperature
256 Torpor in quail embryos and young quail chicks.  B. C. Wentworth*, J. L. Cigan, and T. J. Schaaf, University of Wisconsin, Madison.

The purpose of this study was to explore the state of torpor in Japanese quail (Coturnix coturnix japonica). In this experiment, quail embryos and young quail chicks demonstrate phenomena that simulate torpor that has been documented in families represented by Chimney Swift, Hummingbirds and Whip-poor-wills. The heart rate was determined with an infrared heart rate sensor in an instrument called "Buddy". Six day-old embryos were placed in a cold-room at 13°C for 24 h. After 12 h the embryo body temperature was 13°C and heart rate at 13°C averaged 14 ± 9 beats/min and the average control embryo heart rate at 37.5°C was 311 ± 15 beats/min. The torpor quail embryos had a 24 h delay in hatching at 58%. The controls hatched on time at 81%. Twelve six day-old quail were selected that appeared uniform in size and vigor and were placed in a low temperature environment (13°C) for a period of 6 h. Quail from which the test group was selected were retained in a brooder to serve as a control comparison to those the low temperature (13°C) environment. During the time when the 12 quail were in the state of torpor the heart rate (EKG) for both torpid and control quail was determined with a Tektronix TDS-200 Digital Oscilloscope. The quail in the state of torpor had a heart rate of 14 ± 6 beats/min. The control quail had an average heart rate of 525 ± 24 beats/min. After emerging from the reduced-temperature environment, the torpid quail were placed under an infrared (IR) light producing a brooder-like temperature of 33°C. During observation under the IR, one quail showed signs of life with beak movement in three min. After ten min all quail were breathing and after 25 min some quail were able to stand and peep loudly. After 40 min all quail could walk around and some eat and drank. Ten of the 12 original quail recovered from their torpid state and appeared normal, but two appeared to have neurological problems and were euthanized. These data demonstrate that quail and quail embryos can tolerate 13°C cold environments.

Key Words: torpor, embryo, chick

257 Effect of breeder hen age and incubation temperature on embryonic temperature and development of White Pekin ducklings.  K. A. Kroesen* and M. S. Lilburn, The Ohio State University, Wooster.

In each of two experiments, internal egg temperatures were measured in commercial duck hatching eggs during incubation. In Experiment I, eggs from very young and prime age flocks were individually weighed at setting and incubated at 99.5°F. At multiple ages during incubation, internal egg temperatures were measured on a sample of 20 eggs per hen age. Internal egg temperature increased in a linear fashion from 99.5-100°F on Day 5 to 101.5°F on Day 21 in eggs from both hen ages. On Day 14, the mean temperature difference between flock ages was small (0.8°F) but > 80 % of the prime eggs had internal temperatures > 100°F compared with < 50% of the young eggs. At 21 d, > 80% of the eggs from both hen ages had internal temperatures between 101.4 and 102.2°F. Differences in yolk-free embryo weight (prime vs. young) were 0.7 g at 23 d (34.8 vs 34.1 g) and 1.6 g (46.1 vs. 44.5 g) at 26 d of incubation but there were no differences in embryo length at either embryonic age (Day 23, 15.5 cm; Day 26, 16.2 cm). In Experiment I, eggs from young and prime flocks were incubated at 99.5°F or 101.0°F. Measurements on Day 13 of incubation confirmed that we were successful in creating different internal egg temperatures of approximately 98.5°F and 100°F. In embryos from both age hens, the higher incubation temperature resulted in increased yolk-free embryo weight at Day 20 (21.8 vs 19.3 g; P < 0.001) and embryo length (13.4 vs 12.7 cm; P < 0.001) and the correlation between embryo length and yolk-free embryo weight was 0.84 (P < 0.001). It was also observed that 18.3% of all embryos were upside-down in the egg in the 101.0°F treatment, similar to the 29.3% incidence reported in turkey embryos incubated at 101.3°F.

Key Words: Pekin ducks, embryo, temperature


A deeper assessment is needed of physiological parameters significantly impacting the embryo and chick including the influences of sex (CS) and time of hatch (TOH). This study included 10 replicates of 5 chicks that were identified with their respective individually isolated egg. Percentage egg weight loss (PEWL) was measured through 18 d of incubation, and BW, rectal temperature (RT), hematocrit (HCT), serum refractive index (RI), and plasma glucose (GLU) were measured through 72 h post-hatch. Chicks received nutrition and heated brooding at 12 h post-hatch. The significant correlations found are as follows. Overall (across TOH and CS): RT at 48 h with HCT at 0, 12, 24, and 72 h; 24 h GLU with 0-6, 6-12, 12-18, and 0-18 d PEWL; hatch RI with hatch RT; hatch RI with HCT at 0, 24, 48, and 72 h; and 72 h RI with HCT at 0, 12, 24 and 72 h. Within TOH: 20 d chick 48 h RT with 12 h HCT; and 72 h HCT at 24, 48, and 72 h HCT. 20 d 6 h chick 24 h GLU with PEWL between 0 and 18 d; 24 h RI with both 24 h GLU and 24 h RT; RI at hatch with 0 and 24 h HCT; and 24 h RI with 0, 48, and 72 h HCT. 20 d 12 h chick 24 h GLU with hatch RI; 24 h GLU with 72 h RT; hatch RI with 24 h HCT; and 48 h RT with HCT at hatch. Within CS: Male 24 h GLU with 6-12 and 0-18 d PEWL; 24 h RI with 48 h RT; and hatch RI with 48 h HCT. Female 24 h RT with 0, 12, 24, and 72 h HCT; hatch RI with 0, 12, 24, and 48 h HCT; 24 h RI with 0-6, 6-12, 12-18, and 0-18 PEWL; and 24 h HCT with 0-6, 6-12, 12-18, and 0-18 PEWL. Male mean hatch RT (37.04°C) was significantly lower than that of females (37.54°C), and RI at 24 and 72 h was significantly lower in males than in females. RT in chicks that hatched at 20 d 12 h was significantly lower than those that hatched at 20 d 6 h or earlier. The relationships of physiological markers indicative of performance through the incubational and post-hatch periods were influenced by bird sex and time of hatch. The significance and consistency of relationships among physiological markers is imperative to ascertain their impact on performance.

Key Words: blood, broiler chick, embryo

259 Determination of eggshell microstructural characteristics and associated physiological profiles in MG-vaccinated egg-laying chickens.  S. L. Westmoreland*, S. B. May1, M. I. Gracey1, D. L. Hawkins1, E. D. Peebles2, S. W. Park3, and S. L. Branton1, 1The University of Texas, Arlington, 2Mississippi State University, Mississippi State, 3South Central Poultry Research Laboratory USDA, Mississippi State, Mississippi.

This experiment determined the effect of vaccination of commercial layers with F-strain Mycoplasma gallisepticum on eggshell thickness.
The experiment involved multiple variables in addition to the vaccination, including three different diets (basal diet; 2% PF added; and 2% PF plus phytase and D3) and two ages of lay (24 and 50 wk). Cross-section micrographs were taken on each eggshell and thickness measurements were made. These data were statistically analyzed using SAS statistical software to determine the effects of the variables on shell thickness. For treatment effects, both sham-inoculated and vaccinated data were examined for age-treatment interactions. It was found that for sham-inoculated shells, layers fed diet 1 had thinner shells in young versus old birds, however, in layers fed diets 2 and 3, young birds had thicker shells. Only in diet 3 was this difference significant (P = 0.006). For vaccinated shells, it was found that young birds produced thinner shells in layers fed all three diets. Again, only in diet 3 was this difference significant (P = 0.0011). For diet effects, shells from birds fed each of the three diets were examined for age-treatment interactions. For diet 1, sham-inoculated birds had thinner shells than vaccinated birds at both ages (24 and 50 wk). For diets 2 and 3, sham-inoculated had thicker shells at age 24 wk, but thinner shells at age 50 wk that vaccinated birds. None of these results were significant. For age effects, shells taken from layers at both ages were examined for diet-treatment interactions. At age 24 wk, sham-inoculated birds fed diet 1 had thinner shells than vaccinated birds, but the reverse was true for diets 2 and 3. At age 50 wk, sham-inoculated birds fed all 3 diets had thinner shells. None of these results were significant.

Key Words: F-strain Mycoplasma gallisepticum, commercial layer, eggshell quality

260 Chicken amphiregulin (AR) gene: cDNA cloning, promoter analysis, and regulation of its mRNA expression in the cultured ovarian granulosa cells. Y. Wang*, J. Li, and F. C. Leung, The University of Hong Kong, Hong Kong, HK-SAR, China.

Recent evidence demonstrates that amphiregulin (AR), a member of epidermal growth factor (EGF) superfamily, plays an important role in the regulation of ovarian functions in mammals. However, in non-mammalian species, studies on its role and hormonal regulation in the ovary are rather limited. In the present study, a full-length cDNA coding for the precursor of amphiregulin (210aa) has been cloned from the chicken ovary. To elucidate its potential role in the ovary of chicken, using semi-quantitative RT-PCR assay, we first examined the expression of amphiregulin during ovarian development. The mRNA level of amphiregulin was lowest at the embryonic stages; however, at the post-hatching stages, its expression dramatically increased, suggesting that amphiregulin may play an active role in the initiation or progression of the ovarian follicle growth. Using an in vitro granulosa cell culture system, the regulation of amphiregulin expression by gonadotropin and local growth factors was also investigated. Interestingly, unlike those findings in mammals, follicle-stimulating hormone (FSH) only weakly stimulated amphiregulin expression in the cultured ovarian granulosa cells from F1 follicles. By contrast, EGF, TGF-α, and HB-EGF strongly induced the expression of amphiregulin in a clear time- and dose-dependent manner. In agreement with the above finding, the promoter activity of amphiregulin gene could be enhanced significantly by EGF treatment in the cultured ovarian granulosa cells, indicating that the regulation of amphiregulin expression by EGF may occur primarily at the transcriptional level. Collectively, results from our study provide evidence that ovarian amphiregulin may be actively involved in the follicle growth and its expression is regulated by local ovarian growth factors, probably including amphiregulin itself, in the ovaries of non-mammalian species.

Key Words: amphiregulin (AR), promoter, granulosa cells

261 Cloning of chicken epigen and regulation of its mRNA expression in the cultured ovarian granulosa cells. Y. Wang*, J. Li, and F. C. Leung, The University of Hong Kong, Hong Kong, HK-SAR, China.

Epigen, also named epithelial mitogen, is the latest identified ligand for epidermal growth factor receptor (EGFR). Although much attention has been paid to the mitogenic and antiapoptotic effects of ovarian EGF and TGF-α, little is known about the expression of epigen in the vertebrate ovary. In this study, the cloned full-length cDNA coding for chicken epigen is 2,278bp in length and encodes a putative membrane-anchored precursor (151 amino acids), which shares 61%–65% sequence identity with its mammalian counterpart. Unlike other chicken EGFR ligands, epigen has a long 5′ untranslated region (5′-UTR, 594 bp). Most strikingly, promoter analyses revealed that this long 5′-UTR displayed promoter activity and removal of partial or whole 5′-UTR greatly impaired the basal promoter activities, providing a possibility that this 5′-UTR represents only one of multiple transcriptional initiation sites or promoters used by epigen gene. Using semi-quantitative RT-PCR assay, we also noticed that epigen was one of most abundantly expressed EGFR ligands among all of the EGFR ligands examined in the chicken ovary. And its abundant expression could be detected not only in the adult ovary, but also in the developing ovaries including those from embryonic stages (from day 8 to day 20), strongly suggested that ovarian epigen may have a tonic role during whole process of ovarian development. Moreover, epigen was also highly expressed in the cultured granulosa cells from 6mm, F4+5, and F1 follicles. Like other chicken EGFR family members, administration of exogenous EGF or TGF-α could also significantly stimulate epigen expression in the cultured granulosa cells despite the high basal level of epigen in the cultured conditions. Present results provide evidence, for the first time, that ovarian epigen, like other EGF family members, is also a potent paracrine/autocrine factor involved in the ovarian development of vertebrates.

Key Words: epigen, ovary, EGF

262 Characterization of fourteen chicken PAC1 receptor spliced variants: Evidence for the conserved 13bp intronic sequence as a critical factor to determine signaling properties and splicing patterns of PAC1 receptor. Y. Wang*, J. Li, and F. C. Leung, The University of Hong Kong, Hong Kong, HK-SAR, China.

It is well documented that the actions of PACAP are mediated by three types of receptors, named PAC1-R, VPAC1-R, and VPAC2-R, respectively. Among of them, PAC1-R has attracted much attention due to multiple spliced variants with different signaling properties in mammals. In contrast, little is known about spliced variants of PAC1-R and their functionalities in birds. In this study, using RT-PCR, we have isolated 14 new spliced variants from brain and ovary of adult chickens. In the 3rd intracellular loop, the insertion of 5 types of cassettes (14, 27, 46, 59 and 60aa), which are coded either by exon 14, 15, and 16 alone or in combination, results in 5 spliced variants identified in chicken brain. To test their functionalities, these variants
were cloned into pcDNA3.1 vector and co-transfected with pGL3-CRE luciferase construct into CHO cells. In the presence of these variants (except for 14aa-variant), ovine PACAP38 could strongly increase luciferase activities in a dose-dependant manner with EC50 values lower than 1 nM, suggesting that receptor variants could activate cAMP-PKA signaling pathway. Strikingly, an insertion of 13bp (partial retention of intron 18) into PAC1-R short form and spliced variants results in the cloning of additional 6 spliced variants (with altered C-terminal tails), which could not increase luciferase activities after PACAP treatment. Moreover, 3 variants (457, 356 and 418aa) (due to deletion of exon 18, or exon 17 and 18) were also cloned from chicken ovary. Again, the insertion of 13bp generates a variant with a C-terminal tail (418aa), while absence of 13bp causes a premature stop codon (356aa). Interestingly, the identical 13bp could also be found in PAC1-R gene of zebrafish and frog, suggesting that it plays a critical role in switching the signaling pathway and determining the splicing pattern of PAC1-R in lower vertebrates.

Key Words: PAC1-R, spliced variant, ovary

Embryo Symposium: Managing the Embryo for Performance


Improvements in broiler rate of gain for the past ten years have made the incubation period a larger percentage of the overall growth period for commercial poultry and has increased its importance for improving growth efficiency. Historically, hatchery managers have observed decreases in hatchability and chick performance although temperature profiles in the setters and hatchers have not appreciably changed. Decreases in hatchability, first week livability, hatch time, and overall chick quality have precipitated the need for a change in the way hatcheries are managed. Historically, the poultry industry within the US and UK had successfully utilized multi-stage incubation. Currently, use of single-stage incubation in Europe has increased because research has shown they more precisely meet the demands of the developing embryos. Therefore, research has changed the focus for multi- and single-stage hatcheries in order to determine the proper hatchery conditions to optimize embryo development, chick quality, and their affects on post-hatch performance. Studies have investigated how increases in shell temperature, independent of machine temperature, can result in increases in embryonic mortality, lower heart yield (heart / body weight), lower yolk-free body weight, and increased yolk weight. Factors that have contributed to the increase in heat stress to the developing embryos include egg mass, age of the embryo, air flow, breeder flock fertility, etc. Other studies have shown that the variation in chick performance can be explained by heat stress in the hatchery. Therefore, the symposium will show how improvements in our knowledge of the requirements of the developing embryo can help improve not only hatchability and first week livability, but post-hatch performance of commercial poultry.

Key Words: shell temperature, post-hatch performance, hatchery management

265 Attainment of thermoregulation. B. Tzschentke*, University of Berlin, Humboldt, Germany.

In poultry the early development of adaptive body functions, like the thermoregulatory system, is characterized by the following peculiarities.

I The development of peripheral as well as central nervous thermoregulatory mechanisms starts in the course of the prenatal ontogeny. However, their maturity is attained during early postnatal development. In the perinatal period environmental factors have a high impact on development of temperature regulation.

II Acute changes in the environmental conditions induce as a rule, first uncoordinated and immediately non-adaptive reactions. Later the uncoordinated (immediately) non-adaptive reactions change into coordinated (adaptive) reactions. Prenatal environmental influences may have a ‘training effect’ on the postnatal efficiency of the thermoregulatory system. These ‘training effects’ are necessary for the complete development of body functions like thermoregulation.

III Functional systems of the organism develop from open loop systems without feedback control into closed systems controlled by feedback mechanism. During this ‘critical period’, the actual environment modulates the development of the respective physiological control systems for the entire life period, especially by changes in neuroorganization and expression of related effector genes. Knowledge of these mechanisms might be specifically used to generate long-term adaptation of the organism to the postnatal climatic conditions (epigenetic temperature adaptation: ETA). In poultry ETA was developed by changes in the incubation temperature. Compared to birds, which were incubated at 37.5°C, a low incubation temperature induced postnatal cold-adaptation and warm incubation temperature induced postnatal heat-adaptation. ETA was shown in changes in the neuronal
thermosensitivity in the hypothalamus as well as in changes in peripheral thermoregulatory mechanisms. These alterations could be already found at the end of incubation. Further, changes in the level of circulating hormones as well as in expression of genes and transcription factors were found.

**Key Words:** temperature regulation, environment factors, epigenetic temperature adaptation

### 266 The endocrine interface of environmental and egg factors affecting chick quality. E. Decuyper* and V. Bruggeman, Catholic University, Leuven (Heverlee), Belgium.

Day-old chicks are the end product of the hatchery industry and form important starting material for the broiler farms. The major objective is to obtain a high hatchability of marketable chicks and a low spread of hatch. For the farmers, these chicks have to perform good, which is translated in high viability, high growth rate, high breast meat yield and low feed conversion. A good quality one-day old chick is hence a crucial hinge between the hatchery and the broiler farm. Moreover, maximal hatchability is not always synonymous with maximal post-hatch viability and growth potential of the chick. Quantitative and qualitative scoring of chick quality is assessed and some recently developed scoring systems, converting differences in qualitative parameters into a quantitative score are briefly discussed. Pre-incubation factors such as egg storage duration and age of broiler breeders, as well as incubation conditions will affect day-old chick quality and subsequent broiler performance. Heat production and metabolism, hormonal balances of thyroid hormones and corticosterone and gas exchange (O2, CO2) are of fundamental importance for embryonic development and survival during incubation. Results from our studies indicate that embryos with higher pCO2 levels in the air cell, and higher T3/T4 ratios at internal pipping or in the newly hatched chicks had higher hatchability, chick quality and post-hatch chick growth until 7 days. Incubation factors such as temperature, turning conditions or gaseous environment also affect development, change concentrations of hormones related to metabolism and growth of the embryo, and in this way affect one-day old chick quality. Moreover, also the spread of the hatch process is affected by incubation conditions as well as by the aforementioned pre-incubation factors. Depending on the spread of the hatching curve together with the place in the sequence of hatching (early or late) and in interaction with quality of the eggs set for incubation, storage duration, age of breeders,... there will be a period between hatch and first feeding of variable length. This may have repercussions on overall growth and a number of related physiological processes such as yolk uptake, metabolic 'level', gastrointestinal development,... In its turn, this is related to some crucial hormonal levels and enzyme activities for growth that are strongly influenced by post-hatch food intake such as insulin and p70S6 kinase activity, a key enzyme in the control of protein synthesis. The magnitude of the effect of delayed feeding is dependent on the spread of hatching as well as on the hatching period within the hatching window. This may be related to the different intrinsic quality or characteristics of chicks, e.g. early vs. late hatcher, as was shown by their respective hormonal levels. The latter may be a causal factor for the actual hatching time within the hatching window as well as for the later intrinsic quality of the hatched chick and which is not reflected in any of the actual scoring systems for chick quality. This is largely ignored in previous studies and in hatchery practice so far.

**Key Words:** chick quality, endocrine parameters, interfering factors

### 267 Nutrition of the developing embryo and hatching. E. Moran*, Auburn University, Auburn, Alabama.

Nutrient need by the embryo undergoes three abrupt changes from the initiation of incubation until complete dependence on feed. Glucose is the central nutrient until 7 days when chorioallantois oxygen enables use of lipid reserves to support subsequent development. Nutrient recovery from albumen and yolk is largely proportionate to assembly of the complete embryo through to 14 days. Thereafter, nutrient transferred to the body proper exceed the needs for growth and are intended as reserve in support of eventual emergence and short-term survival. Sero-amnionic sac rupture mixes albumen in the amnion for actual consumption by the embryo. The small intestine absorbs a large portion of this colostrum equivalent to foster extensive glycogen storage in liver and hatching muscle. Concurrent recovery of yolk lipid enlarges specific body depot and cholesterol in the liver. A rapid translocation of calcium from shell to long bones gives physical integrity for the rigors of hatching while a substantial quantity is complexed in the yolk sac with lipovitelline-phosvitin granules. Loss of the chorioallantois with pipping initiates pulmonary respiration, and oxygen becomes restricted when energy need maximizes. Anaerobic metabolism of glucose from glycogen reserves now becomes essential. The GI system must also reorient itself from macromolecule transfer to foodstuff digestion during the next 7 days. Mobilizing body fat complements diminishing yolk sac contents that not only provides a continuum of energy but generates heat and water. Vast hepatic cholesterol appears to relieve its need for post-hatch food intake such as yolk and p70S6 kinase activity, a key enzyme in the control of protein synthesis. The magnitude of the effect of delayed feeding is dependent on the spread of hatching as well as on the hatching period within the hatching window. This may be related to the different intrinsic quality or characteristics of chicks, e.g. early vs. late hatcher, as was shown by their respective hormonal levels. The latter may be a causal factor for the actual hatching time within the hatching window as well as for the later intrinsic quality of the hatched chick and which is not reflected in any of the actual scoring systems for chick quality. This is largely ignored in previous studies and in hatchery practice so far.

**Key Words:** albumen, embryo nutrition, yolk sac
Metabolic Disease Symposium: Metabolic and Cardiovascular Diseases in Poultry: Nutritional and Physiological Aspects

268 Inadequate pulmonary vascular capacity and susceptibility to pulmonary hypertension syndrome in broilers. R. F. Wideman*, University of Arkansas, Fayetteville.

Broilers are susceptible to pulmonary hypertension syndrome (PHS, ascites) when their pulmonary vascular capacity (PVC) is anatomically or functionally inadequate to accommodate the requisite cardiac output (CO) without an excessive elevation in pulmonary arterial pressure (PAP). The consequences of an inadequate PVC include sustained pulmonary hypertension (PH), systemic hypoxemia, right ventricular hypertrophy, and right A-V valve failure leading to central venous hypertension. PVC encompasses anatomical constraints related to the compliance and effective volume of blood vessels, as well as functional limitations related to the tone (degree of constriction) maintained by the precapillary arterioles within the lungs. Anatomical constraints on PVC are evident from poor correlation between lung volume and body mass, coupled with elevated pulmonary vascular resistance (PVR) attributable to non-compliant, fully engorged vascular channels. Surgical occlusion of one pulmonary artery halves the anatomical PVC, doubles the PVR, eliminates PHS-susceptible broilers, and reveals PHS-resistant survivors whose lungs are innately capable of handling sustained increases in CO. Intravenous microparticle injections also increase the PVR and trigger PH sufficient in magnitude to eliminate susceptible broilers while identifying robust survivors to serve as progenitors of PHS-resistant commercial lines. The microparticles obstruct pulmonary arterioles and cause local tissues and responding leukocytes to release vasoactive substances. Eicosanoid vasodilators of mammalian lungs (PGI2, PGE2) are ineffective in broilers, whereas the vasodilator nitric oxide (NO) and vasoconstrictors TXA2 and serotonin (5-HT) are highly effective. NO is the principal vasodilator and 5-HT is the principal vasoconstrictor involved in the PH response and ensuing mortality triggered by i.v. microparticle injections. These observations demonstrate that susceptibility to PHS is a consequence of anatomically inadequate pulmonary vascular capacity combined with the functional predominance of 5-HT mediated vasoconstriction over NO mediated vasodilation. Supported by USDA/CSREES/NRI 2003-35204-13392

Key Words: ascites

269 Patho-physiology of heart failure in broiler chickens: Structural, biochemical, and molecular characteristics. A. Olkowski*, University of Saskatchewan, Saskatoon, SK, Canada.

Modern strains of fast growing meat type poultry are highly susceptible to heart failure. Heart related mortalities are observed predominantly in fast growing broiler chickens, with ascites and sudden death syndrome (SDS) being the most common heart related conditions in modern broiler flocks. This paper examines the role of structural, molecular, and biochemical factors pertinent to patho-physiology of heart failure in fast growing broilers. Evidence explaining the pathogenesis of both acute and chronic heart failure, in the context of the underlying molecular and biochemical changes in the cardiomyocytes, contractile apparatus and extra-cellular matrix in the ventricular myocardium, are critically evaluated and discussed with reference to the clinical signs associated with deterioration of heart pump function. The secondary patho-physiological effects on the cardiovascular system, resulting from hemodynamic changes associated with failing heart pump, are also reviewed and critically discussed.

Key Words: broiler, heart failure, patho-physiology

270 The response of the heart and vasculature to hypoxia, pressure and volume. R. J. Julian*, University of Guelph, Guelph, ON, Canada.

Heart muscle is very sensitive to hypoxic damage. Mild generalized lack of oxygen or other pathology may result in death of individual cardiac myocytes. As the heart wall muscle thins the ventricle wall dilates, the myocytes lengthen and the chamber enlarges. This heart structural response is described as dilatotomy cardiomyopathy. This response occurs in spontaneous turkey cardiomyopathy and in furazolidone toxicity. The heart muscle response to increased pulmonary or systemic blood pressure (increased workload) is hypertrophy of cardiac myocytes by adding sarcomeres in parallel to make myocytes and the ventricular wall thicker. This response can be seen in the right ventricular wall in pulmonary hypertension syndrome in broiler chickens and in the left ventricle in sudden death in turkeys. The response to reduced pressure is atrophy with the individual myocytes and the ventricular wall become thinner as occurs in the left ventricular wall in broilers in chronic right ventricular failure. The response to increased blood volume is enlargement of the heart because of enlargement of the chambers by myocytes becoming longer as sarcomeres are added in sequence. This may have a physiologic or pathologic etiology. The pulmonary arterioles are not sensitive to local hypoxia but air capillary hypoxia causes immediate contraction of pulmonary arterioles that may result in pulmonary hypertension and increased pressure in the pulmonary arteries and right ventricle. Increased blood volume through the pulmonary arteries and blood capillaries may also cause pulmonary hypertension as may high blood viscosity, or lung pathology reducing vascular space. The response of pulmonary arterioles to increased pressure is hypertrophy of the myocytes of the arteriolar wall with thickening of the wall and a reduction in lumen size. This structural change further increases pulmonary arteriolar pressure resulting in increased pressure in the right ventricle which if sustained results in right ventricular failure. Hypertension in other arteries may cause fibromuscular dysplasia of the artery wall or necrosis with rupture of the artery. These responses will be described and illustrated.

Key Words: heart, vasculature, pathophysiology

271 Metabolic and cardiovascular diseases in poultry: Role of dietary fat. G. Cherian*, Oregon State University, Corvallis.

Due to progress and advances in genetic selection, the modern day commercial broiler chicken has a fast growth rate, high feed conversion ratio and metabolic rate. These features also predispose broiler birds to metabolic diseases such as pulmonary hypertension syndrome, cardiac arrhythmias and sudden death, with a mortality rate over 5%. Despite the high economic loss to the industry, very little research effort has been directed toward investigating the role of dietary fatty acids in minimizing the risk of metabolic diseases in broiler chickens. In the US, supplemental dietary fat provided as an animal-vegetable blend...
Historical perspective on the development of poultry welfare. A. J. Pescatore*, University of Kentucky, Lexington.

Domestic animals are dependent on man for their existence and their well being. Well being is the satisfaction of basic physical needs and the encouragement of necessary behaviors. Societal involvement in welfare began in the 1860’s as local societies for the prevention of cruelty to animals were being created to prevent the abuse of horses, this continued with the passage of the 28-hour law in 1873 which required animals to have feed, water and rest every 28 hours. In 1926 the transportation of poultry was addressed when shippers agreed to uniform coops and standards. This was an era that centered on protection of the birds from the elements. This was also a time for documenting many disease conditions. Pullorum Disease and protozoan diseases were major concerns in the 1930’s. Many great nutritional discoveries were made at this time. The post WWII era saw the movement of birds into poultry houses. Space allocation, heat stress and cannibalism were welfare topics. The 1950’s saw the refinement of the housing systems. Social aggression was a concern with numerous prevention strategies including tranquilizers. In 1958 the Humane Slaughter Act took effect and even though it did not apply to poultry it encouraged research on the humane slaughter of poultry. The understanding of the interaction of stress and disease began in the 1960’s. This was the time that pharmaceuticals had a role in poultry welfare. The next decade introduced social indexes and multi focus studies. Blood parameters became a common measure of well being. The late 1970’s saw the emergence of metabolic diseases as welfare issues. In the 1980’s there was more emphasis on social rank and stressors and less emphasis on productivity. Measures of welfare involved the interaction of behavior with physiology and immunity. The late 1980’s and 1990’s enter an era of increase emphasis on behavior especially the fear response. Alternative systems for housing and processing were topics of concern. Cellular immunity was used as an indicator of stress. In the current decade consumer pressure and independent audits characterize current trends.

Key Words: poultry welfare, animal well-being


Two views are broadly accepted in developed societies which have made animal care guidelines inevitable. These are that domestic animals are sentient, and that humans are responsible to ensure the proper care of domestic animals. Despite these common views, people, having differing moral understandings of the human-animal relationship, are sharply divided over how these views should be applied to domestic animal care. Animal care guidelines have been developed in different nations at several organizational levels to represent a compromise that is acceptable to a majority of people. These organizational levels include individual poultry companies, national poultry associations, individual customers of the poultry industry, national associations of customer companies, national governments, and international organizations. Animal care guideline development has typically included input from producers and scientists, and depending on the sponsoring organization, animal advocates and government representatives as well. Animal advocacy groups have also sought to influence domestic animal care by campaigning against animal production practices, or by offering their preferred guidelines for poultry companies to adopt in the hope that the endorsement of the welfare group would add value to the product. Originally, animal care guidelines were only recommended, with little or no requirement for compliance. In recent years, the need for retail companies to assure certain welfare standards has led to animal welfare auditing of poultry facilities. Animal care guidelines primarily have sought to establish standards for handling and husbandry in existing production systems. Future guidelines may call for adoption of alternative management practices or housing systems based on the combined assessment of welfare improvement, feasibility and market access. International animal care guidelines are now being developed on two levels, i.e., among national governments to create a common standard for trade in animal products, and within international retail companies to create company-wide animal care standards. These initiatives may eventually unify animal care standards world-wide.

Key Words: animal care guidelines, poultry welfare

A non-cage housing system is one that allows caretakers to walk inside the system. From a poultry welfare perspective, significant features of non-cage versus cage systems include sturdier flooring, larger group size, increased enclosure space, and greater structural complexity. Flooring sturdy enough to support people carries a risk of increased exposure to pathogens, ammonia and dust but, when covered by litter, reduces the risk of leg deformities and breast blisters in heavy birds, and facilitates foraging and dust bathing behavior. Large group size may benefit a majority of flock members by lowering aggression, providing a perception of security in numbers, and increasing opportunities to find resources through social learning, but at a cost of increased disturbance while resting, an increased risk of hysteria, and, unless birds are beak trimmed or of a non-cannibalistic strain, a greater risk of cannibalism. Increased enclosure space reduces plumage wear and enables greater movement, promoting bone strength and reducing the risk of fractures when handled. Greater structural complexity can increase the risk of fractures and bruises due to collisions and falls but also provides birds with refuge from perceived danger. Given the diversity of non-cage systems, the dichotomy between cage and non-cage systems has been over-emphasized in debates over poultry welfare. Welfare can be very good or very poor in non-cage systems and is strongly influenced by early rearing conditions, specific housing design features, genetic selection, and management factors. The available evidence suggests that, although there are risks to poultry welfare when managing large groups in non-cage systems, these risks are balanced to varying degrees by environmental enrichment effects that enhance the ability of poultry to cope with challenges.

Key Words: animal welfare, housing, environmental enrichment


The molting of commercial layers has been under increased scrutiny by animal rights groups who have said that this practice is highly stressful, and one which negatively affects the welfare of the hen due to the initial period of fasting that has been used to stop egg production. In recent years, there has been a recognized need to develop practical alternatives to molting layers other than the use of fasting. Thus, the Univ. of IL (IL), Univ. of NE (NE), NC State Univ. (NC), and Univ. of CA (CA) have all researched this area. In the IL, NE, NC, and CA studies, the methods involved comparing a normal fasting method (i.e., 5 to 13 d), to feeding low energy/protein diets using ingredients such as wheat middlings, soybean hulls, and corn, or diets with graded levels of added salt and without salt (NE, CA). The molt period (28 d) included full-feeding these diets. In these studies, post-molt production performance for the non-feed withdrawal techniques was comparable to the fasting method. Several researchers have also evaluated the behavioral repertoire of laying hens which includes feeding, drinking, comfort, social, reproductive, and anti-predator behaviors. In addition, related behaviors such as aggression, escape/avoidance, and submission have been of particular interest as potential indicators of welfare during molting. In these studies, genetic selection, strain, density, or molt program do not appear to adversely influence the behavioral patterns during the molt. The behavior patterns displayed during a molt program appear consistent with the response to physiological changes that layers experience and did not appear to compromise the welfare status of the hens. Appetitive behaviors were not affected by strain, but were affected by production phase and molting. Strain or production phase did not influence the frequency of aggressive and submissive acts. Thus, the use of alternative non-feed withdrawal molting methods, provide comparable laying hen well-being and may enhance the transition from a productive to a resting state.

Key Words: molting, laying hens, behavior

276 Density allowances for broilers, turkeys and layers: Where to set the limits? I. Estevez*, University of Maryland, College Park.

Stocking density has critical implications for the poultry industry as higher returns can be obtained as number of birds per space unit increases. Assigned densities have been primarily driven by cost-benefit analysis, but economic profit may come at the cost of reduced bird performance, health and welfare if the system is overly forced. These negative effects have raised consumers’ concerns regarding maximum density, and are now included in most poultry welfare guidelines. The question is what should be the maximum density that will insure welfare while still allowing a profitable production? And, can we scientifically establish what this number should be? We can determine the extremes with no difficulty, but there is a whole spectrum of conditions that are more difficult to determine. This is so because the effects of density are not in simple linear relation to the number of birds. Factors such as management practices, environmental control, or quality of bird care has been proven to have major effects on poultry health and welfare. We should take a more imaginative look at the issue of density. In some instances it may be that, all things considered, maintaining high densities it may not be as profitable for industry as initially thought, especially as new environmental regulations come into play. For broilers, turkeys and ducks we use a bi-dimensional space while heat, cool and ventilate in three dimensions. A better environmental design may allow birds to use this third dimension, allowing increasing floor densities while improving welfare. It would also make more sense to base density on a ‘range’ rather than on a fixed number, so that farmers can keep higher or lower densities depending on their welfare scores. This approach would not only work as an incentive to good care with subsequent benefits to the birds but also may result in a more positive attitude towards welfare issues by industry. For caged layers the situation is different because they do not normally have enough available space to perform most basic behaviors. Based on research a minimum of 750cm² should be allowed to meet this requirement. Can industry be up to this challenge?

Key Words: densities, welfare, performance
S-P212  Effect of two commercial competitive exclusion probiotics on *Salmonella enterica* serovar *enteritidis* infection of Leghorn chicks. M.A. Juarez-Estrada*, L. Gonzalez-Soto, and R. Merino-Guzman, Department of Animal Production: Poultry; FMVZ-UNAM., Mexico, D.F. Mexico.

A trial was developed in order to evaluate one defined competitive exclusion probiotic (DCEP) and one non-defined competitive exclusion probiotic (NDCEP) on *Salmonella enterica* serovar *enteritidis* phagotype 13a (SE PT13a) infection. One-day-old Leghorn chicks were reared in electrical batteries. Four groups and 6 replicates of 20 birds each one (n=240) were used in two challenge times. Experimental groups were: A) Negative control, B) DCEP (Broilact®) 1 mg at first day, C) NDCEP (Aviguard®) 12.5 mg at first day, D) Positive Control. Groups B, C and D were SE PT13a (1x10^8 UFC/bird) challenged at 11 and 19 days. On 12 and 20 days, 60 birds from every challenged groups were euthanized. SE PT13a was recovered from liver-spleen (LS), and cecal tonsils (CT) from each chick. At 20 days, group B showed up 21.7% of SE PT13a from LS, lower (P<0.05) than group D (51.7%). Group C (36.7%) was not different to B or D treatments. There were no differences in recovery rates from CT at either, 12 or 20 days. Group A was always negative to *Salmonella* isolation. Although, there was not difference in LS protection level between DCEP or NDCEP groups, DCEP showed up a more solid protection. Intestinal native microbiota from DCEP took almost three weeks in settling down into the chickens gun, thus, its protection effects were delayed, since they were observed until 20 day of age. In order to get an effective protection level from DCEP against early *Salmonella* infection, it should be tested the effect of a booster DCEP treatment in chicks from one to twenty days old.

**Key Words:** probiotics, *Salmonella* control, Leghorn chicks, layer farm, fertile eggs


In order to evaluate a defined competitive exclusion product (DCEP) with only one per os treatment at one-day-old or a drinking water booster treatment, was carried out one experiment. At first was divided into three groups with 28 birds each and three replicates by group. Group A) At first day DCEP (1 mg/bird Broilact®) was gave per os, 28 birds were challenged with *Salmonella enterica* serovar *enteritidis* fagotype 13A (SE PT13A) (1 x 10^8 CFU/bird) each time at 7, 13 and 23 days of age; B) At first day chicks received DCEP, it was boosted by drinking water (1 mg/bird Broilact®) at 6, 12 and 22 days of age, 24 hours after every booster treatment 28 birds were challenged with SE PT13A; C) At first day of age birds received PBS, they were challenged per os with SE PT13A at the same time like groups A and B. All birds were euthanized 24 hours after every challenge. SE PT13A was recovered from liver, spleen (LS) and cecal tonsils (CT). At 14 days of age SE PT13A isolates from group B (LS 4.5% and CT 22.7%) were lower (P<0.05) than group D (LS 34.6% and CT 96.1%); and group A (LS 17.2% and CT 62.0%) respectively. With only 28 birds by treatment, group A was not different to B or C treatments. At 8 and 24 days there were not differences between groups. The booster treatment was better than only one DCEP dose, however, booster treatment with DCEP delayed to diminish SE PT13A infection from LS and CT, until the last of the second week. Prophylactic treatment with defined competitive exclusion products would be a good biological skill toward *Salmonella* infection in Layer farms.

**Key Words:** probiotics, booster treatment, *Salmonella* control, breeder hens, Leghorn chicks
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