# ABSTRACTS

## 2009 Poultry Science Association

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Keynote Symposium: Tomorrow’s Poultry: Genomics, Physiology, and Well-Being

1 Breeding of tomorrow’s chickens to improve well-being. H. W. Cheng*, Livestock Behavior Research Unit, USDA-ARS, West Lafayette, IN.

Change is defined as ‘becoming different’ or ‘modification’. Our world (natural environment) is continuously changing. In nature, the changing environment constantly puts selection pressure on animals for survival and reproduction (natural selection). Animals have the ability to change their behavior and physiology (plasticity) based on the costs and benefits in order to ‘fit’ the changing environment (adaptation). Through natural selection, the population preserves and accumulates traits that are beneficial and rejects those that are bad in their prevailing environments. The surviving populations are able to contribute more genes associated with traits for increased fitness to subsequent generations. Natural selection is slow but constant; accumulating over multiple generations, and generally the animals’ change is silent and/or undetectable at a given point in history. Chickens were domesticated from the wild red jungle fowl. The principle of domestication of animals by humans is similar to that of natural selection: selecting the best animals with the highest survivability and reproducibility (artificial selection). Compared to natural selection, the process of artificial selection is motivated by human needs and acts more rapidly with more visible results over a short time period. This process has been further accelerated following the development of current breeding programs and the emergence of specialized breeding companies. A laying hen, for example, produces more than 300 hundred eggs a year, whereas a jungle fowl lays 4-6 eggs in a year. During the domestication process, chickens retained their capability to adapt to their housing environment, which is usually achieved by genetic changes occurring during each generation and over generations. Genes control animals’ physiological, immunological, and psychological responses to stressors, including environmental stimulation. Genetic improvement of chickens will speed up breeding programs and has the potential to be used very successfully in selecting animals with high production efficiency and optimal welfare, resulting from resistance to stress, disease or both.

Key Words: chickens, breeding, selection, adaptation, well-being

2 Why using genetics to address welfare may not be a good idea. P. B. Thompson*, Michigan State University, East Lansing.

Welfare of animals in livestock production systems is now widely defined in terms of three classes of measures: veterinary health, mental well-being (or feelings) and natural behaviors. Several well documented points of tension exist among welfare indicators in these three classes. Strategies that aim to improve welfare using genetics can increase resistance to disease, and may also be able to relieve stress or injury. One strategy is to reduce the bird’s genetic proclivity to engage in behaviors that are frustrated in modern production systems. Another is to develop strains less prone to behaviors hurtful to other hens. Yet another is to make overall temperament a goal for genetic adjustments. These genetic approaches may score well in terms of veterinary and psychological well-being. Yet they also involve changes in behavioral repertoire and tendencies of the resulting bird. While it has seemed reasonable to argue that such animals are better off than frustrated or injured animals reflecting more species typical behaviors, there is a point of view which holds that modification of a species typical trait is ipso facto a decline in the animal’s well-being. What is more, a significant amount of anecdotal evidence has been accumulated which suggests that many animal advocates and members of the public find manipulation of genetics to be an ethically unacceptable approach to animal welfare, especially when modifications in the environment could also be a response to welfare problems. Hence, though promising from one perspective, genetic strategies to improve welfare may not be acceptable to the public.

Key Words: animal welfare, public acceptability


Primary breeders are well aware that selecting for better health and welfare along with economic traits such as faster growth rate, higher levels of meat yield and improved efficiency of feed utilization are critical to balanced long term genetic progress of their pedigree pure
lines as well as to increased production efficiency of broiler products for the broiler industry. Cobb collects and selects on over 50 phenotypic observations per pedigree candidate at various ages. Over one half of these collections are more or less an evaluation of birds’ health, welfare and fitness. Some examples of these traits are: various chick defects, various broiler age skeletal and leg abnormalities, feather cover, various physiological measures of heart and lung functions and various causes of mortality. Large pedigree populations, massive data collection infrastructure, integration of better technolo- gies in evaluation of phenotypes and sophisticated data analysis capability have allowed geneticists to perform selections that are balanced for both economic and welfare traits. Cobb’s internal as well as world-wide sponsored research has facilitated geneticists to make science based breeding decisions. Each pedigree line, per product available to primary breeders, exhibits its own unique characteristics that are enhanced by selective breeding and positioned in special mating schemes to produce the product and welfare performance that our customers demand. Additionally, most if not all primary breeding companies now offer different products for different markets which exhibit varying levels of performance and behavior to fit customer needs. Future expansion of these products and creation of new products by breeding companies will be in large dictated by both our customers and consumers.

Key Words: broiler breeding, balanced selections, broiler welfare, sustained genetic progress

4 Genomics, physiology, and well-being: Layer industry breeder’s perspective. N. P. O’Sullivan*, Hy-Line International, Dallas Center, IA.

The egg industry has been challenged by production system changes over the previous 75 years. Starting with extensive floor production systems, moving to adoption of cages, and returning, first in EU, followed by N. Am., with increases in use of enriched colony cages and floor and aviary systems. Thus a moving selection environment for breeders. Selection continues to evolve to meet systems of production needs. Selection of laying hen lines, have included evaluation of both purelines and crossbred daughters, the latter under group housing to amass data for egg production, sexual maturity, livability (in rearing, and adults), egg weight curve, and egg quality traits (shell strength, shell color, albumen height, and freedom from interior and exterior defects), adults body weight, feed efficiency, feather cover, and dry manure. In addition group evaluation, of livability without beak treatment and of nest laying behavior were adopted. All group evaluation is done with either full or half sibling groups. Genomics has been applied for simple single gene traits, such as MHC B bloodgroups, fast and slow feathering, recessive and dominant white, FMO3 mutant elimination have all become routine in breeding programs. More advanced use of validated markers for additive traits have improved with better marker density of Marek’s disease alleles and complex curve traits like the egg weight curve with markers which differ between different points of the egg weight curve. Whole genome selection testing is currently being evaluated in Hy-Line lines with SNP panel developed for this specific purpose. While this technique is currently under experimental review, if it proves practical, feasible, and more effective than current industry practices, we will see a paradigm shift in laying hen breeding in the next five years. The results could yield a halving of generation interval, in addition to improved identification of males to select within full sibling families.

Key Words: laying hen genetics, selection traits, group selection, laying hen genomics, whole genome selection

5 Profitable turkey production and animal welfare are not mutually exclusive and can be selected for simultaneously. B. J. Wood*, Hybrid Turkeys, Kitchener, ON, Canada.

The aim of primary breeding companies focuses on maximising profitability for end users of their product. Consequently, selection pressure has been placed on traits such as growth rate, feed conversion and carcass yield that have an influence on profitability. Maximising profit does not necessarily mean that welfare is forgone, as the two are often positively correlated. When welfare and profitability are closely linked, consideration should be given to the balance between them as improving welfare can then improve profitability. For example, improving livability decreases the financial loss incurred by feeding and housing birds that fail to achieve market age. Placing appropriate selection pressure on liveability improves both the returns and the welfare indicator. Other measures of welfare, like footpad score and behaviour, are not as easily linked so calculating a value relative to other traits is more difficult. There are observable differences in both litter wetness (correlated with footpad lesions) and behaviour in both pure-line and commercial crosses indicating the traits have a genetic basis and could therefore be used as selection criteria. Welfare indicators such as liveability and footpad scores can also be affected by management factors like growing density. Increasing floor space can improve both liveability and footpad scores but fixed costs are then allocated across fewer birds which may lower the profit margin per unit. Decreasing the allowable density has been used to penalise producers with measurably poorer welfare. Conversely, producers with better welfare scores may be given the opportunity to increase bird density and hopefully subsequent profitability. From a primary breeding standpoint, the rearing environment for pure line candidates should simulate the highest densities that their commercial progeny would likely experience. This effectively decreases the likelihood of a genotype x environment (GxE) interaction. These GxE interactions may occur when progeny are grown at a higher density compared with the selection environment.

Key Words: turkeys, welfare, foot pads, mortality, liveability

6 Animal welfare and the future of poultry genetics. S. Avenida*, and D. A. Emmerson*, Aviagen Ltd., Edinburgh, United King- dom, 2Aviagen Inc., Huntsville, AL.

Welfare related traits such as leg and skeletal defects and metabolic disorders have long been important to primary breeders. These traits represent a challenge to breeders based on their relatively low heritabilities and unfavorable genetic correlations with broiler traits. Aviagen has included welfare related traits in breeding goals since the early 1990s making the improvement of both skeletal and metabolic traits its trademark. An inherent challenge to the introduction of welfare related traits into breeding goals is the actual definition of welfare. This can vary depending on the specific market, legal considerations and social perceptions and can be as specific as any trait compromising livability or as broad as any aspect related to bird well-being. In a global market where live performance of broiler products must be increasingly expressed in compromised environments, improvement of welfare will have a direct impact on profitability through their relationship with livability. Breed- ers record data on dozens of characteristics and have the opportunity to select for multiple traits in a balanced manner. Advanced statistical methods, including novel genomics information, can then be applied to provide accurate prediction of breeding values for both performance and welfare related traits. Medical technologies provide tools to dissect complex and lowly heritable welfare traits into more heritable compo- nents and to target underlying physiological systems. Alteration of the
Selection environment welfare can also be an important strategy to allow more effective selection for welfare by increasing trait heritabilities. Although genetic selection for improved welfare characteristics inevitably requires compromise and a delicate balance with other traits under selection, it is possible to improve welfare traits and economic performance simultaneously. As an industry it will be important to determine the optimal balance between genetic and non-genetic strategies to most effectively address welfare considerations.

**Key Words:** genetics, welfare, breeding objectives

### 7 The European experience in poultry welfare: A decade ahead.
C. Beaumont*1, S. Mignon-Grasteau1, and C. Leterrier2, 1INRA, Unité de Recherches Avicoles, Tours, Nouzilly, France, 2INRA, Unité Physiologie de la Reproduction et des comportements, Tours, Nouzilly, France.

Farm animal welfare is a major issue in Europe, and has resulted in regulations and development of research dedicated to animal welfare, especially on standard poultry production which is often considered as resulting in a very poor welfare. The effect of selection is also often questioned. Indeed, capacities of adaptation have been very little considered during the first years of commercial selection and thus reduced. But nowadays, a much greater importance is given to welfare related traits and genomic selection should alleviate the need for their measurements in the short term. However the choice of the fittest selection criteria is still to be made. Since behavioural traits are highly dependant on environment, general propensity may be more efficient. For example, selection against undesirable behaviour such as feather peaking has been proven to be efficient (Kjaer and Sorensen, 1997) but selection for reduced mortality rates in collective cages proved to be preferable (Craig and Muir, 1996). The direction of selection is also to be considered: while social motivation appears to be important in large scale flocks, increasing it to a too large extent results in increased aggressivity (Richard et al., 2008). Moreover, a general propensity will not result in overall improvement: for example, while duration of tonic immobility is a general measure of fearfulness, selection on it does not modify response to social stress (Mills et al., 1993). Detrimental effects on other traits may also be observed: while genetic resistance to diseases should increase animal welfare, it may also result in increased frequency of silent carriers and in turn to human transmission. Studying lines selected for or against these traits will be of great help to choose the best strategy of selection. Another and longer term concern should be on links with other production traits but also on sustainability which will probably be of greater importance in the coming years.

**Key Words:** poultry, welfare, genetics, genomics, Europe

### 8 Molecular, neuroendocrine events during stress in poultry.
W. J. Kuenzel* and A. Jurkevich, University of Arkansas, Fayetteville.

Over the past several years, two assays continue to be utilized as indicators of stress levels in poultry and objective markers of poultry welfare: the heterophil to lymphocyte ratio and plasma levels of corticosterone (CORT). The purpose of this review is to focus upon the second measure of stress to provide an understanding of how the neuroendocrine system responds to stress to regulate blood levels of CORT. Two key groups of neurons, corticotropin releasing hormone (CRH) and arginine vasotocin (AVT) project to the median eminence and are responsible for releasing the two neuropeptides into the portal system that bind to receptors found on corticotropes in the anterior pituitary to release ACTH. Two major receptor types, CRH-R1 and VT2-R, have been found co-localized in the cell membrane of corticotropes. When the two peptides are injected centrally, each is able to stimulate release of CORT from the adrenal gland, however, concurrent administration does not result in significant increases in the stress hormone. In contrast, simultaneous, peripheral administration of the two neurohormones results in a synergistic increase in plasma CORT. Each of the two receptor types has a different signal transduction pathway and the one associated with the CRH-R1 (involves the second messenger cAMP) shows a greater than doubling of its release with co-administration of the two peptides in cell cultures transfected with both receptor types. It is hypothesized the two receptors, CRH-R1 and VT2R form functional complexes, heterodimers, that are responsible for augmenting the intracellular signal transduction mechanism. To date is unknown whether acute or chronic stress results in augmenting intracellular signals. Data suggest the need to find another marker; e.g. cytokines, in the blood indicative of second messenger activation to complement standard plasma determinations of CORT to serve, perhaps, as a better combined measure of stress levels in birds. 

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**Key Words:** CRH, AVT, corticosterone

### 9 Understanding stress-induced immunosuppression: Exploration of cytokine and chemokine gene profiles in chicken peripheral leukocytes.
S. Shini*1, G. R. Huff2, and P. Kaiser3, 1University of Queensland, Gatton, QLD, Australia, 2USDA-ARS, University of Arkansas, Fayetteville, 3Institute for Animal Health, Compton, Berkshire, United Kingdom.

At present, the poultry industry has gained a lot of ground, being viewed as providing a healthy alternative to red meat. If this trend is to be maintained, solutions must be found to improve chickens’ resistance to disease, which often is weakened by stressful conditions. In poultry, stress-induced immunosuppression (IS) is manifested with failures in vaccination and increased morbidity and mortality of flocks. The use of cellular and molecular markers of immunity could help to assess IS and improve stress-minimizing strategies. The full complement of cytokines and chemokines in the chicken genome has been recently characterised. Using quantitative reverse transcriptase-polymerase chain reaction (qRT-PCR) assays, a broad spectrum of avian cytokines and chemokines can be quantified in birds and then be used to examine the effects of stress on chicken immune competence. We are investigating immune and endocrine interactions in the chicken, in particular the cells and molecules of the immune response known to be involved in such interactions in mammals. We have evaluated the effects of stress, mimicked by administration of corticosterone (CORT) on peripheral lymphocyte and heterophil cytokine and chemokine gene profiles. In particular, there seem to be effects on cytokine and chemokine mRNA expression levels from both lymphocytes and heterophils, especially with expression of proinflammatory interleukin (IL)-1β, IL-6, and IL-18, and chemokines CCL2, CCL5, CCL16 and CXCL1 initially being upregulated, and potentially modulating the adaptive immune response. Chronic treatment with CORT downregulates proinflammatory cytokines and chemokines suggesting that the delayed effects of chronic stress can hamper immune response. Gene expression levels of TGF-β4 are also upregulated. It appears that the balance between Th1 and Th2/Treg cytokine production is altered in conditions associated with significant changes in CORT concentration. Experiments are underway to decipher the cytokine and chemokine responses to vaccination and bacterial challenge on the background of IS.

**Key Words:** stress, immunosuppression, cytokine, chemokine, gene expression
Genetics and genomic approaches to address both breeding and management issues of poultry well-being. W. M. Muir* and T. Nguyen, Purdue University, West Lafayette, IN.

Classical genetics and genomics can both be utilized to improve productivity. However, if applied to the wrong unit of selection (the individual), well-being can be compromised due to social interactions, while if applied at the production level unit (cage or pen), well-being will always be improved. For non socially induced issues, such as leg problems, direction selection is necessary; unfortunately such traits usually have low heritabilities and are difficult to quantify. Whole genome selection shows great promise to address these types of problems, both by increasing the accuracy of selection and by reducing the need to phenotype candidates. Unresolved issues are 1) how to quantify well-being and 2) which management practices necessarily compromise well-being. All physiological responses to the environment are mediated by genes interacting with other genes and/or environmental inputs. These interactions occur first at the RNA level, which are then translated into structural or regulatory proteins. Physiological quantification of well-being has usually occurred at the protein level or higher. But not all proteins can or have been quantified. An alternative is to quantify and profile the transcriptome through cDNA re-sequencing or microarrays. Quantifying the transcriptome profile in known conditions, or among questionable conditions, followed by supervised or unsupervised clustering respectively, and discriminant analysis, allows a scientific approach to combine or classify like management practices into states of well-being and thus offers a holistic metric for comparison. Finally, the physiological mechanisms that change as a result of genetic selection that impact well-being are not well understood. Again functional genomics comparing response of all genes in the transcriptome followed by gene ontology and path analysis allows us to uncover previously unsuspected mechanisms, which can in turn be used to modify management to address those mechanisms. Both genomic selection and functional genomics approaches to address well-being are a direct result of sequencing the poultry genome.

Key Words: classification, welfare, breeding, stress, behavior

Modification of animals versus modification of the production environment to meet welfare needs. S. E. Aggrey*, University of Georgia, Athens.

The balance between genetic modification and welfare may be as old as “the chicken and egg debate”. Meeting welfare needs of farm animals has become an integral part of animal agriculture. Until recently, environmental and management modifications have been the methods of choice for meeting welfare needs of animals. While genetic selection over the past 50 years has improved growth, livability and general welfare, some aspects of welfare like metabolic disorders, susceptibility to some diseases and skeletal problems have increased. Several reports have demonstrated genetic variability in behavioral and physiological traits relating to welfare thus raising the possibility of selecting for welfare-related traits. Recent advances in molecular biology have also made it possible for the identification of quantitative trait loci for behavioral and welfare traits. Identification of causal or associative genes for welfare traits and improved biotechnology tools raises the possibility of either selecting for improved welfare or genetically modifying birds to suit commercial production environments. However, animal welfare is not only a scientific or commercial producers concern but public acceptance is equally important. Therefore, an integration of management, genetics and genome tools should be employed to genetically improve production and welfare traits with concurrent welfare risk assessments to address public and consumer concerns.

Key Words: welfare, genetic modification, environmental modification, selection, genomics


The activities and observations of the author are reported. The 2009 Extension Special Recognition Award is presented to Jacquie Jacob, University of Kentucky, for her sustained, significant contributions to the PSA National Extension Workshop, National Poultry Waste Management Symposium, other extension programming, and the American Poultry Historical Society. The National Institute of Food and Agriculture has replaced the Cooperative State Research, Education and Extension Service, and the Agriculture and Food Research Initiative has replaced the National Research Initiative. Progress is being made in multi-state research committees: the Agricultural Bioethics (NCCC209) web site will facilitate writing collaborative papers on bioethics, and animal welfare or well-being (more participates are welcome); NE1022 is being rewritten as NEtemp1561, Optimization of Poultry Welfare and Production Systems for the 21st Century. Portfolio reviews are yearly (Knowledge Area (KA) 306, Environmental Stress in Animals; KA308, Improved Animal Products (Before Harvest); KA315, Animal Welfare), with a five year summary review due in 2009. The 2009 Southern Region (Quadrennial) Poultry Extension Workshop, will be in Raleigh, NC, November 9 - 12 (contact Ken Anderson for details). Proceedings are available for the 2008 National Poultry Waste Management Symposium. Edgar Oviedo (NC) will coordinate the 2010 symposium. The 2008 Future Trends in Animal Agriculture symposium provided a neutral and balanced forum for positive dialogue on animal welfare (AW) issues. The annual Animal Welfare Assessment Contest for students at Land Grant and other universities, held at Michigan State University, now includes components for veterinary students and for graduate students. The contest helps train students in AW and animal behavior areas, and emphasizes the importance of collaboration between disciplines and commodities to address AW issues. Bioethics are simply ethics as applied to biological systems, and are thus important in discussions of AW and animal rights issues. Discussions of bioethics help us understand value-driven societal perspectives, and restrictions or imperatives of animal use.

Key Words: Recognition Award, bioethics, animal welfare, assessment contest, extension workshop
13 **Improving broiler industry and university collaboration.** H. M. Engster*, Perdue Farms, Inc., Salisbury, MD.

Progress made in the broiler industry in the last 50 years has been nothing short of amazing. Much of this progress can be attributed to the implementation by the industry of both basic and applied research in genetics, management, nutrition and health of the modern day broiler. This has taken students trained by universities, research conducted at universities and extension outreach to assist in the implementation of practical research. The need for well-trained expertise will only increase going forward. However, additional areas of focus will be needed in food safety, poultry welfare and behavior, environmental impact, meat quality and genomics in addition to the traditional performance metrics of weight gain, feed conversion and breast meat yield. Collaboration between industry and academia will be necessary for continued advancement, and could include permanent broiler industry advisory boards at universities and consistent participation of broiler industry professionals as invited college and graduate level lectors. University professors and students need to continually be invited to tour industry facilities to ensure that their knowledge of industry practices is current and their research is relevant. Real-world solutions will be needed to meet the ever-increasing consumer needs beyond a quality product at a competitive price. A balance will need to be struck between industry and universities regarding the true value of proprietary intellectual property, its ownership and use. The increasing need for transparency in the industry will demand more detailed questions being answered about how our food is grown.

**Key Words:** broiler industry, university, collaboration

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14 **University and turkey industry collaboration.** G. Engelke*, Cornerstone Resources LLC, New Brighton, MN.

There are many words that describe the current relationships of the university system and the turkey industry. However, there are potentially few words to describe what the future will hold, those being: united we stand, divided we fall. The potential of how the turkey industry can fulfill the global needs for customer desired products is only limited by the boundaries that we place. First and foremost is that we need access to the best student talent. We cannot allow other disciplines to out maneuver us in signing the top students into our poultry science and animal science departments. To get these students, we need our most talented educators teaching and interacting with undergraduate and graduate students. For this to be accomplished, the system must provide the proper credit in evaluations for this critically important function. To achieve enhanced efficiencies in production, there needs to be greater focus on the horizon for two to three research projects in a combined discovery process of university and private enterprise. This needs to be supported through a combination of government funding and industry support. The ownership of these technologies will need to be shared through equitable means. The deployment of best management practices and learning need to be a shared process between industry, allied industry, and university. Not all areas can and should be treated the same. There will need to be a realignment of resources that match the value that will be derived. The extension service cannot continue to serve two masters.

**Key Words:** university, industry, teaching, research, extension

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15 **What is needed to improve university and industry collaboration: Comments from one egg industry representative.** H. R. Ball*, Michael Foods, Inc., Minnetonka, MN.

Land Grant Universities (LGU) have a rich history of providing education, outreach, and research that enabled development of a highly productive, very technical, and efficient food production system in the United States. Early history shows close relationships between LGU and the agricultural community generating a large support base for the LGU. However, as rural demographics changed and modern agriculture/food systems have evolved to large regional/national based industries, the base of support for LGU agriculture departments has decreased. There is strong competition for federal and state support. Consequently, industry funding of research is critical for leveraging of long-term public support of LGU. In general, states with strong poultry industry segments have been able to maintain LGU departments with significant poultry focus. However those departments are, by structure and knowledge-base, capable of providing only a portion of the technically trained employees, outreach, and research needs required by poultry industries. Future collaboration between LGU and industry may of necessity focus on overcoming barriers to development of regional and nationally based centers of excellence with abilities to solicit and fund education and research from a broad range of specialties outside typical poultry-focused LGU departments. Looking ahead, there will also be social and politically driven challenges that may create small, dispersed producers that would benefit from traditional models of support from LGU. LGU agriculture departments will be challenged to maintain appropriate levels of effort and development of future faculty who can work collaboratively to develop and adopt emerging technology that sustains production of safe, economical, and quality food. Industry will need to find appropriate methods of supporting collective as well as proprietary information requirements. Industry associations may be the most appropriate vehicles for general support of federal and state resources as well as direct funding of identified research and training priorities.

**Key Words:** centers of excellence, collaboration, industry associations

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In a normal broiler breeder flock, rate of lay peaks early and then gradually declines and egg quality drops through thinning of the shell and reduced albumen quality. In an investigation of the effects of 3 female broiler breeder target BW profiles on subsequent egg composition and quality attributes was investigated. A total of 216 Ross 708 pullets were reared in floor pens. Birds were individually caged at 16 wk and assigned to a BW profile: STD (Standard BW control), HIGH or LOW (10% higher or lower BW than STD, respectively). Following peak feed at 30 wk, feed declined 3.3 (HIGH), 2.5 (STD) or 2 (LOW) g/wk, on average, until 43 wk of age. Feed then increased 1g/wk, on average, to 50 wk of age. Individual egg production records were kept, and egg composition and quality (% shell, shell thickness, albumen height, specific gravity) determined at 5 wk intervals from 30 wk of age.

At 60 wk of age, BW was 3.93 (HIGH), 3.59 (STD) and 3.26 (LOW) kg. Ovary weight of LOW hens was 16.2% lighter than that of the larger hens and, when combined with the 17 fewer eggs produced, suggested that egg production was inadequately supported by nutrition. While onset of lay was delayed in LOW birds, production declined at a similar rates in all BW profiles. The rate of feed withdrawal caused BW losses in HIGH and STD hens between 36 and 48 wk of age, while LOW hens stayed constant. The % yolk was greater in HIGH than in LOW eggs at 35 and 40 wk of age, but grew similar after this. Shell thickness, % shell and egg specific gravity were all higher in LOW than in HIGH eggs at 30 wk. The % shell measure, while least affected by age, was most affected by BW profile, averaging 8.4% (HIGH) vs. 8.7% from 35 to 40 wk of age. All measures of egg quality dropped between 30 and 40 wk. Shell thickness and egg specific gravity rose again once feed allocations climbed again. Hen BW was less important than feed allocation for egg composition and quality traits, which were negatively affected by rate of feed withdrawal.

Key Words: broiler breeder, growth profile, feed withdrawal, egg traits, shell quality


The effects of 3 female broiler breeder target BW profiles on the growth, sexual maturity, reproductive performance, and carcass characteristics were investigated. A total of 216 Ross 708 pullets were reared in floor pens. Birds were individually caged at 16 wk and assigned to a BW profile: STD (Standard BW control), HIGH or LOW (10% higher or lower BW than STD, respectively) which were first reached by 20 wk of age. Individual sexual maturation age, BW and external carcass traits were measured and egg production (total and small [< 52 g] eggs), laying sequence patterns, fertility and hatchability were determined to 60 wk of age, when all birds were dissected to assess internal traits.

The HIGH target profile birds reached sexual maturity 3.9 d earlier than STD birds and LOW hens began to lay 5.3 d later than STD hens. LOW hens laid 14.1 fewer eggs than STD or HIGH hens, on average (154.1, 168.2, 171.1 eggs, respectively). LOW birds produced more small eggs (11.2) than STD (8.9) or HIGH (7.5) birds and the opposite was true for double yolked eggs (HIGH=0.4%, STD=0.2%, LOW=0.05%). The prime laying sequence length differed among BW profiles (19.0, 16.6, and 9.7 d in HIGH, STD, and LOW hens, respectively). In addition to laying fewer eggs, LOW hens also had lower egg weight and egg mass than STD birds. Despite similar rates of lay in STD and HIGH hens, STD birds were more efficient, consuming 306 g feed/chick compared to 344 g in HIGH hens and 314 g in LOW hens. Target BW profile did not significantly affect hatchability traits. Final chick numbers were 122, 135, and 133 for the LOW, STD, and HIGH birds, respectively. Despite differences in BW at 60 wk of age, birds had a similar proportion of breast muscle. LOW hens had only 3.8 ovarian large yellow follicles at that time compared to 4.2 in both STD and HIGH hens. This study suggests no improvement to production efficiency by shifting the target BW profile 10% higher or lower.

Key Words: broiler breeder, growth profile, sexual maturation, egg production, hatchability

18 Feeding and lighting of male broiler breeders in tropical regions: From experimental research to field experience. H. Romero-Sanchez*1,3, C. Lozano3, and J. Brake4, 1Grupo Grica, Faculty of Agriculture, University of Antioquia AA, Medellín, Colombia, 2Trouw Nutrition Hifeed B.V, Boxmeer, NL, 3Grupo Italcol, Bogota, Colombia, 4North Carolina State University, Department of Poultry Science, Raleigh.

Male broiler breeder management in tropical regions has traditionally followed BW recommendations published in the management guides of the various genetic companies that produce and supply the males. These recommendations have been influenced by experimental research and practical experience under controlled environment conditions in subtropical conditions. Analyses of 40 Hybro and Cobb flocks reared under commercial conditions during the last four years in tropical
areas of Latin America were conducted to determine the effect of two lighting systems during rearing (brown-out house versus open house) as well as different feeding programs and BW profiles on fertility and hatchability. Males reared in open houses tended to reach a higher BW at the onset of the production period and exhibited better fertility and hatchability. Males that received higher crude protein diets in production and/or gained BW more consistently during the production period also exhibited significantly better reproductive performance. Analyses of data suggested that under commercial conditions in tropical Latin America, male broiler breeders performed better in open houses and required heavier BW than that suggested by breeder management guides in order to perform optimally. Therefore, it may be concluded that higher than normal nutrient intakes are required in such environmental circumstances to sustain fertility during the production period.

Key Words: broiler breeder males, rearing, lighting systems

Broiler breeder males reared on a conventional vs. accelerated growth schedule. W. Berry*, S. Oates, L. Stevenson, and J. Hess, Auburn University, Auburn, AL.

Male broiler breeders are reared using feed restriction to control body weight and delay sexual maturation. Earlier maturation of breeder males, involving less feed restriction, may lower feed costs, improve breeder male fitness and welfare, and provide for more flexibility in scheduling. In this study, male breeder chicks reared using a conventional feeding/growth schedule (CON) were compared to males reared in an accelerated maturation group (ACCEL). The ACCEL males were grown on a linear growth line designed to reach the normal 22-week body weight at 16 weeks. Male breeder broiler chicks in both treatments were started on a standard starter diet and full fed for 3 weeks. ACCEL male chicks were started 5 weeks after CON. The birds were placed in 3 replicates containing 14 chicks per rep at 4 weeks of age. Both treatments were then fed 15% protein grower diet for the remainder of the rearing period. The birds received 8 hours light/day during rearing. The birds were transferred to breeder housing, with 22 week-old females, at 22 weeks of age (CON) or 17 weeks of age (ACCEL). Light was increased 0.5 hour/week to a maximum of 16 hours. Birds in both treatments were fed to maintain the same body weight profile from housing until termination of the experiment. Body weight, uniformity, and mortality were monitored throughout the experiment. Skeletal growth and organ weights were measured during the rearing period. Fertility was monitored starting at experiment week 28 and ending at week 60. Mortality was not different between the treatments. Birds in the ACCEL treatment had lower overall body weight uniformity (Body weight CV: CON=11.5, ACCEL=12.1). Life of flock fertility was higher for CON treatments relative to ACCEL. The ACCEL =92.9%). Rearing breeder males on a schedule accelerated by 5 weeks relative to a conventional rearing schedule did not improve body weight uniformity and appears to reduce overall fertility.

Key Words: broiler breeder, male, maturation, uniformity, fertility

Sex-separate versus mixed-sex rearing of broiler breeder males. J. T. Brake*, North Carolina State University, Department of Poultry Science, Raleigh.

Broiler breeder males were reared sex-separate to 5 wk of age and then either mixed with females or reared separately on either a Low or High plane of feeding to 21 wk of age under a standard black-out lighting program. There were 4 pens that held 24 males each for each of the two sex-separate male treatments. In order to avoid confounding, there were 24 males mixed into each of 12 replicate pens of 190 females each at 5 wk of age. At 21 wk the males were removed from 8 pens and replaced with either the High or Low sex-separate reared males. There were 4 mixed-sex pens that remained intact without disturbance. Furthermore, during rearing there were 6 pens of females that each received either a High or Low plane of feed intake. Thus, the experiment was a 3 X 2 completely randomized design. All birds were moved to a two-thirds slat breeder house and photostimulated at 21 wk of age. All birds were fed and managed similarly after 21 wk. Males were fed sex-separate during the production period and eggs were gathered twice daily. There were 180 eggs from each pen set every two weeks for determination of fertility and fertile hatchability. Mortality of males and females were determined daily. BW was determined on a regular basis throughout the growing and production periods. As expected, BW during rearing positively reflected plane of feed intake but no differences persisted during subsequent production. The High sex-separate reared males exhibited improved fertility at the initiation of lay but no cumulative effect was observed. However, females that were mated to sex-separate reared males exhibited an improved consistency of lay compared to females mated to mix-sex reared males. There were no effects on fertile hatchability or mortality of either males or females. These data show that mix-sex and sex-separate rearing of broiler breeder males can be equally successful.

Key Words: broiler breeders, rearing programs, fertility


The reproductive development of 2 meat strains (A and B) of broiler breeder males provided different levels of total feed intake during rearing was evaluated. Strain B is a newly developed parent line that is related to strain A. Six hundred d-old cockerels from each strain were divided among 4 feeding treatments (full fed; and low, standard, and high restricted feed levels) with each treatment and strain housed separately. The low and high feeding treatments were 5-10% above or below strain guidelines. All cockerels were full fed to 3 wk of age, with the 3 feed restricted treatments implemented at 22 d and continued to 20 wk of age. At 21 wk of age 20 cockerels from each feeding treatment and strain were moved to individual cages, photostimulated and fed to maintain target body weight. The remaining birds were maintained in the floor pens with 8 h of light and fed to maintain their target body weights until 28 wk of age. All of the birds were weighed at 7, 11, 15, and 20 wk of age. Testes were collected from 5 cockerels from each feeding treatment and strain at 6, 8, 11, 13, 15, 18, 21, 25, and 28 wk of age. Blood was collected biweekly from 10 randomly selected cockerels in each feeding treatment and strain from 6 to 28 wk of age and from the caged roosters until 40 wk of age. Plasma total testosterone concentrations were determined by RIA. Total testes weight relative to total body weight was greater in the full fed cockerels compared to restricted birds at all measured time points except at 6 wk of age. There were no differences in relative testes weight between any of the feed restricted birds. For the entire rearing period, the overall relative testes size was greater for strain B than strain A. Regardless of the feeding regimen total testosterone concentrations reached detectable levels 2 to 4 wk earlier in strain B than strain A. The caged strain B roosters had a greater concentration of testosterone through 25 wk of age. The ontogeny of detectable plasma testosterone levels was also negatively correlated with total feed intake.
The results suggest that sexual maturation in strain B may occur at a faster rate than strain A.

**Key Words:** testosterone

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**22 Effect of feeder space during growing and feeding to peak program on growth of broiler breeder progeny.** N. Lekrisompong*, M. Arguelles-Ramos, J. Small, E. Oviedo-Rondon, and J. T. Brake, North Carolina State University, Department of Poultry Science, Raleigh.

A study was conducted to determine if there were differences in growth of breeder progeny from two breeder strains (Ross 308 and 708) that had been subjected to two female feeder space allocations (5.3 cm vs 7.1 cm) during the growing period in floor pens followed by two female feeding to peak programs in cages. There were 16 pens of 75 females each assigned to the two feeder space allocations from 1 to 22 wk. At 22 wk, 128 females that represented the middle of the BW distribution in each pen, 8 per pen, were placed in individual cages and subjected to one of two feeding to peak feed increase programs (Slow or Fast) in a 2 x 2 factorial design with 16 pens per interaction cell and 64 pens per main effect. Individual females were weighed at 22 wk and 31 wk. Breeder females from the 708 strain were heavier than those of the 308 strain at both 22 and 31 wk and exhibited the greatest BW increase. Two eggs from each hen were weighed and yolk weight, shell weight, and albumen weight and height determined at 28 wk. The fast feeding to peak program and the 708 strain produced eggs with greater albumen height, while 7.1 cm of growing feeder space and the 308 strain produced eggs with greater percentage eggshell. Eggs produced at 31 wk of age were collected for 5 consecutive days and then incubated and chicks hatched for a broiler trial. Seven male and 7 female broiler chicks were randomly assigned to each of 32 pens in the 2 x 2 x 2 design with 4 replicate pens per interaction cell. Broilers from the 308 strain and the slow feeding to peak program were heavier at 14, 28, and 42 d of age. There was no difference in BW due to growing feeder space but 5.3 cm of breeder female growing feeder space in combination with the slow feed increase to peak program produced the heaviest broilers at 42 d. The lower albumen height of the slow feed increase program may have positively affected embryological development and post-hatch growth.

**Key Words:** broiler breeders, broiler progeny growth, feeding programs

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**23 Effect of genetics, breeder nutrition, and management practices on leg health of broiler progeny.** P. E. Eusebio-Balcazar1,3, E. O. Oviedo-Rondón1, J. T. Brake1, M. J. Wineland1, N. A. Barbosa1,2, C. E. Aker1,3, N. A. Ardón1,3, and H. R. Cutchin Evans1,1 North Carolina State University, Department of Poultry Science, Raleigh, 2Universidade Estadual Paulista - UNESP, Jaboticabal, São Paulo, Brazil, 3Escuela Agrícola Panamericana Zamorano, Tegucigalpa, Honduras.

The objective of this study was to evaluate the effects of broiler breeder nutrition and management on progeny leg health. Broiler breeders of two strains (C vs R) were housed in 16 pens and fed either corn or wheat based diets during rearing and production. During rearing sigmoid late fast (LF) and sigmoid late slow (LS) feeding programs were used. At 23 wk, hens and roosters that represented the BW distribution from each treatment were moved to a cage breeder house and placed at either 1 or 2 hens/cage. At 31 wk, eggs were evaluated for yolk weight, albumen and shell percentages, yolk/albumen (Y:A) ratio, haugh units, egg shape index (SI), egg surface area (ESA), and additional eggs were incubated to obtain egg moisture loss and eggshell conductance (G). Hens were inseminated at 32 wks and eggs were collected for 8 d. The eggs were then incubated and all progeny were identified with neck tags and placed to track individual breeder hen effects. Broiler gait scores (GS) and leg problem incidence were evaluated at 28 and 45 d. Data was analyzed as a 2x2x2 factorial design with strain, diet type, feeding program, and cage space as main factors. Broilers from C strain had a higher (P<0.05) GS 2 incidence at 28 and 45 d. Also, C broilers had a higher (P<0.05) GS 3 and valgus incidence at 45 d. Eggs from breeders fed wheat diets had a higher (P<0.05) Y:A ratio but lower ESA. Eggs from C breeders had lower (P<0.05) Y:A ratio and higher haugh units. C breeders housed in 2 hens/cage laid eggs with the lowest (P<0.001) eggshell G, and their progeny had the highest (P<0.05) incidence of twisted legs at 28 d and highest (P<0.05) GS 3 at 45 d. Although, genetics may play a role in the incidence of leg problems, breeder management and nutrition affect egg traits that may be important in embryo development and affect bone growth post-hatch, and thus the incidence of leg problems and locomotion in broiler progeny.

**Key Words:** broiler breeder, management, nutrition, bone development, leg health

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**24 Predication equation for feed allocation decisions for broiler breeder pullets.** A. Pishnamazi*, M. J. Zuidhof, R. A. Renema, and D. Paul, University of Alberta, Edmonton, AB, Canada.

Determining feed allocation for restricted broiler breeders can be very challenging. Feed must be gradually increased to meet target BW gains without over- and under-compensating, which can lead to mixed messages to the bird’s metabolism. Environmental temperature can also affect feed allocation though altering energy requirements for basal metabolism. A total of 800 Ross 708 pullets were randomly housed in 8 environmental chambers containing 4 pens each (total of 32 pens). Seven, 2-wk temperature treatments were imposed from 4 to 18 wk, with 4 rotating temperature treatments (15, 19, 23, and 27°C) randomly allocated to each chamber. Individual BW at start and end of each treatment period was recorded. Group BW was recorded twice/wk and kept to specific target BW via twice/wk feed allocations. Body weight and feed allocation data were used to determine temperature effects on BW gain and feed allocation. Amount of feed allocation was estimated using a mixed model, accounting for correlations between repeated measures within each chamber. The model was based on use of a 2,750 kcal ME/kg feed.

Temperature had large effect on feed allocation. During the 4 to 18 wk period, feed allocation should increase by 0.6 g/d to generate a 10 g/d BW gain when barn temperature is 21°C. For each 1°C increase in environmental temperature, feed allocation must decrease by 0.1 g to reach the 10 g/d BW gain target, with the opposite true for temperature decreases. According to the model, a 5 g/d increase in feed allocation would increase BW gain by 13.2, 15.3, 17.5 and 19.6 g/d at 15, 19, 23, and 27°C, respectively. This large difference in growth rates over a 12°C range in barn temperature demonstrates the importance of considering environmental temperature when allocating feed to broiler breeders.

**Key Words:** feed allocation, broiler breeder pullets, environmental temperature, body weight gain, feed restriction
25  Modeling poultry physiological parameters using neural networks. H. A. Ahmad*, Jackson State University, Jackson, MS.

Artificial intelligence models were developed with poultry physiological variables, such as broiler growth, guinea fowl growth and egg production in layers. These models were validated using software validation, by comparing with actual published/unpublished data of the variable in question and by comparing with their counterpart mathematical models. The present research addresses two objectives: simulate data using published/unpublished literature for different poultry variables of interest; and develop artificial intelligence models with various architectures of neural networks. For example, in case of broiler, actual growth data were divided into five-day intervals, with known means and standard deviations and used to generate normal distributions for the growth curves using @Risk software. These simulated data were then used to recognize data patterns and model growth curves with various neural networks. Three neural networks, namely BP-3 (three layers back propagation, each layer connected to previous layer), BP-5 (five layers back propagation, each layer connected to previous layer) and Ward-5 (five hidden slabs with various activation functions) were used in this research. Once the networks were sufficiently trained, they were exposed to actual growth data that they were not previously exposed to predict growth over the next 50 days. BP-3 neural network gave the best fitting line with predictions tightly fitting to the actual data points. The $R^2$ was 0.998, a near perfect. The $R^2$ for BP-5 and Ward-5 neural networks were 0.967 and 0.973, respectively. To further test the approach, the same methodology was applied on guinea fowl growth and on egg production in layers. For guinea fowl growth prediction the $R^2$ was 0.96, both for General Regression (GR) and Ward-5 neural networks. For egg production prediction GR neural network gave the best fitting curve with $R^2$ = 0.70. All three tested networks, GR, BP-3 and Ward-5 over-predicted egg production during the first few wk but were very inefficient afterwards. The predicted egg productions were compared with other similar US strains to validate such prediction models.

Key Words: poultry, modeling, simulation, neural networks

26  Effects of attic inlets on broiler performance. E. O. Oviedo-Rondon*1 and L. Wang2, 1North Carolina State University, Department of Poultry Science, Raleigh, 2North Carolina State University, Department of Biological and Agricultural Engineering, Raleigh.

Tunnel ventilated houses have large roof areas of dropped ceiling that collect solar energy. Attic inlets are installed to use this energy to preheat the air coming into the house, reduce fuel usage and facilitate higher ventilation rates. Their benefits on improving energy efficiency have been verified, but there is not much data on broiler performance. This project evaluated the effects of attic inlets on house temperatures (T), ammonia concentrations [NH3], propane gas usage (PGU), and broiler performance under commercial conditions. On a single broiler farm, 2 paired houses were selected and actuated attic inlets were installed, while the other 2 houses served as controls. Two trials were conducted with Ross TP16 broilers (20600/house) placed on used litter and raised up to 63 d. Portable Multi-Gas Units equipped with 2 Draeger electrical-chemical sensors were used to continuously measure in-house [NH3] over a 48 h sampling period at 5 wk. PGU was recorded per house. Internal house, attic, and outside T were recorded with 2 Hobo data loggers per house. Individual broiler body weights (BW) were collected at 42 d and final flock performance was obtained at market age. In Trial 1 all houses had the same target T, but attic inlet houses were consistently hotter (3°F) during 2 to 32 d. The attic inlet houses had higher ventilation rate than the control houses causing 10 to 15 ppm reduction in [NH3]. Air coming from attic inlets was 5°F hotter than air coming from sidewall inlets causing a 7.7% reduction on PGU (230 gallons). Broiler BW and flock uniformity was better at 42 d in houses with attic inlets. Conversely, broiler BW at processing plant were lower (4069 vs 4032g) and the FCR was worse (2.05 vs 2.10) for chickens in attic inlet houses. In Trial 2, fans were programmed to minimize house overheating, and attic inlets closed when T was 4°F above house target T. This programming kept T warmer only during the first week in attic inlet houses. Final BW was similar and FCR better (2.18 vs 2.14) in houses with attic inlets, while PGU was 10.4% (80 gallons) lower. Appropriate management of attic inlets is necessary to achieve benefits on broiler performance and energy use.

Key Words: broiler performance, attic inlets, energy, ammonia

27  Hot air alternative heating sources for broiler houses has potential. B. D. Fairchild*,1, M. Czarick1, and D. Dartnell2, 1University of Georgia, Athens, 2Georgia Forestry Commission, Athens, GA.

Most broiler houses in the United States use propane or natural gas as the primary fuel source. Propane prices have doubled over the last 10 years dramatically reducing grower profit margins. The objective of this study was to compare fuel savings and benefits of a biomass alternative heating system which utilized wood. Two houses were equipped with the treatment systems. In one house the heat system burned wood pellets while the other used wood chips as the fuel source. These houses were compared to two houses on the same farm using radiant brooders with propane as the fuel source. The treatment units were indirect fire units that pulled air from the houses passed it through a heat exchanger and then returned it to the house after heating it to 150 to 200°F. The heated air of one treatment house was distributed via a duct system at the ceiling while the second house used circulation fans hung from the ceiling to move air throughout the house. House temperatures, relative humidity, and fuel consumption were monitored. Ammonia, litter quality and fuel usage were also monitored.

The furnaces supplied sufficient BTUs and the distribution systems adequately distributed the heat throughout the house. Propane usage for the flock was reduced by 80% while the adjusted fuel savings for the flock in the pellet and chips houses were 25% and 60% respectively. Ammonia was lower in the furnace houses and can be attributed to lower house relative humidity and drier litter. Litter quality was better in the treatment houses compared to the controls but was best in the furnace house with circulation fans as the distribution method. While propane usage was significantly reduced in the treatment houses the cumulative fuel savings between the two treatment houses differed due to the expense of the fuel used. These alternative heating sources may have potential, especially if the trend of increasing propane and natural gas prices continues.

Key Words: broilers, alternative heating sources

28  The potential for plants to trap odors from farms with laying hens. P. H. Patterson*,1, A. Adrizal2, R. M. Bates1, R. C. Brandt1, R. M. Hulet1, E. F. Wheeler1, D. A. Despot1, and P. A. Topperr1, 1The Pennsylvania State University, University Park, 2Jambi University, Jambi, Indonesia.

The potential for plants to trap odor discharged from exhaust fans at research and commercial hen houses was evaluated in Aug and Sept 2008. Poultry NH3 emissions and particulate matter are a concern for
air quality, surface deposition, animal and human health and regulated by the US EPA in non-attainment areas. Odor is a nuisance issue for commercial farms near housing developments and other urban settings and often a constituent of dust and emissions. At a Penn State research hen house five tree species comprising a vegetative buffer were planted in pot-in-pot containers in five rows downwind of four hen house fans. Both laboratory olfactometry detections threshold (DT) and field olfactometry dilutions-to-threshold (D/T) measurements were made with and without the trees to study the impact of vegetation on odor thresholds. Odor samples for the laboratory olfactometry were secured in Tedlar™ bags and evaluated in 24h time. At a commercial hen complex with six 250,000 hen houses, vegetative buffers with four rows were established downwind of three house’s fans (27 tunnel fans each) while the other three houses served as controls. Laboratory olfactometry DT measurements were made at both the Penn State and commercial hen complex with and without trees to study the impact of vegetation on odor thresholds. Six trained odor assessors made laboratory DT determinations, and four odor assessors using the Nasal Ranger™ made field D/T evaluations with and without trees at Penn State. Laboratory DT results for Aug and Sept at the commercial complex averaged 29 and 44 respectively for the houses with and without trees. Measurements made in Aug at the commercial site were significantly less when trees were present (P<0.10). Laboratory DT results at the Penn State farm averaged 21 and 39 respectively, with and without trees (P>0.10). However, using the Nasal Ranger™, D/T results averaged 4.3 and 9.4 with and without trees (P=0.01). Despite low background odor levels at both research and commercial sites, both consistent numerical and statistically significant results suggest vegetation reduces odor.

Key Words: odor, olfactometry, laying hens, detection threshold, vegetation

29 Evaluation of a new poultry house for the presence of Salmonella at different sites through the broiler production continuum. J. A. Byrd*, T. C. Crippen, C. L. Sheffield, T. L. Poole, and D. J. Nisbet, USDA-ARS, SPARC, Food and Feed Safety Research Unit, College Station, TX.

Poultry companies continue to produce safe and wholesome products while facing increased regulatory pressure to control foodborne pathogens. Although many risk factors that contribute to Salmonella concentrations have been identified, precise identification of the most effective sites for intervention have not been established. The present study evaluates a naïve (new) poultry house with different environmental parameters on Salmonella incidence at different points of production.

One broiler house with four consecutive flocks were studied. Preharvest sample points included: tray pads (2/sample point), litter (12/sample point), water (3/sample point), feed (3/sample point) and birds (20/sample point) sampled at days 0, 18, 32, 46, and 62. All samples were evaluated for Salmonella. Prior to placement on the farm, Salmonella were detected in all water, feed, hatchery (traypads), and in 18% of the litter samples. Water samples were 100% positive for Salmonella at Days 1 and 18 in Flocks 1-3. Similarly, Salmonella was detected in high levels (60-100%) in Flocks 1 and 3 on Days 1 and 18. However, ceca samples evaluated for Salmonella were found under 5% on all days except for Flock 3 which had Salmonella 95% (Day 1) and 25% (Day 18). Campylobacter was not detected on the farm during the entire study. The data demonstrates the importance of pathogen-free environmental conditions even on naïve farm. Data from this study may help poultry professionals understand how environmental factors may affect foodborne pathogens in poultry and the difficulty that may be encountered in making risk management decisions.

Key Words: new house, environmental, Salmonella, poultry

30 Investigation of growth performance and ascites mortality in broiler chickens reared in a greenhouse or a conventional house at a high altitude area. F. Khajali*1,2 and M. Faraji1, 1Shahrekord University, Shahrekord, Iran, 2University of Arkansas, Fayetteville.

In the present study, a greenhouse was constructed to meet the birds environmental needs and welfare and the response of broiler chickens (Ross 308) in terms of growth performance, physiological variables and mortality from ascites grown in the greenhouse were studied in relation to a conventional house with similar conditions. Four hundred day-old chicks were randomly distributed among 8 groups and placed either in the greenhouse (4 groups) or the conventional house (4 groups). The experiment was conducted in floor pens in both houses from 2 to 42d in a completely randomized design. Results showed that the birds in the greenhouse ate significantly (P<0.05) more feed than those reared in the conventional house in the growing (21-42d) and throughout the trial (2-42d). Differences between the houses were not significant for body weight gain and feed conversion ratio in different periods of the experiment. FCR throughout the trial was 1.78 and 1.81 for the birds housed in the conventional house and the greenhouse, respectively. Mortality from ascites was 9.5 and 12% in birds housed in the conventional house and the greenhouse, respectively. There were no significant differences with respect to hematocrit and serum nitric oxide concentration between the houses.

Key Words: greenhouse, broiler, ascites

31 Susceptibility of commercial broiler chickens that differ in innate immune responsiveness to coccidial infection. M. H. Kogut*, C. L. Swaggerty1, I. Y. Pevzner2, and J. R. Nerren1, 1USDA-ARS, College Station, TX, 2Cobb-Vantress, Inc., Siloam Springs, AR.

Traditionally, genetic selection of poultry based on immunity/disease resistance has centered on inherent resistance to a specific infectious agent. Given the ability of the innate immune system to recognize a variety of pathogens, we hypothesize that innate immunity could be a more useful marker when genetically selecting chickens for disease resistance. We have identified two lines of broiler chickens divergent in their innate response (line A = highly efficient and line B = low efficiency). We have shown that this functional efficiency of the innate response can be genetically transferred to progeny, is sex-associated, and genetically influenced by the sire. Furthermore, we have shown that increased in vitro innate immune function corresponds with increased in vivo resistance to infections by Gram-positive and Gram-negative bacteria. Coccidiosis remains one of the most common and most expensive diseases of poultry worldwide. The objective of the current study was
to determine if the previously reported differences in susceptibility to bacterial infections between the lines A and B translates to an increase in resistance or susceptibility to infection with *Eimeria tenella*. Two-week old broilers from lines A and B were randomized by weight into 4 treatment groups: uninfected controls or those challenged orally with either 15, 30, or 45 x 10^3 sporulated oocysts of *E. tenella* (PSU strain). Six days later all birds were sacrificed, weighed, and the ceca from each chicken lesion scored. Line A chickens had significantly greater weight gains and significantly lower cecal lesion scores when compared to challenge dose-matched line B chickens. These results are further proof that the differential in vitro innate immune function between line A and B chickens corresponds with increased in vivo resistance to not only bacterial infections, but also parasitic protozoan infections.

**Key Words:** innate immunity, *Eimeria tenella*, disease resistance

### 32 Immunomodulatory effects of a commercially available probiotic on coccidiosis vaccination in broilers. K. Stringfellow*1, D. Caldwell1, J. Lee1, A. Klein1, S. Pohl1, R. Beltran2, G. Schatzmaysr3, S. Fitz-Coy3, C. Broussard3, and M. Farnell1, 1Texas AgriLife Research, College Station, TX, 2Biomin GmbH, Herzogenburg, Austria, 3Intervet/Schering-Plough Animal Health, Summit, NJ.

Probiotics in poultry diets enhance gut health as well as stimulate both innate and adaptive immunity. The hypothesis of this study was that probiotic administration would modulate the immune response against coccidiosis vaccination and subsequent clinical *Eimeria* challenge in broilers. This trial consisted of a negative control, probiotic alone, vaccine alone, and probiotic with vaccine combined experimental groups. Probiotic was administered through the drinking water and coccidiosis vaccination and subsequent clinical *Eimeria* challenge in resistance or susceptibility to infection with *Eimeria tenella*. Two-week old broilers from lines A and B were randomized by weight into 4 treatment groups: uninfected controls or those challenged orally with either 15, 30, or 45 x 10^3 sporulated oocysts of *E. tenella* (PSU strain). Six days later all birds were sacrificed, weighed, and the ceca from each chicken lesion scored. Line A chickens had significantly greater weight gains and significantly lower cecal lesion scores when compared to challenge dose-matched line B chickens. These results are further proof that the differential in vitro innate immune function between line A and B chickens corresponds with increased in vivo resistance to not only bacterial infections, but also parasitic protozoan infections.

**Key Words:** innate immunity, *Eimeria tenella*, disease resistance

### 33 Influence of probiotic administration, coccidiosis vaccination, *Eimeria* challenge, or ionophorococcidiatat administration on gut morphology in broilers. S. L. Dunn*1, D. J. Caldwell1, J. T. Lee1, K. D. Stringfellow1, A. E. Klein1, R. Drolskesey2, M. Mohl1, R. Beltran1, G. Schatzmaysr3, S. Fitz-Coy4, C. Broussard4, and M. B. Farnell1, 1Texas AgriLife Research, College Station, TX, 2SPARC-USDA, College Station, TX, 3Biomin GmbH, Herzogenburg, Austria, 4Intervet/Schering-Plough Animal Health, Summit, NJ.

Probiotics are beneficial bacteria that can stimulate avian mucosal immune function. We hypothesized that stimulating the innate immune system with probiotics would improve the adaptive immune response to coccidiosis vaccination, and possibly improve gut health. The current study investigated the effects of a probiotic, a live oocyst coccidiosis vaccine, or an ionophorous coccidiostat on the intestinal morphology of broilers. On day-of-hatch, straight-run broilers were placed into floor pens with built up litter. Experimental groups consisted of negative control, probiotic alone, vaccine alone, probiotic with vaccine, coccidiostat alone, and coccidiostat with probiotic. Birds were challenged with *Eimeria* oocysts via day 14 litter application and day 36 oral challenge. On days 6, 22, 36, and 43, samples of duodenum were collected and stored in neutral buffered formalin, then prepared for morphological evaluation. On day 6, intestinal villi heights of the vaccinated alone group were significantly higher when compared to the negative control. On day 22, intestinal villi heights were increased in the coccidiostat alone and in the coccidiostat with probiotic groups. On days 36 and 43, there were no differences in any groups when compared to the negative control. These data suggest that probiotics and vaccination may benefit villus height initially. On the other hand, the coccidiostat seem to prevent normal exposure of the avian immune system to invasive coccidia for the development of immunity because, once coccidiostat was removed from the ration, villi heights were reduced (p<0.05), indicating the prevalence of infection. Further investigation is necessary to explore the effects of ionophores on immune function.

**Key Words:** gut morphology, probiotic, coccidiosis, vaccine, ionophore

### 34 Flow cytometric analysis of the binding of agonistic anti-chicken CD40 mAb to primary chicken B-cells and macrophages. C-H. Chen*1, D. Abi-Ghanem1, L. Njongmeta1, J. Bray2, W. Mwangi3, S. D. Waghele3, N. Ing2, and L. R. Berghman1,3, 1Texas A&M University, Poultry Science Department, College Station, 2Texas A&M University, Animal Science Department, College Station, 3Texas A&M University, Veterinary Pathobiology Department, College Station.

Purpose: CD154, a member of the TNF superfamily, which is transiently expressed on activated TH cells, has several essential immune functions. The interaction between CD40 and CD154 mediates specific T-cell help to B-cells in response to T-cell dependent antibodies; it also provides signals crucial for affinity maturation and generation of class-switched memory B-cells. Agonistic anti-CD40 monoclonal antibodies (mAbs) successfully mimic the actions of CD154 on antigen presenting cells, leading to enhanced antibody production and isotype switching of B-cells. Biological effects of the anti-chicken CD40 (cCD40) mAbs we produced include induction of nitric oxide (NO) synthesis in chicken HD11 macrophages and enhancement of cell proliferation in chicken DT40 B-cells. In the present study, we describe the interaction of the agonistic anti-cCD40 mAb 2C5 with the extracellular domain of CD40 on both primary chicken B-cells and macrophages.

Experimental design: The monoclonal anti-cCD40 antibody 2C5 was purified by protein A affinity chromatography, isotyped, and then labeled with R-phycoerythrin. Primary chicken B lymphocytes and mononuclear cells were purified from chicken spleen by use of Histopaque®-1077. Primary chicken macrophages were collected from differentiated mononuclear cells cultured in vitro. Viable B lymphocytes and macrophages were stained with labeled mAb 2C5 and then analyzed by
flow cytometry. Chicken DT40 B-cells and HD11 macrophages were similarly stained and analyzed.

Results: Immunoglobulin isotyping assay showed that the anti-cCD40 mAb 2C5 is IgG1. Flow cytometric analysis showed that 2C5 recognizes CD40 on primary chicken B lymphocytes and macrophages, as well as on chicken DT40 and HD11 cell lines.

Conclusion: We have previously shown that mAb 2C5 stimulates proliferation of chicken DT40 cells and NO production by chicken HD11 cells. In this abstract, we report that anti-cCD40 mAb 2C5 is agonistic and can be used to further study the T-cell dependent B-cell activation pathway in chickens.

Key Words: chicken CD40, monoclonal antibodies, flow cytometry, primary chicken B-cells, primary chicken macrophages

35 Immunization of turkeys with live attenuated Salmonella vectors expressing CD154. K. M. O’Meara*1, C. J. Kremer1, S. L. Layton2, B. M. Hargis2, and K. Cole1, 1The Ohio State University, Columbus, 2University of Arkansas, Fayetteville.

Food–borne illness is a worldwide public health concern and an estimated 1.4 million cases are due to human Salmonella infection each year. Even though the organism has been isolated from most food animals, poultry has been identified as the clearest link to human Salmonellosis. Therefore, there is a need to find an effective vaccine that protects poultry against multiple Salmonella serotypes. Using the Red recombinase system in combination with overlapping extension PCR, several novel attenuated Salmonella enteritidis strains (SAE) that express variations of a potential immune–enhancing CD154 peptide sequence on the outer membrane protein (lmb) in association with an M2e epitope were developed. The three CD154 peptide sequences evaluated in this study correspond to those naturally occurring in turkey, human and chicken species. Pouls were challenged with 10^6–10^8 cfu/poults via oral gavage at day–of–hatch and again at 21 d post–hatch with salmon or a recombinant Salmonella strain (SVE–M2e, SVE–M2e–TurkeyCD154, SVE–M2e–HumanCD154, SVE–M2e–ChickenCD154). Liver/spleen andecal tonsils were aseptically removed at d 7 and weekly through d 42 post–hatch for detection of SAE strain recovery, and blood samples were obtained for determination of M2e–specific antibody response. There were no differences observed in SAE–specific antibody response due to the simultaneous expression of CD154. The vaccine candidate strains harboring a CD154 peptide sequence demonstrated faster clearance from the flock when compared to the vaccine candidate strain that does not express a CD154 sequence. However, there were no differences observed between the vaccine candidate strains expressing a CD154 peptide sequence. These data suggest that these Salmonella–vected vaccines expressing a CD154 peptide sequence are able to invade the liver and spleen, thereby stimulating an immune response.

Key Words: Salmonella, CD154, colonization, immune response

36 Cloning and functional characterization of avian interleukin-19. S. Kim*1, K. B. Miska2, A. P. McElroy1, M. C. Jenkins2, R. H. Fetterer2, and R. A. Dalloul1, 1Virginia Polytechnic Institute and State University, Blacksburg, 2Animal and Natural Resources Institute, Beltsville, MD.

An interleukin (IL)-10 family member, IL-19, is a recently discovered T helper type-2 (Th2) cytokine of mammals. As best characterized so far, IL-19 alters the balance of Th1 and Th2 cells in favor of the Th2 type. Existence of the avian IL-19 gene has been indicated, but no research has reported its functional characterization. The full-length avian IL-19 gene, located on chromosome 26, was amplified from LPS-stimulated chicken monocytes, and cloned into either a prokaryotic (pET28a) or an eukaryotic (pcDNA3.1) expression vector. The confirmed avian IL-19 nucleotide sequence has 47% homology with human and murine IL-19, with a predicted protein sequence of 176 amino acids. Analysis of avian IL-19 amino acid sequence showed conserved and structurally relevant 6 cysteine residues like in mammals, but not the N-glycosylation residue. The bacterially expressed avian recombinant IL-19 (rIL-19) was purified by Ni+-resin column and the endotoxin removed. Using purified avian rIL-19, expression of Th2 cytokines was measured in splenocytes using quantitative real-time PCR (qRT-PCR). Isolated splenocytes were cultured in the presence or absence of rIL-19 for 6 and 12 hours. Total RNA was extracted, cDNA prepared, and qRT-PCR performed to assess the levels of Th2 cytokine transcripts. In the presence of rIL-19, expression levels of IL-4 and IL-13, as well as IL-10, were significantly increased in both 6- and 12-hour treatments. This was confirmed by treating splenocytes with supernatants from IL-19 transfected cells. Also, avian monocytes incubated with rIL-19 manifested increased expression of IL-1beta, IL-6, IL-10, and IL-19. This study represents the first report for the cloning, expression, and functional characterization of avian IL-19. Taken together, avian IL-19 function seems to be conserved and similar to that of mammals and may play an important role in responses to extracellular poultry pathogens.

Key Words: IL-19, avian immunity, Th2, real-time PCR

37 Expression of innate immunity genes during Eimeria praecox infection in broilers. L. H. Stuard*1, K. B. Miska2, M. C. Jenkins2, R. H. Fetterer2, and R. A. Dalloul1, 1Virginia Polytechnic Institute and State University, Blacksburg, 2Animal Parasitic Diseases Laboratory, USDA/ARS, Beltsville, MD.

Intestinal colonization of avian species by Eimeria parasites results in the enteric disease, coccidiosis. Compared to infection by E. maxima alone, the simultaneous presence of E. maxima and E. praecox in the gut has a positive impact on weight gain and feed efficiency. A study was carried out to assess the immunological effects of E. praecox infection on the gut of infected broilers. Birds were orally gavaged with 10,000 E. praecox oocysts at 2 weeks of age and intestinal sections were sampled consecutively on days 1 through 7 post-infection. Intestinal expression of innate immune gene transcripts was analyzed by real-time PCR. Since E. praecox and E. maxima infect the duodenum and jejunum, respectively, research was focused on the proximal sections of the small intestine. Analysis of relative gene expression revealed a decrease (P < 0.05) in Toll-like receptor (TLR)-15 in the jejunum of infected birds on day 2 post-infection. On day 3, cathelicidin antimicrobial peptide was downregulated in the jejunum of infected broilers. Expression of liver-expressed antimicrobial peptide 2 (LEAP-2) in infected birds was also significantly lower than the control in the duodenum on days 3 through 6, and in the jejunum on day 4. Interestingly, there was also a difference (P < 0.05) in the expression of LEAP-2 between the two intestinal sections of both infected and control birds on all 7 days. TLRs participate in innate immunity by acting as pathogen recognition receptors that control the expression of cytokines and chemokines. TLR-15 is an avian-specific TLR suspected to play a role in the defense against bacterial infections. The observed downregulation of TLR-15 suggests that E. praecox infection may have a unique effect on this particular TLR, resulting in a compromised innate immune system. Antimicrobial
peptides act as immunomodulators by affecting the membrane permeability of a variety of target cells. While the upregulation of chicken cathelicidin and LEAP-2 has been observed in response to bacterial infections, the results of this study imply that these peptides may react differently to parasitic infections, specifically *E. praecox*.

**Key Words:** Eimeria, innate immunity, broiler, LEAP-2, TLRs

### 38 Characterization of turkey iNOS and development of assays to study its role in poult enteritis. R. R. Meyerhoff*, R. A. Ali, and M. D. Koci, North Carolina State University, Raleigh.

Acute viral enteritis is one of the leading causes of morbidity and mortality in both animals and humans. However, despite its prevalence, our understanding of the mucosal immune response to these enteric pathogens is limited. In turkey production, viral enteritis causes significant financial losses due to decreased growth and feed conversion, increased veterinary care, and in extreme cases increased mortality. In spite of the known impact on poultry production, very few treatment and control strategies have been developed. In an effort to further characterize this host-pathogen interaction, our laboratory has developed a model of acute viral disease mediated by turkey astrovirus type-2 (TAstV-2).

In previous studies, we demonstrated that TAstV-2 infection induces severe watery diarrhea and growth depression. However, these clinical signs are associated with only mild histological changes. Although there was no sign/evidence of inflammation or immune response to infection, RNA expression analysis suggests an increase in the expression of constituents of the innate immune system, specifically inducible nitric oxide synthase (iNOS). Subsequent studies suggest that expression of iNOS and its virucidal product (NO) can inhibit TAstV-2 replication. To further understand the role iNOS plays in the anti-TAStV-2 response, we sequenced the full length turkey iNOS (tkiNOS) cDNA, compared it to known iNOS genes, and produced goat-anti-tkiNOS peptide anti-sera. The results of this work are the first, to our knowledge, to describe the full cDNA sequence of the tkiNOS gene and develop tkiNOS specific reagents. These new reagents and assays will play a key role in our ability to determine the effect of iNOS and NO on TAStV-2-mediated enteritis as well as other enteric infections.

**Key Words:** turkey astrovirus, inducible nitric oxide synthase

### 39 The effects of the DFM Primalac® on energy repartitioning to the immune system of broilers. R. Qiu*, J. Croom, R. Ali, and M. D. Koci, North Carolina State University, Department of Poultry Science, Raleigh.

Direct fed microbials (DFMs) are used in poultry production to as an alternative to the subtherapeutic use of antibiotics. The mechanisms by which they improve animal performance are still unknown. In previous studies the DFM Primalac® has been shown to improve animal performance in broilers. The mechanisms by which they improve animal performance are still unknown. In previous studies the DFM Primalac® has been observed in response to bacterial infections, the results of this study imply that these peptides may react differently to parasitic infections, specifically *E. praecox*.

**Key Words:** Eimeria, innate immunity, broiler, LEAP-2, TLRs

### 40 Effect of chromium sources on immune responses of heat stressed broiler chicks. M. Shivazad*1, M. Toghyani2, and S. H. Zarkeshi1, 1University of Tehran, College of Agriculture, Karaj, Iran, 2Islamic Azad University of Khorasgan, Isfahan, Iran, 3University of Isfahan, Isfahan, Iran.

The present study investigated the effect of different levels of organic and inorganic chromium (Cr) on immunity of heat-stressed broiler chicks. Four hundred and twenty day-old male broilers (Ross 308) were reared in heat stress condition(s) for 42 d. Seven dietary treatments consisted of the basal diet supplemented with 0 (control), 500, 1000 and 1500 micro gram of Cr/kg of diet in the form of Cr nicotinate (contain 12.25% Cr) and Cr chloride (contain 18% Cr) respectively, as organic and inorganic sources. Antibody titers against Newcastle and Influenza virus at 18 and 30d, heterophil to lymphocyte ratios, albumin to globulin ratios and concentration of immunoglobulin G in serum were measured at 21 and 42 d. On day 42, thymus, spleen and bursa of Fabricius were collected, weighed and expressed as a percentage of live body weight. Antibody titers against Newcastle and Influenza virus were elevated at 30d of age in broiler chicks fed supplemental Cr, especially organic Cr. Heterophil to lymphocyte ratios decreased in broiler chicks fed 1000 micro gram of organic or inorganic Cr/kg diet at 21 d. Concentration of immunoglobulin G in serum was increased by organic and inorganic Cr supplementation. Albumin to globulin ratios and weights of lymphoid organs were not affected by supplemental Cr. The results suggest that organic and inorganic Cr supplementation improves some immune responses of heat-stressed broiler chicks.

**Key Words:** DFM, probiotics, immune function, energy metabolism, broiler

### 41 Humoral immune response in breeding hens and protective immunity provided by administration of purified Salmonella gallinarum porins. G. V. Gomez-Verduzco1, G. Tellez*2, A. L. Quintana1, A. Isibasi3, and V. Ortiz-Navarrete4, 1Departamento de Producción Animal, AVES, FMVZ, UNAM, Mexico City, Mexico, 2University of Arkansas, Department of Poultry Science, Fayetteville, 3Unidad de Investigación Médica en Inmunológica del Hospital de Especialidades

in whole body energy expenditure or bodyweight gain between treatments but did decrease ileal O2 respiration (P<0.05). Analysis of other tissues demonstrated no changes in the mass or respiration rate of breast muscle, liver or spleen with PRIM (P>0.05). In contrast, bursa weight and the respiration rate of thymus were increased (P<0.05). PRIM treated animals also demonstrated an increase in the ATP level of PBL and an increased rate of ATP usage (p<0.01). This suggests that PRIM treatment increased energy consumption by the immune system. To determine if this increased energy utilization corresponds with an altered immune response, broilers were challenged with sheep red blood cells (SRBC) and assayed for differences in their humoral response. PRIM treated birds demonstrated a faster kinetics in their anti-SRBC IgG and were found to have more total sIgA as compared to controls. Collectively, these data suggests that PRIM supplementation increased energy partitioning to the immune system and enhanced immune response to SRBC challenge. Further investigation is needed to more completely describe the role of PRIM and DFM in the repartitioning of energy to the immune system.

**Key Words:** DFM, probiotics, immune function, energy metabolism, broiler
del Centro Medico Nacional del IMSS, Mexico City, Mexico, Departamento de Biomedicina Molecular del Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV), Mexico City, Mexico.

The current studies were undertaken to assess the ability of humoral immune response in breeding hens and the protective immunity provided by administration of purified Salmonella gallinarum (SG) porins to the progeny. Two hundred and ten broiler breeder hens, 53 weeks old, were divided into three groups and subcutaneously immunized via multiple sites at 0 and 10 days with either: a) 10 μg SG porins; b) 30 μg of SG porins; or c) control, inoculated with phosphate buffer solution (PBS) without porins. Seven days after the second immunization, the levels of SG-specific antibodies were determined in the serum and fertile eggs collected from hens using an enzyme linked immunosorbent assay. Furthermore, fertile eggs were collected again from hens in all treatments and incubated for 21 days. On day of hatch, chicks were placed in groups of 30 birds per group and gavaged with 20, 100 and 500 LD50% of SG. Results indicated that purified SG porins induced the production of IgY class antibodies detected in the serum and eggs of SG porin-immunized hens (P<0.05). In addition, SG porins cross-reacted with porins of Salmonella typhi. Compared to control immunized hens, the progeny of immunized hens were protected by 53 to 70% fold against challenges of 20 – 500 LD50 % of SG (P<0.001). These results suggest that porins of SG as well as those of other Salmonella species participate in the induction of protective immunity, and modulation of humoral immune response is one of the mechanisms involved.

**Key Words:** Salmonella gallinarum, porins, immunity, chickens

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**Metabolism and Nutrition I: Vitamins and Minerals**

43 Effects of different dietary copper sources at pharmacological levels on laying hen performance, egg yolk cholesterol and blood parameters. A. Y. Pekel* and M. Alp, Istanbul University, Faculty of Veterinary Medicine, Istanbul, Turkey.

An experiment was conducted using a total of 120, 16-wk-old, Lohmann Brown hens to compare three different supplemental dietary copper (Cu) sources at prophylactic levels (250 mg/kg) on hen performance, egg yolk cholesterol and blood parameters. Layers were randomly allocated to four dietary treatments with ten replications of three birds each per treatment. Layers were fed diets containing 0 (Control) or 250 ppm Cu from copper sulfate (Cu-sulfate), copper proteinate (Cu-proteinate) or Copper lysine (Cu-lysine) for 24 wk. There were no differences among copper sources for live weight, egg specific gravity, yolk cholesterol, plasma total cholesterol, high-density lipoprotein cholesterol (HDL), triglycerides and glutathione (GSH). Supplementation with 250 ppm Cu-sulfate improved egg production and feed conversion ratio but decreased egg weight (P<0.05) and feed intake (P<0.01) compared with other diets. Supplementation with Cu-proteinate resulted in decreased feed intake (P<0.01) and improved feed efficiency (P<0.05) but egg production and egg weight were not changed as compared with control. Cracked egg ratio of layers given Cu-proteinate was higher (P<0.01) than those of birds fed other diets. Birds fed the Cu-lysine diet had lower egg shell thickness (P<0.001) and lower egg shell weight (P<0.05). Egg shell thickness of layers given Cu-sulfate was also lower than control (P<0.001). Copper content of the eggs and excreta were significantly (P<0.001) increased regardless of copper source compared with birds fed the control diet. The results of this trial do not confirm previous findings that copper alters lipid metabolism resulting in reduced egg yolk cholesterol. However, the addition of 250 ppm copper from Cu-sulfate might be beneficial in improving the layer performance more so than Cu-lysine and Cu-proteinate.

**Key Words:** copper, layer, performance, cholesterol, egg quality

44 Selenium enrichment of table eggs. D. C. Bennett* and K. M. Cheng, University of British Columbia, Vancouver, BC, Canada.

Selenium (Se) is an essential micronutrient with a recommended dietary allowance for human adults of 55 μg/d. However, there is evidence that greater dietary intakes may have possible health benefits, including a reduction in the risk of cancer. Several studies have shown the feasibility of enriching eggs using organic sources of Se, and that Se-enriched eggs are an effective way to supplement human diets. However, few studies have examined the response of egg Se concentration to high (>1 ppm) dietary organic Se levels. Organic Se is less toxic than sodium selenite. The objective of the current study is to examine the effect of

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**Effect of dietary Cinnamomum cassia and Curcuma longa on Eimeria tenella infection in broiler chickens.** S-H. Lee*, S. Jang¹, D. Kim¹, M. Park¹, C. Ionescu², D. Bravo², and H. Lillehoj¹, ¹Animal and Natural Resources Institute, Agricultural Research Service-U.S. Department of Agriculture, Beltsville, MD, ²Pancosma S.A., Geneva, Switzerland.

The protective effect of dietary cinnamaldehyde (Cinnamomum cassia) and turmeric (Curcuma longa) on avian coccidiosis was evaluated in young broilers. One-day-old broiler chickens were continuously fed with a standard diet alone or standard diets supplemented with cinnamaldehyde or turmeric extracts for 3 weeks. Body weight gains, fecal oocyst shedding, antibody titers, splenocytes proliferation, and pro-inflammatory cytokine production were measured as parameters of protective immunity following infection with E. tenella at 14 day of age. There was no toxicity associated with feeding these two plant extracts. Chickens fed turmeric-supplemented diet showed significantly increased body weight gain and shed significantly reduced fecal oocysts compared with birds fed the standard diet alone or the cinnamaldehyde-supplemented diet following challenge infection with E. tenella. Both groups fed cinnamaldehyde- or turmeric-supplemented diet showed significantly improved splenocytes proliferation compared with control birds. Chickens fed cinnamaldehyde-supplemented diet produced higher serum antibody titers compared to the groups fed the standard diet or turmeric-supplemented diet. Finally, the levels of local cytokine transcripts of IL-1β and IL-15 were consistently higher in the turmeric-fed group compared to the groups fed the standard diet alone or cinnamaldehyde-supplemented diet. This study provides first immunological evidence that dietary supplementation of cinnamaldehyde and turmeric enhance local innate immunity and turmeric induces higher protective immunity against E. tenella infection.

**Key Words:** broiler, Eimeria tenella, Curcuma longa, dietary supplement, cytokine
higher dietary organic Se levels on production, egg mass and egg Se levels. These were assessed by feeding 3 strains of laying hens (Barred Plymouth Rock, Loahlmann Brown, Lohmann White) a basal diet containing 0.3 ppm Se as sodium selenite. This diet was then supplemented with Se-yeast (SelenuSource AF, Diamond V Mills, Cedar Rapids, IA) at 1, 2, 4, or 5 mg Se/kg diet. These three supplemented diets were fed to seven cages of hens (2.5 hens/cage) from each strain, respectively, for four weeks. Feed consumption, egg production and egg mass were not affected by the dietary Se concentration in any of the strains. At the end of 4 weeks, irrespective of strain, egg Se concentration was increased 190, 450, and 900%, respectively, over the initial 0.33 ug/g WM. Based on the results of this study and a survey of the literature, hens would need to be fed 1.4 ppm organic Se in the diet to achieve an egg containing 55 µg Se.

**Key Words:** selenium, laying hen, enriched egg

45 Use of the broiler (Gallus gallus) as an in vivo screening tool for Fe bioavailability. E. Tako*, M. A. Rutzke, and R. P. Glahn, USDA/ARS, Robert W. Holley Center for Agriculture and Health, Cornell, Ithaca, NY.

Iron fortification of foods and biofortification of staple food crops are strategies that alleviate Fe deficiency. The common bean (Phaseolus vulgaris L.) is an attractive candidate for biofortification since it contains relatively high Fe concentrations. Beans are also high in polyphenols that may inhibit Fe absorption. In vitro studies using a Caco2 cell model have repeatedly shown that Fe bioavailability from white beans is higher than colored beans. However, there is a need to test the in vitro observations in animal model prior testing crops in human efficacy studies. The broiler may be a useful model for in vivo screening of Fe bioavailability in foods due to its growth rate, anatomy, size and cost. The objective of the present study was to assess the broiler as a model to link between in vitro observations and human nutrition. We compared Fe bioavailability between diets containing either white (Matterhorn) or red (Merlot) beans which differ in polyphenol content. One wk old chicks were divided into four treatment groups: 1. 'WB-': 40% white bean diet (58ppm Fe); 2. 'RB-': 40% red bean diet (53ppm Fe); 3. 'WB+': 40% white bean diet (176ppm Fe); 4. 'RB+': 40% red bean diet (181ppm Fe). Diet 1-2 had no supplemental Fe. For 8 wks, hemoglobin (Hb), feed consumption and BW were measured. After 8 wks, birds were anesthetized and duodenal sections were collected for analysis of expression of Fe transport genes and morphometric measurements. Cecal contents were collected for microbial analysis. DMT1, Dcytb and ferroportin expressions were higher (P<.05) and villus surface area was lower in the 'RB-' group compared to other groups. Cecal microflora did not differ btw groups. Hb, Hb-Fe and BW were lower and HRE was higher in the 'RB'- group compared to other groups (P<.05). In vitro analysis of Fe bioaccessibility showed lower (P<.05) ferritin concentrations in cells exposed to 'RB-' diet. We conclude that the in vivo results match the in vitro observations; white beans contain more bioavailable Fe than red beans. Results indicate that, the broiler model can serve as an intermediate screening tool for Fe availability.

**Key Words:** broiler, iron, screening tool, bioavailability

46 Performance effects of feeding broilers with diets containing low levels of supplemental Zn as Zn(HMTBa)® or inorganic Zn vs. industry levels of inorganic Zn. M. K. Manangi*, S. Richter, J. D. Richards, and M. Vazquez-Anon, Novus International, Inc., St. Charles, MO.

A 42 d experiment was conducted to determine the performance impact of feeding broiler chicks diets containing low levels of supplemental Zn in the form of organic (Zn(HMTBa)® as MINTREX® Zn) or inorganic Zn (ZnSO4) in comparison to industry level of inclusion of inorganic Zn. A total of 1680 Ross-708 male and female chicks were distributed separately into 70 pens with 24 chicks per pen. The experiment consisted of 6 treatments with 13 replicate pens per treatment for T1 to T5, and 5 replicate pens for T6. The treatments consisted of: 0 ppm Zn as -ve control, T1; 10 ppm ZnSO4, T2; 20 ppm ZnSO4, T3; 10 ppm Zn(HMTBa)®, T4; 20 ppm Zn(HMTBa)®; T5; 100 ppm ZnSO4 as +ve control, T6. All the chicks were vaccinated with coccidiosis vaccine on d 18 (2x dose; oral gavage) and challenged with lipopolysaccharide (from E. coli; 1mg/kg BW, S/C) on d 28. There was a treatment effect for cumulative weight gain (cGain), F:G ratio adjusted for mortality (adj F:G), and cumulative performance index (cPI) (P<0.05). D 42 data for cGain, adj F:G, and cPI indicates that birds supplemented with diets containing 20 ppm Zn(HMTBa)® were not different from birds (P>0.05) fed 100 ppm ZnSO4. Birds fed 20 ppm ZnSO4 yielded significantly (P<0.05) lower cGain and cPI but similar adj F:G (P>0.05) than birds fed 20 ppm Zn(HMTBa)® or 100 ppm ZnSO4. The cPI data shows that the -ve control performed poorly (P<0.05) compared to all other treatment groups suggestive of Zn deficiency. In summary, bird performance was improved when supplementing Zn in the diet and this was more pronounced with Zn(HMTBa)® than ZnSO4. Reducing dietary supplemental Zn from 100 to 20 ppm can be achieved without compromising bird performance when feeding solely Zn(HMTBa)® but not ZnSO4. Future work will examine the impact of feeding lower levels of Zn(HMTBa)® on other functional aspects of health.

*MINTREX® is a trademark of Novus International, Inc., and is registered in the United States and other countries.

**Key Words:** Zn(HMTBa)®, mirex®, broiler, zinc

47 Zinc amino acid complex supplementation improves performance and influences intestinal immune response after coccidial vaccine challenge. C. Troche*, Z. Jiang, and T. J. Applegate, Purdue University, West Lafayette, IN.

Dietary incorporation of Zn sources complexes with amino acids has been shown to improve performance and alter certain immune functions. An experiment was conducted to evaluate the effects of Zn source on intestinal characteristics. Broiler chicks were fed in a two phase feeding program: 0 to 14d and 14 to 21d. Dietary treatments (8 pens/diet; 40 birds/pen) included: 90ppm of Zn from Zn-sulfate, 50ppm of Zn from Zn-sulfate and 40ppm of Zn from Availa-Zn (as a complex with amino acids; Zinpro Corp.), or 90ppm of Zn from Zn-sulfate and 40ppm of Zn from Availa-Zn. From 0 to 14d, feed intake and feed-to-gain was higher in birds supplemented with 90ppm Zn-sulfate compared to those supplemented with 130ppm total Zn. In order assess the immunomodulatory effects of Zn, 1 bird per pen was orally challenged with a 5X dosage of coccidial vaccine and challenged and non-challenged birds were sampled 5 d after challenge. Histological evaluation of oocyte infiltration, villus height, crypt depth, and numbers of goblet cells were not different between treatments from distal jejunal sections. Measures of active transport and jejunal electrical resistance using Ussing chambers and jejunal mucosal disaccharidase activity were not affected by diet. Cecal tonsils were analyzed for IL1β and IL10 using Taqman probes for qRT-PCR. A significant diet by challenge interaction for IL10 occurred
with Zn-sulfate supplemented chicks, wherein coccidial challenged birds had lower IL10 levels when supplemented with Zn-sulfate (P=0.04). The anti-inflammatory effects of IL10 with coccidial vaccine challenge were maintained with inclusion of a Zn amino acid complex. Key Words: broiler, cytokine, zinc source

48 Effect of copper sulfate in the drinking water on egg production and other parameters in commercial laying hens. H. N. Albrecht*, D. M. Karcher, and R. J. Balander, Michigan State University, East Lansing.

This study looked at the effects of adding copper sulfate at 125 PPM to the drinking water of W-36 Hyline hens from twenty-four to forty-one weeks of age. The 1152 birds were randomly assigned to either the control group or the copper sulfate treatment. The experimental design was twenty-four rows of twelve cages per row with four birds per cage. Birds were weighed at the beginning of the trial and monthly thereafter. Egg production was analyzed weekly by row. Specific gravity and egg weights were measured on thirty eggs from each row (720 eggs total) starting at week five of production and every two weeks thereafter. Feed consumption was measured monthly and water consumption was measured weekly for the first five weeks and then biweekly for the remainder of the trial.

Bird weights by pen were slightly, but significantly heavier for the control birds at five, ten and fourteen weeks of production. Egg production was not significantly different between treatments with the exception of week nine. Egg weights and specific gravity were not significantly different at any time. Feed and water consumption were not significantly different at any time. Key Words: copper sulfate, laying hens, egg production


A study was conducted to determine the effect of sources and levels of zinc on the performance and carcass quality of broilers. A total of 6,000 d-old straight-run broiler (Ross ×Ross) chicks were allotted randomly to four dietary treatments. A corn-wheat-soybean meal basal diet (Control) was formulated, and 40 ppm inorganic zinc (40 IZ), 40 ppm organic zinc (40 OZ), and 80 ppm organic zinc (80 OZ) were added to the basal diet to give four dietary treatments. During the 4-wk experimental period, feed and water were provided ad libitum. At the end of the feeding trial, five birds from each treatment were randomly selected for carcass evaluation and these five birds were considered as five replicates in each treatment. Results showed that the thickness of tibia skin epidermis was not affected by dietary zinc supplementation, but that of back skin in 40 OZ was significantly increased (P<0.05). Significant increases in the thickness of tibia and back skin dermis were observed in response to increased levels of dietary organic zinc supplementation. Collagen content in the back skin of 80 OZ was significantly higher than the other treatments; however, supplemental zinc had no significant effect on collagen content of breast and thigh muscle. The shear force values of back skin were not affected, but those of breast muscle were increased (P<0.05) in 40 OZ and 80 OZ compared to 40 IZ. It can be concluded that organic zinc increases dermis thickness of tibia and back skin of broilers. Key Words: broiler, zinc source, zinc level, supplement, skin quality

50 Effects of maternal age, sex and dietary phosphorus level on broiler performance and bone strength. A. L. Shaw*, J. P. Blake, and E. T. Moran, Auburn University, Auburn, AL.

Two experiments were conducted to 1) assess differences in breaking force of tibia bones with or without flesh attachment and 2) determine effects of dietary non-phytate phosphorus (npP), maternal flock age and chick sex on broiler performance and bone strength. For Exp. 1, 60 chicks were placed in battery cages and weekly both tibiae were excised and flesh was either intact or removed (15 chicks/wk) to determine breaking forces with a texture analyzer. For Exp. 2, Ross 708 chicks (1220) were hatched of young (25 wk) and old (65 wk) maternal flocks, separated by sex, vaccinated for coccidiosis, and placed on used bedding across 64 floor pens (18 males or 17 females/pen, 8 reps/trt). All birds were fed a corn-soybean meal diet (22% CP, 3086 kcal/kg) adequate in all nutrients but npP. Diets were formulated to contain 0.50% (standard, SP) or 0.35% (marginal, MP) npP and were fed for 28 d. Individual body weights and pen feed consumption were recorded weekly and corrected for mortality. At hatch, both tibiae from 15 chicks per flock and sex were analyzed. Each week thereafter, 24 birds per treatment were sacrificed for evaluation of both tibiae. Exp. 1 resulted in no differences in breaking force, whether flesh remained on the bone or was removed.

Due to the lower npP level in Exp. 2, MP chicks weighed 6.6% less (P<0.001) than SP birds at 28 d. Bone breaking forces were improved (P<0.001) when chicks were fed SP (17.3 kg) rather than MP (14.9 kg). Weight gain (1033 vs. 1194 g), feed consumption (1773 vs. 2020 g), and breaking force (17.4 vs. 14.8 kg) differed (P<0.001) from 0-28 d for chicks hatched from the 25- and 65-wk-old breeder flocks, respectively. In comparison with females, male chicks had an increase (P<0.001) in final body weight (1089 vs. 1220 g), total feed consumption (1783 vs. 2010 g) and tibia breaking force (14.6 vs. 17.6 kg). These results indicate that broiler growth and performance can be affected by maternal flock age, chick sex, and dietary npP.

Key Words: phosphorus, bone strength, maternal age, broiler


Fluoride (F) has been shown to have varying degrees of beneficial effects on bone mineralization and strength, despite its toxic effects on growth and leg disorders. Some studies have demonstrated an increase in bone ash due to F supplementation. The purpose of the present study was to determine whether low levels of dietary F had any beneficial effect on bone strength and leg disorders of young chicks. Effects on body weight and feed efficiency were also analyzed to monitor for F toxicity.

Day-old Cobb × Cobb broiler chicks were weighed and randomly allocated into treatment groups with ten chicks per replicate. Chicks were identified by metal wing bands and were housed in electrically heated Petersime raised–wire–floor battery brooders. All chicks were provided with water and experimental diets ad libitum. Two control diets were formulated with two different phosphorus (P) sources in the two experiments (Exp 1 and 2): Treatment 1 contained purified dicalcium phosphate to represent a diet with zero F; Treatment 2 contained unpurified dicalcium phosphate to simulate a commercial diet with low–level F. Treatments 3 and 4 used purified dicalcium phosphate as the P source and contained 22 and 44 ppm F from NaF, respectively.

Four more treatments were added for the Exp 2: Treatments 5, 6, 7 and 8 used purified dicalcium phosphate as the P source and contained 66, 88, 110 and 132 ppm F from NaF, respectively.
Chicks fed purified vs. commercial dicalcium Phosphate grew better in Exp 1 (p<0.05) and had less incidence of P-deficiency rickets in Exp 2 (p=0.01). Percent bone ash responded differently to F in Exp 1 vs. Exp 2 (p=0.046). Percent bone ash was increased by increasing F level in the diets in Exp 1, but not Exp 2. It is important to note that even low levels of F like those used in our study have the potential to create a measurable effect.

**Key Words:** fluoride, broiler, bone ash, phosphorus rickets, body weight gain

**52 Comparative effect of vitamin C and direct-fed microbial on the broiler performance, ileal microbial population profile, and gut morphology under heat stress condition.** R. Poureslami*,1,2, A. Yaghobfar3, A. Karimi3, and A. Kamyab4,1

The objective of this study was to evaluate the effect of vitamin C and direct-fed microbial (DFM) on the broiler performance, ileal microbial population profile, and gut morphology under heat stress (HS) condition. Four hundred eighty chickens were fed with either one of the 5 diets (1-42 d) in 6 replicates; basal diet as control diet (C), basal diet supplemented with either 0.1% Saccharomyces cerevisiae (S), 0.2% Aspergillus oryzae (A), 0.1% Primatal (P), or 4 ml/l liquid vitamin C (V). The room temperature was maintained 5 °C higher than the conventional temperature for 3 hours a day to induce HS. At 42 d of age, chickens were killed, and gastrointestinal tract was excised from 3 carcasses per pen for lab analysis. Plating method was used to count the total number of microbes in ileum. Morphometric analysis of small intestine was performed using PAS staining method. Dietary treatments did not have an effect on feed intake, FCR, and live weight (p<0.05). Diets had no effect on ileal pH, and counts of Enterococcus, Clostrifoms, Aspergilus, Saccharomyces, Lactobacillus, Bifidobacterium, Clostridium, total anaerobic and aerobic bacterial (P<0.05). Villus height, villus width (μm), crypt depth (μm), and villus height/crypt depth ratio in ileum, jejunum, and duodenum were influenced by the dietary treatments (P<0.05). However, this effect was not consistent in different segments. For instance, villus height in ileum, jejunum, and duodenum was higher in C, S, and A respectively compared to the other groups (P<0.05). In conclusion, low level of liquid vitamin C and DFM in the diet did not induce a significant effect on broiler performance under heat stress condition in this study however a moderate change occurred in the small intestine morphology.

**Key Words:** direct-fed microbial, broiler, heat stress

**53 Effect of source and level of maternal vitamin D on carryover to newly hatched chicks.** C. A. Coto*, F. Yan, S. Cerrate, Z. Wang, Y. Min, F. Perrazo, and P. W. Waldroup, University of Arkansas, Fayetteville.

Fraser and Emtrage (1976) found 5% of the vitamin D deposited in the egg as 25-hydroxycholecalciferol (25-OH). This suggests that 25-OH might not be effective in supplementing vitamin D to the developing embryo. Maternal stores may play an important role in alleviating early-onset rickets. A study was conducted to evaluate the effect of maternal cholecalciferol (VitD3) and 25-OH on the progeny performance. Breeder pullets were fed during two months a vitamin D deficient diet to deplete liver stores; samples were taken to evaluate the vitamin D status. Afterward, experimental diets were assigned in a 2 x 5 factorial arrangement with two levels of supplemental 25-OH (0 or 69 μg/kg) and five levels of Vit D3 (0, 300, 600, 1200, 2400 IU/kg). Records of body weight, egg production, egg weight, and egg shell thickness were maintained. At the end of two months on test diets, samples of eggs yolks were collected for VitD3 and 25-OH determination. Eggs were hatched by maternal diet. At day 1, livers and tibia samples were collected to determine vitamin D forms and mineralization, respectively. Chicks were fed a common diet containing 5500 UI/kg of VitD3 for 21 days. Body weight (BW), mortality and feed conversion (FCR) was determined at 7, 14 and 21 days. At day 21, samples of birds were collected for toe ash and TD determination.

Eggshell thickness, egg production and egg mass were improved by increasing levels of VitD3 and the addition of 25-OH. Interaction between VitD3 and 25-OH was found for these parameters, where 25-OH addition at low VitD3 levels improved performance with no effect at high VitD3 levels. Bone mineralization at day 1 was improved by increasing levels of VitD3; 25-OH was effective at low VitD3 levels with no effect at high VitD3 levels. Progeny FCR and BW were improved by increasing levels of VitD3 and the addition of 25-OH. Moreover, 25-OH improved mineralization and reduced the severity of TD. These results support maternal 25-OH supplementation as an effective means to supply vitamin D to the developing embryo.

**Key Words:** vitamin D, 25-hydroxycholecalciferol, breeder hens, leg weakness

**54 Effect of dietary vitamin U supplementation on the growth performance of young broiler chickens.** R. Thanissery*, K. S. Macklin, W. Zhai, J. P. Blake, and Y. O. Fasina, Auburn University, Auburn, AL.

Vitamin U (DL-Methionine methyl sulfonyl chloride) is known to have intestinal healing effects in humans and swine, and improve growth performance in different animal species such as cattle and hog. The objective of this study was to evaluate the effect of vitamin U on the growth performance of young broiler chicks. Using a randomized complete block design, day-old male broiler chicks obtained from a commercial hatchery were randomly assigned to 36 pre-heated pens (14 chicks per pen) for 3 experimental treatments. Each treatment had 12 replicate pens. Experimental starter and grower diets were made up of commercial hatchery feed and water throughout the study. Body weight, body weight gain, feed and water throughout the study. Body weight, body weight gain, feed intake, and feed conversion were calculated weekly. Mortality was recorded daily. Data collected was subjected to one-way ANOVA using the General Linear Models procedure of SAS. Results showed no differences (P > 0.05) in growth parameters between chicks in CN and CV throughout the experiment. However, chicks in CB treatment had higher body weight (P < 0.05) compared to those in CN and CV. Lastly, mortality was lower for the CV treatment (P < 0.05) compared to both the CN and CB during the first week of experiment. It was concluded that dietary supplementation of vitamin U at 1.993g/kg level of the diet did not improve growth performance, but reduced early chick mortality.

**Key Words:** vitamin U, bacitracin methylene disalicylate (BMD), growth performance, broiler chicks
55 Egg folate concentration and indices of folate status in laying hens supplemented with dietary folic acid and 5-methyltetrahydrofolate. G. B. Tactacan,1 M. Jing,1 S. Thiessen,1 D. L. O’Connor,2 J. C. Rodriguez-Lecompte1, W. Guenter1, and J. D. House1, 1University of Manitoba, Winnipeg, MB, Canada, 2Hospital for Sick Children, Toronto, ON, Canada.

The deposition of dietary folic acid (FA) into the chicken egg is likely regulated by its conversion to 5-methyltetrahydrofolate (5-MTHF), the predominant form of this vitamin in eggs (>80%). Supplementation of 5-MTHF in the laying hens’ diet may therefore enhance total egg folate concentrations. To this end, a study was conducted using equimolar concentration of either FA or 5-MTHF in diets fed to both Shaver White and Shaver Brown laying hens, to investigate their influence on total egg folate concentrations, and indices of performance and folate status. A total of 24 laying hens (24 weeks) from each strain were randomly assigned to receive 1 of 3 (n=8) dietary treatments: 1) basal diet with no supplemental folate and 2) basal diet + 10 mg/kg FA and 3) basal diet + 11.30 mg/kg 5-MTHF, for 21 days. Production performance, plasma homocysteine, liver, serum and egg folate concentrations were measured. Feed efficiency for birds consuming diet 3 improved (P<0.05) by 11.9 and 10.7% respectively, compared to hens consuming diet 1 and diet 2; while egg weight increased (P<0.05) by 6% compared to diet 1. Plasma homocysteine was lower (P<0.05) by 14.2%, while serum and egg folate were higher (P<0.05) by 78.3 and 61.8% in hens consuming either folate species as compared to control. Liver 5-MTHF was not affected by folate supplementation. Together, these data provide evidence that supplementation of FA and 5-MTHF have equivalent effects in enhancing egg folate concentrations and improving folate status in laying hens. Supplementation of 5-MTHF may improve production performance, but this remains to be determined in larger production studies. The data also support a point of regulation of egg folate deposition that is prior to hepatic folate metabolism, possibly at the level of intestinal folate uptake and metabolism.

Key Words: folate, folic acid, 5-methyltetrahydrofolate, egg, laying hen


The Reduced Folate Carrier (RFC; SLC19A1) is regarded as an important folate transporter in humans and other mammals. However, its importance in avian systems is unclear. In the present study, the molecular cloning and tissue distribution of RFC and the impact of dietary folate supplementation on the mRNA expression of this transporter were investigated in the chicken. Twenty-four (n = 8/treatment) Shaver White laying hens were randomly divided to receive one of three dietary treatments: a) basal diet with no supplemental folate; b) basal diet + 10 mg/kg crystalline folic acid; or c) basal diet + 11.30 mg/kg 5-methyltetrahydrofolate (5-MTHF) for 21 d. RFC mRNA levels were analyzed by real-time PCR. The results showed that the RFC cDNA containing the full coding region was cloned from duodenum with 99% identity to the reference gene available in GenBank. RFC transcripts were detected in a variety of chicken tissues (e.g., brain, liver, kidney, intestine, etc). Real-time PCR analysis showed no differences (P > 0.05) due to diet in the duodenal and cecal RFC mRNA levels. However, compared with the basal diet, jejunal RFC mRNA was depressed (P < 0.05) in hens fed the 5-MTHF diet, and a reduction (P = 0.077) was also found in hens fed the folic acid diet. Taken together, these data showed that the RFC cDNA containing the entire coding region was successfully cloned from laying hens. A broad tissue distribution of RFC mRNA may indicate the importance of RFC in the folate transport process in chickens. Furthermore, jejunal RFC mRNA was down-regulated by dietary folate supplementation. These findings contribute to our understanding of folate transport in avian systems, including laying hens.

Key Words: reduced folate carrier (RFC), dietary folate supplementation, cloning and tissue distribution, mRNA expression, laying hens

Physiology, Endocrinology, and Reproduction


Fully characterizing the protein composition of spermatozoa is the first step in utilizing proteomics to delineate the function of sperm proteins. To date, sperm proteome maps have been partially developed for the human, mouse, rat, bull and several invertebrates. Here we report the first proteomic analysis of turkey and rooster spermatozoa, using MALDI-TOF and LC-MS/MS. Semen was centrifuged through a discontinuous Accudenz gradient to remove seminal plasma. Protein was extracted from isolated sperm cells and the soluble fraction separated by 2-D SDS-PAGE (pl 5-8). Excised spots were digested with trypsin and prepared for MALDI-TOF analysis. Proteins were identified from Peptide Mass Fingerprints using the MASCOT search engine (Matrix Science). Samples yielding non-significant Mowse probability scores were subjected to LC-MS/MS analysis. When necessary, homology searches were performed for unnamed protein products via BLAST searching. A total of 94 and 36 proteins were identified from turkey and rooster spermatozoa, respectively. All proteins identifications were limited to Gallus gallus and/or Meleagris gallopavo. For turkey sperm, 9 hypothetical proteins (6 matching to chicken chromosome open reading frames via BLAST search) were identified, while another 16 were predicted proteins of unknown function. For rooster sperm, 5 hypothetical proteins (2 matching to chicken chromosome open reading frames) were identified, and an additional predicted protein of unknown function was positively identified. Identified proteins were associated with the acrosome (pro-acrosin), mitochondria (enolase 1, voltage-dependent anion channel 2, creatine kinase), and flagellum (capping protein, dynein, tektins 1-5). Several chaperone (heat shock protein 70) and calcium-binding (EF-hand protein) proteins also were identified. Three proteins not previously found in sperm were identified: dihydropyrimidinase, mitofilin and mitochondrial tri-functional protein. While the latter 2 mitochondrial proteins most likely exist in sperm from other species, the discovery of dihydropyrimidinase as a predominant soluble protein in poultry sperm poses interesting functional implications.

Key Words: turkey, rooster, sperm, proteome, dihydropyrimidinase
58 Germline replacement by transferring primordial germ cells into sterilized embryos in the chicken. Y. Nakamura*1,2, F. Usui1, K. Takekura, T. Ono1, K. Nirasawa2, H. Kagami1, and T. Tagami2, 1Shinshu University, Minamimino, Nagano, Japan, 2National Institute of Livestock and Grassland Science, Tsukuba, Ibaraki, Japan.

It is possible to produce avian germline chimeras by transfer of exogenous primordial germ cells (PGCs) into host embryos. However, a lack of definitive method to incorporate donor PGCs into the host germline has been due to the limitation of applied researches. Here, we report a generally applicable strategy for replacement of the host germline with donor germ cells in the chicken. Barred Plymouth Rock (BPR) and White Leghorn embryos were used as donors and hosts, respectively. Both males and females of PGCs were collected separately from blood of donor embryos incubated for 52 h. Additionally, some PGCs were labeled with the fluorescent dye to monitor the gonadal migration. To deplete endogenous PGCs of host embryos, 100 µg of busulfan was applied at 0 h of incubation. Each of 200 donor PGCs were transferred into bloodstream of busulfan treated- or untreated control host embryos at 55 h of incubation with the same sex combination of donors and hosts. Manipulated embryos were incubated for a total of 6 d, or until they hatched. Germline chimerism in the gonads at 6 d of incubation was evaluated by immunohistochemical analysis using anti-chicken vasa homolog antibody. After sexual maturation of chatted chickens, germline chimerism was evaluated by testcross analysis using artificial insemination with BPR. The proportion of donor PGCs in the embryonic gonads in busulfan treated hosts (98.8 ± 1.7 %) was significantly higher than that in untreated control hosts (6.9 ± 1.4 %) (P < 0.01). The hatchability in busulfan treated hosts (40.4 %) was significantly lower than that in untreated control hosts (76.5 %) (P < 0.05). Testcross analysis showed that the germline transmission rate in busulfan treated hosts was 100 %. In contrast, the rate that in untreated control host was 5.3 ± 4.8 %. These results suggested that donor PGCs were successfully settled to host gonads where endogenous PGCs had been depleted and differentiated normally into functional gametes. In conclusion, the present method enables to produce chimeric chickens in which host germline has been almost totally replaced by donor germ cells.

Key Words: germline replacement, primordial germ cells, sterilization, chicken, busulfan

59 Cryopreservation and transplantation of ovarian tissue in Japanese quail. J. Liu*1, Y. Song1,2, K. M. Cheng1, and F. G. Silversides2, 1Avian Research Centre, University of British Columbia, Vancouver, BC, Canada, 2Agriculture and Agri-Food Canada, Agassiz, BC, Canada.

A protocol for the transplantation of frozen-thawed gonadal tissue has been developed as an effective method for germplasm conservation in chickens. We attempted to adapt this protocol for conservation of Japanese quail. Ovaries of week-old quail were removed and frozen in 0.5 ml straws with 10% (v/v) DMSO, using a programmable freezer. The straws were then stored in liquid nitrogen. Vitrification was done by submerging pieces of tissue in 7.5% (v/v) DMSO for 10 min and then 15% DMSO for 2 min at room temperature (RT). The tissue was then quick-frozen and stored in sealed cryovials in liquid nitrogen for at least 48 hr. Straws containing slow-frozen samples were thawed in ice water, and the thawed tissue was rinsed in DMEM containing 10% FBS. Vitrified samples were removed from the vials and transferred in sequence into 1M, 0.5M, and 0.25M sucrose and DPBS, each for 5 min at RT. Viability after freezing was estimated as the viability of dissociated cells using a hemocytometer and by histological examination of frozen ovarian tissue. Frozen-thawed tissue from WB (recessive plumage colour) chicks was transplanted into week-old ovariectomized QO (wild type plumage) chicks with some chicks receiving fresh tissue as a control. At sexual maturity, QO recipients were mated to WB males and the production of WB offspring demonstrates successful cryopreservation and transplantation. Both freezing methods led to significantly (P<0.05) lower cell viability compared to fresh cells. Vitrified quick frozen cells survived (77%) significantly (P<0.05) better than step-wise frozen cells (70%). Histological examination showed reduced follicle counts in both methods. Two out of 9 birds receiving slow-frozen grafts produced donor-derived offspring. Further optimization will be needed to improve the efficiency of this cryopreservation method.

Key Words: Japanese quail, ovarian tissue, cryopreservation, transplantation


In the layer and broiler industries, approximately 50% of all chicks that hatch are killed immediately because they are the non-preferred sex. Manipulation of the hens such that they preferentially produce more female or male offspring has the potential to increase efficiency and productivity in the industry. Previous studies in both wild and captive birds suggest that treatment with hormones can stimulate females to manipulate the sex of their offspring before eggs are even ovulated. In particular, chronic treatments with corticosterone, the primary stress hormone produced by birds, stimulated significant skew towards female offspring in avian species and it has been suggested that corticosterone acts by influencing which sex chromosome is donated by the heterogametic female bird into the ovulated ovarian follicle. However, the corticosterone treatment was given over a long period of time, making it impossible to pinpoint when its effects on offspring sex occurred. We treated laying hens with acute high-dose corticosterone injections 5h prior to ovulation and quantified the sex of the subsequently ovulated eggs. We hypothesized that an injection of corticosterone coincident with the segregation of the sex chromosomes would stimulate females to produce more female offspring than male offspring. Contrary to our predictions, hens injected with corticosterone produced nearly 76% males, a significant bias towards male offspring. Based on the results, we propose that an acute increase in corticosterone during genetic sex determination is a possible mechanism for sex ratio manipulation in birds, and that acute corticosterone exposure, compared with chronic exposure, may act through a different mechanism to skew offspring sex.

Key Words: sex ratio, corticosterone, stress hormones, sex determination, meiosis

61 Use of transponder implants for the accurate determination of air cell temperature, eggshell conductance and their functional relationships in embryonated broiler hatching eggs. R. Pulikanti* and E. D. Peebles, Mississippi State University, Mississippi State.

Broiler hatching eggs obtained from a young breeder flock (Ross X Ross 308; 34 wk of age) were weighed and set on 8 replicate trays (incubator levels; approximately 20 eggs per tray) of a single incubator. On Day 11 of incubation, all eggs were weighed, and temperature transponders were implanted in the air cells of 4 randomly selected embryonated eggs per tray for determination of internal egg temperature (IT). Two water filled vials per tray containing transponders were also used for...
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memory caused by epigenetic adaptation. Thermal (heat) manipulations
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more attention. It can be related to the recognition that during this

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and chick juvenile growth.

lasting physiological memory
18 of incubation) and post-hatch periods.
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TM during incubation at periods critical for the hypothalamus-pituitary-
parameters were significantly lower than that of control, suggesting a
constant and plasma concentrations of thyroxine, triiodothyronine and
corticosterone were significantly lower in comparison with the control.
egg shell temperature and oxygen consumption increased along with the
elevation of incubation temperature. However, heart rate was relatively
constant and plasma concentrations of thyroxine, triiodothyronine and
corticosterone were significantly lower in comparison with the control.

During the endothermic period of incubation, on days 18 onwards, all
parameters were significantly lower than that of control, suggesting a
significant decline in the embryo’s metabolic rate which lasted along the
post-hatch growth period of the chickens. It can be concluded that
TM during incubation at periods critical for the hypothalamus-pituitary-
thyroid development, induces a long-lasting-thermoregulatory response
characterized by significant decline in metabolic rate on pre- (from day
18 of incubation) and post-hatch periods.

Key Words: broilers, embryogenesis, thermal manipulations, long
lasting physiological memory

62 Preparing the broiler embryo for post hatch hot environmental
conditions. Y. Piestun1, O. Halevy2, and S. Yahav*1, 1Institute of
Animal Science ARO the Volcani Center, Bet Dagan, Israel, 2Department
of Animal Sciences, Faculty of Agriculture, the Hebrew University of
Jerusalem, Rehovot, Israel.

During the last decade the incubation period of broilers has gotten
more attention. It can be related to the recognition that during this
period various manipulations may induce long-lasting-physiological-
memory caused by epigenetic adaptation. Thermal (heat) manipulations
during the period of the hypothalamus-pituitary-thyroid or adrenal axes
development and maturation have demonstrated a significant improve-
ment in thermotolerance acquisition of broiler chickens up to market-
ing age. However, the effect of these manipulations on the embryos’
thermoregulation is still not clear. This study aimed at elucidating the
effect of continuously or intermittent (12 h/day) thermal manipulations
(TMts) at 39.5°C between days 7 to 16 (included) of embryogenesis
on egg shell temperature, oxygen consumption and heart rate of the
embryos, as well as on the plasma concentration of the thyroid and
corticosterone hormones. During the ectothermic period of incubation,
egg shell temperature and oxygen consumption increased along with the
elavation of incubation temperature. However, heart rate was relatively
constant and plasma concentrations of thyroxine, triiodothyronine and
corticosterone were significantly lower in comparison with the control.

During the endothermic period of incubation, on days 18 onwards, all
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characterized by significant decline in metabolic rate on pre- (from day
18 of incubation) and post-hatch periods.

Key Words: broilers, embryogenesis, thermal manipulations, long
lasting physiological memory

63 Comparison of Cobb and Ross strains in embryo physiology
and chick juvenile growth. K. Tona*1, O. M. Onagbesan2, V. Brugge-
man3, B. Kamers3, N. Everaert3, and E. Decuyper3,1University of Lome,
Lome, Togo, 2University of Agriculture, Abeokuta, Nigeria, 3Catholic
University of Leuven, Leuven, Belgium.

Broiler performance is known to be related to embryonic developmental
parameters. However, strain or genotype differences with regard to
embryo physiological parameters and juvenile growth have received
little attention. A total of 1,200 hatching eggs produced by Cobb and
Ross broiler breeders of the same age were studied. At setting for
incubation and between 66 and 130 h of incubation, eggs resonance
frequency (RF) was measured as indicator of embryonic development.
From d 10 to 18 of incubation, remaining albumen was weighed and at
d 18 of incubation, eggs were weighed. During the last days of incuba-
tion, hatching events were monitored every two hours. Hatched chicks
were recorded and weighed. At internal pipping (IP) stage, gas partial
pressures in egg air chamber were measured. Hatched chicks
were reared for 7 d and weighed. Results indicate that RF of Ross eggs
were lower than that of Cobb eggs (P < 0.01) and starting time point of RF
decrease occurred earlier in Cobb eggs than in Ross eggs. Relative egg
weight loss up to 18 d of incubation was lower in Cobb than in Ross (P
< 0.05). At IP, pCO2 was higher in Cobb than in Ross (P < 0.05) with
shorter incubation duration in Cobb. Between 6 and 60 h post-hatch,
heat production (HP) was higher in Cobb than in Ross (P < 0.05). At 7
d post-hatch Cobb chicks were heavier than Ross chicks (P < 0.05).
It is concluded that Cobb and Ross embryos/chicks have different growth
trajectories leading in different patterns of growth resulted from differences in physiological parameters.

Key Words: Cobb, Ross, embryo physiology, hatching events, juvenile growth

64 The role of syndecan-4 covalently attached chains in muscle
growth and development. Y. Song* and S. G. Velleman, Ohio Agri-
cultural Research and Development Center, The Ohio State University,
Wooster.

Skeletal muscle formation is a complex process involving the interac-
tions between cells and their extracellular matrix (ECM). Syndecan-4 is
a cell membrane heparan sulfate proteoglycan that translocates signals
from the ECM into the cell. Syndecan-4 is composed of a transmembrane
core protein and covalently attached glycosaminoglycan (GAG) chains
and N glycosylation (N) chains. The GAG chains have been shown not
to be required for syndecan-4 to regulate muscle cell proliferation and
differentiation. The N chains have been reported to be involved in protein
proper folding, and cell surface localization of membrane proteins. It is
possible that N chains influence syndecan-4 core protein three dimen-
sional structure and the availability of the GAG chains to interact with
other molecules. In this study, the role of syndecan-4 N chains and the
interaction between GAG and N chains in muscle cell proliferation and
differentiation were explored. Turkey syndecan-4 with or without GAG
chains was cloned into the pCMS-EGFP vector and used as a template to
generate syndecan-4 N chain mutants with or without GAG chains. Syn-
decan-4 N chains are attached to the core protein at Asn124 and Asn36.
The N chain one-chain and no-chain mutants were obtained by changing
each Asn to Ala. Wild type syndecan-4, syndecan-4 N chain mutants
with or without GAG chains, and the pCMS-EGFP empty vector were
transfected into turkey skeletal muscle satellite cells. After transfection,
cell proliferation and differentiation were measured. The overexpression
of syndecan-4 N chain mutants with GAG chains did not change cell
proliferation, while syndecan-4 N chain mutants without GAG chains
increased cell proliferation. Cell differentiation was not changed when
cells were transfected with syndecan-4 N chain mutants with or without
GAG chains compared to wild type syndecan-4. These results suggest that syndecan-4 GAG chains and N chains function together to regulate muscle cell proliferation, but not differentiation.

Key Words: syndecan-4, muscle, turkey, glycosaminoglycan, N glycosylation

65 Coenzyme Q10 content varies based upon muscle phenotype and age in turkeys. L. S. Nierobisz*, N. G. Hentz, J. V. Felts, and P. E. Mozdziak, North Carolina State University, Raleigh.

The cellular antioxidant Coenzyme Q10 (CoQ10) is one of the major components of mitochondrial electron transport and plays an important role in the production of cellular energy in the form of ATP. Histological alterations in muscle fibers have been correlated with a type of cellular energy. The objective of this study was to determine the relationship between mitochondrial protein, CoQ10 content, and muscle type in turkeys. Anterior Latissimus Dorsi (ALD; slow/oxidative muscle), Posterior Latissimus Dorsi (PLD; fast/glycolytic muscle), Pectoralis Major (PM), and Biceps Femoris (BF) muscles were analyzed in 9 and 20-week old turkey toms. The amount of muscle mitochondria was determined using Bradford assay and CoQ10 content was measured using HPLC-UV. The amount of mitochondrial protein relative to total protein significantly decreased (P<0.05) between 9 and 20 wk of age. Significant differences (P<0.05) in total muscle and mitochondrial CoQ10 content were observed with age. Additionally, total muscle and mitochondrial CoQ10 content in ALD and BF muscles was significantly higher (P<0.05) than that in PLD and PM muscles. The mitochondrial CoQ10 content significantly increased (P<0.05) between 9 and 20 wks in ALD and BF muscles, but it significantly decreased (P<0.05) in PLD and PM muscles. On week 20, the mitochondrial to total muscle CoQ10 ratio was significantly higher (P<0.05) in ALD and BF muscles than that in PLD and PM muscles. It appears that there is an age-related decrease in mitochondrial and CoQ10 content, and that muscles with a slow phenotypic profile contain a higher proportion of CoQ10 than muscles with a fast phenotypic profile.

Key Words: Coenzyme Q10, HPLC, mitochondria, muscle phenotype, turkeys

66 Mitochondrial proton leak kinetics and relationship to feed efficiency within a single genetic line of male broilers. W. G. Bottje*, M. D. Brand1, C. Ojano-Dirain3, K. Lassiter1, M. Toyomizu4, and T. Wing1. 1University of Arkansas, Department of Poultry Science, Center of Excellence for Poultry Science, Fayetteville, 2Buck Institute for Age Research, Novato, CA, 3Mitochondrial Disease Research Lab, College of Medicine, University of Florida, Gainesville, 4Graduate School of Agricultural Science, Tohoku University, Sendai, Japan, 5Cobb-Vantress, Inc., Siloam Springs, AR.

Studies were conducted to assess proton leak kinetics (proton conductance) in breast muscle mitochondria isolated from broiler breeder males within a single genetic line exhibiting either high (HFE) or low (LFE) feed efficiency. Proton conductance was determined by simultaneously measuring mitochondrial membrane potential (MMP) and State II (resting) respiration rate in breast muscle mitochondria as succinate oxidation was progressively decreased by malonate. Control proton conductance was similar in HFE and LFE mitochondria and decreased in both groups in response to bovine serum albumin (BSA). Whereas treatment of mitochondria with glutamate (Glut) or guanosine diphosphate (GDP) had no effect, retinal (RET) increased and carboxyatractylate (CAT) alone or in combination with glutamate (Glut) decreased proton conductance relative to control proton conductance in both HFE and LFE mitochondria. Following treatment with either GDP or CAT alone, proton conductance was lower in HFE compared to LFE mitochondria. With the exception of BSA, proton conductance in HFE mitochondria following the various chemical treatments was either less than or equal to, and never greater than proton conductance in the LFE mitochondria. The results suggest that there are subtle differences in membrane characteristics (e.g. lipid composition or integral membrane proteins) that affect proton conductance during the utilization of BSA. The results also suggest that there are differences in membrane characteristics (e.g. lipid composition or integral membrane proteins) that affect proton conductance in broiler muscle mitochondria that may in turn play a role in the phenotypic expression of feed efficiency in broilers.

Key Words: broiler, feed efficiency, mitochondria, proton leak kinetics

67 Functional characterization of the chicken glucocorticoid and mineralocorticoid receptors. M. Proszkowiec-Weglarz* and T. E. Porter, University of Maryland, College Park.

Glucocorticoid receptors (GR) and mineralocorticoid receptors (MR) are ligand-activated transcription factors that belong to the nuclear hormone receptor superfamily. Once activated by their steroid hormone ligands, they bind to specific glucocorticoid response elements (GRE) in gene promoters to regulate transcription. Chicken GR (cGR) was recently cloned, while chicken MR (cMR) was only partially sequenced. Little is known about the functional properties of cGR and cMR. Therefore, the aim of this project was to clone the full length cGR and cMR, determine whether cGR and cMR proteins have the ability to bind glucocorticoids and mineralocorticoids and induce transcription through a classical GRE, and define the dose-response relationships for cGR and cMR to steroids. Cos-7 cells, lacking endogenous GR and MR, were transiently transfected with pCMVSport6.1-cGR or -cMR expression vectors, MMTV-Luc GRE-reporter construct, and pSV40 renilla construct (to correct for transfection efficiency). Cells were then treated with increasing doses of corticosterone (CORT) or aldosterone (ALDO), and transactivation of cGR or cMR was evaluated by luciferase assay. CORT and ALDO induced cGR- and cMR-driven MMTV transcriptional activity in a dose-dependent manner. Each receptor responded to both steroids, but cMR responded to lower levels of CORT and ALDO than cGR. Dose-responses for the two steroids differed significantly (P<0.05) at the 1 and 100 nM doses for cGR and at the 0.1 nM dose for cMR. Furthermore, CORT-dependent transactivation of cGR was significantly (P<0.05) blocked by its antagonist (ZK98299). Our results indicate that cGR and cMR genes express functional, ligand-activated receptor proteins that have the ability to bind to the classic GRE sequence and induce transcription. Better understanding of cGR and cMR function will be helpful in defining their physiological roles in avian species.

Supported by USDA-CSREES Grant #2009-35206-05189.

Key Words: GR, MR, steroids, nuclear receptor

68 A novel antibody for the detection of gonadotropin releasing hormone receptor-2 protein in chickens. H. O. McFarlane* and G. Y. Bédécairats, University of Guelph, Guelph, ON, Canada.

Two gonadotropin releasing hormone receptors have been characterized in chickens (cGnRHR-1 and cGnRHR-2), with cGnRHR-2 being pituitary specific. The purpose of this study was to validate a novel antibody specific to cGnRHR-2 and, using this antibody, determine if
pituitary protein levels change during sexual maturation. Two antibodies were developed using the BioPerformancePlus protocol (Affinity BioReagents) by immunizing rabbits with synthetic peptides corresponding to portions of the cGnRHR-2 N-terminal extracellular domain. Specific immuno-globulins (Igs) were affinity purified and evaluated through dot-blot analysis. Western blots were performed on pituitaries harvested from immature and sexually mature male and female Barred Plymouth Rock chickens to further quantify any changes in receptor levels during sexual maturation. Furthermore, Igs were also tested on COS-7 cells transfected with either cGnRHR-2, cGnRHR-1, chicken gonadotropin inhibiting hormone receptor (cGnIHR) or empty pcDNA3 expression vectors.

Initial dot-blot analyses revealed that Igs against peptide 1 had the highest affinity and titre. Thus, these Igs were selected for further validation. Western blots showed a strong specific band in pituitary samples at around 50kDa that was competed out by pre-incubation with peptide 1. In pituitaries, the lowest receptor levels were observed in immature males, significantly increasing post photostimulation. In females, cGnRHR-2 levels also increased post photostimulation with levels consistently higher than in males. In addition, a shorter receptor variant, possibly corresponding to an mRNA splice variant previously identified, was also detected. However the amount was 6-10 fold lower than that of the full length receptor. Immunocytology experiments revealed that in live cells, Igs are specific to cGnRHR-2.

In summary, our antibody is specific to cGnRHR-2 and can be used for western blotting as well as immunohistology. In addition, levels of receptor in chicken pituitaries appear to be higher in females than males and increase in both sexes post-photostimulation.

Key Words: gonadotropin releasing hormone, receptor, chicken, sexual maturation, pituitaries

69 Melanopsin in the pre mammillary nucleus of the avian hypothalamus may trigger seasonal reproduction. S. W. Kang*, B. Leclerc, and M. E. El Halawani, University of Minnesota, St. Paul.

Melanopsin (cOPN4) has been proposed as an important photoreceptive molecule regulating the avian circadian system. Previous studies in our laboratory have shown that co-localized dopamine-melanin (DA-MEL) neurons in the hypothalamic pre mammillary nucleus (PMM) are photosensitive and exhibit circadian rhythms. This study investigates chicken OPN4 (cOPN4) mRNA distribution in the turkey hypothalamus and brainstem, and characterizes cOPN4 mRNA expression in PMM DA-MEL neurons, using in situ hybridization (ISH), double-label immunocytochemistry (ICC), double ISH/ICC, and real time-PCR. cOPN4 mRNA was found in anatomically discrete areas in or near the hypothalamus and the brainstem, including POM (nucleus preopticus medialis), SL (nucleus septalis lateralis), PMM and the pineal gland. Double ICC, using tyrosine hydroxylase (TH)/cOPN4 antibodies, confirmed that the cOPN4 protein coexisted in the DA-MEL neurons and cOPN4 mRNA expression was confirmed with double ISH/ICC using cOPN4 mRNA and TH immunoreactivity. PMM and pineal gland cOPN4 mRNA expression levels were high during the night and low during the day, indicating circadian rhythmicity. Stimulation with light during the dark period in short day hens downregulated cOPN4 expression level significantly at the avian photosensitive phase (circadian time 14 h; CT14), more so than it did at CT8 and CT20. There was a significantly lower level of cOPN4 mRNA in PMM neurons in photorefractory hens as compared with short and long day hens. The present study is the first to show that cOPN4 is expressed in the DA-MEL neurons controlling seasonal reproduction and also the first to show cOPN4 expression peaking at night as part of the circadian rhythm. The results suggest that cOPN4 in the PMM DA-MEL neurons in the hypothalamus might constitute an important photoreceptive system for regulating reproductive function in the female turkey. Supported by National Research Initiative Grant (2007-35203-18072) from the USDA Cooperative State Research, Education, and Extension Service

Key Words: melanopsin, dopamine, turkey, avian reproduction, real-time PCR

70 Evaluation of the minimum dose of dietary thyroxin sufficient to induce molt in turkey breeder hens. V. A. L. Gulde*1, R. Renema*, and G. Y. Bedecarrats1, 1University of Guelph, Guelph, ON, Canada, 2University of Alberta, Edmonton, AB, Canada.

In the turkey industry, the standard method of molting consists of removing feed and water and reducing the photoperiod. As this results in severe stress, an alternative needs to be developed. Our previous study showed that 10 days of 40 ppm dietary thyroxin (T4) supplementation induces a complete molt in turkeys when combined with a reduction in photoperiod. The present study aimed at determining the minimal dose of T4 sufficient to induce molt while allowing hens to return into production. Spent White turkey hens (75 weeks old; n=220) were randomly split into 8 groups (5 floor pens (replicates)/group, 5 hens each). During the first 10d, all groups were kept under 15h light and, while 2 control groups were fed a breeder’s diet, the 6 remaining groups were given either 1, 10 or 20 ppm T4 (2 groups/dose). On d10, all groups were switched to 6h light and fed a holding diet. After a 6 or 12 wks holding period, 1 group per treatment (control, 1, 10 and 20 ppm T4) was photostimulated with an abrupt change to 15h light and was fed the breeder’s diet. Egg laying, feed intake, body weight, molt and behavior were monitored. Hens from the 20 ppm group ceased laying by d23 while all other treated hens ceased laying by d28 and control hens by d33. All hens resumed lay 30d after stimulation, reaching peak production 20d later. During the T4 supplementation period, feed intake for the 20 ppm groups was lower (P<0.05) than for the control groups. By d5, all hens fed T4 showed a rapid body weight loss (P<0.001). However, control hens also lost weight (P<0.001) by d13. By d18, the rate of molt was significantly higher for hens fed 10 and 20 ppm (P<0.01). Although all hens completed molt by d68, completion was faster for hens fed 20 ppm T4 (P<0.05). Throughout the experiment, no hens showed increased aggression, hunger, or stereotypies and there was no difference in heat stress between groups. In summary, although a drop in photoperiod was sufficient, a more rapid complete molt was successfully induced by 10 ppm T4 supplementation.

Key Words: molting, turkey hen, breeder, diet, thyroxin


An experiment of 3 x 2 factorial arrangement was conducted to determine the influence of 2 different molting methods compared with non-molting group (20’000 ppm zinc oxide per kg diet “Zinc method” vs. California method vs. non-molting) on productive performance and the immune response of 2 different strains of laying hens (Bovans
Brown commercial strain-BB vs. Red Baladi “Egyptian native strain developed from a cross between Red Rhode Island males and Fayoumi females-RB”). At 65 wk of age 285 hens (153 from BB and 132 from RB) were housed in individual cages and fed a commercial layer ration (17% crude protein, 2800 kcal AMEn/kg, 3.7% calcium and 0.66% total phosphorus) except during the induced molting periods. Productive performance traits were recorded daily from 71 to 88 wk of age. At 0, 5, 10 and 30 days from the beginning of treatments, 10 birds were selected randomly per treatment per period and injected intramuscularly with 1 ml of 10% sheep red blood cell’s (SRBC’s) suspension prepared in 0.9% physiological saline to measure the antibody production titer against SRBC’s and Newcastle Disease Virus. Results indicated that induce molting improve productive performance whereas, no differences were detected between molting methods. Non-molting group recorded lower values for egg rate (48.0 vs. 59.7 vs. 60.8%; P < 0.0001) and feed conversion ratio (4.74 vs. 2.88 vs. 2.95; P < 0.0001) compared to Zinc and California methods, respectively. Hens molted with California method recorded higher antibody titer against SRBC’s (8.04 vs. 5.96 vs. 5.21; P < 0.0001) than hens treated with Zinc method or non-molting hens, respectively. However, the antibody titer against Newcastle Disease Virus was not affected. Hens of RB have lower productive performance but higher antibody titer against SRBC’s (7.56 vs. 5.25; P < 0.0001) than BB hens, respectively. We conclude that both molting methods have the same impact on hen’s productivity and California is better than Zinc for affecting humoral immune response. In addition, RB hens have lower productive performance but higher immunity than BB hens.

**Key Words:** molting, laying hen performance, immunity

### Environment and Management II

#### 72 Differences in growth parameters and response to yeast components in chicks seeded with gut microflora from high and low weight broilers. R. Van Wyhe*,1, M. Bedford1, R. Dalloul1, and A. P. McElroy1, 1Virginia Polytechnic Institute and State University, Blacksburg, 2Ab Vista, Marlborough, Wiltshire, United Kingdom.

Research has shown that gut microflora in obese and normal weight animals differs in composition. The objectives of this trial were to 1) evaluate the effect of feeding cecal droppings collected from heavy (HW) or low weight (LW) broilers on performance and 2) to determine if dietary supplementation with yeast derivatives would effect growth and gut morphology in broilers fed the cecal droppings from HW or LW populations. Cobb 500 broiler chicks were given a standard commercial diet and raised to 28 d of age. At d28, birds of top 10% and bottom 10% body weight (BW) were moved into batteries and cecal contents were collected for a period of 24 hours. Cecal droppings collected from the HW and LW populations were collected for a period of 24 hours and then fed to Cobb 500 chicks (n=1400/group; HW or LW microflora) for a period of 48 hours. After 48 hours, chicks from each microflora treatment were weighed and placed in floor pens (n=42/pen) according to 4 dietary yeast treatments. Diets were 1) control (C); 2) HCT, (C+0.1% HCT); 3) PO24 (C + 0.1% PO24); 4) RNA (C + 0.1% RNA) for a resulting 8 total treatments (n=8 reps/diet). BW and feed intake were measured for the feeding periods of starter (d0-10), and grower (d10-28), and cumulative (d0-28). On d10 and d28, 1 bird per pen was selected for the measurement of villus height (VH), crypt depth (CD) and villus height:crypt depth ratio (VCR) in the duodenum, jejunum and ileum. Cumulatively and during the grower period feed conversion was reduced (P<0.05) and BW was increased (P<0.05) in the control compared to HCT or PO24. There were no differences in microflora treatments or dietary and microflora interactions for performance. On d28, in the ileum, VCR of control was less (P<0.05) than that of the HCT diet. In the jejunum and ileum, VCR was higher (P<0.05) and CD was lower (P<0.05) in the LW group on d 28. These results suggested that in a non-challenge setting early feeding of microflora from HW or LW broilers or dietary yeast products effected intestinal morphology, and yeast derivative feeding was not beneficial for growth performance.

**Key Words:** bacteria, yeast, poultry, gut, performance


Coccidiosis costs the poultry industry billions of dollars annually due to anticoccidial medications, disease-invoked losses in bird performance and mortality, and treatment. To reduce anticoccidial costs, increasing the length of the non-medicated, withdrawal period may be considered; however this raises concern regarding late-breaking coccidial infections. This experiment evaluated the effect of Maxiban® withdrawal period length on bird performance during a mild environmental coccidia exposure. Day-old Cobb 500 male broilers were placed in floor pens (43 birds/pen) on pine shavings previously seeded with 3 species of Eimeria and raised to day 40. Each pen received one of 5 dietary treatments (n=12 reps) including a non-medicated control diet or one of 4 diets consisting of the control supplemented with the anticoccidial Maxiban® from day 1 to day 25, 28, 31, or 34. Birds were fed non-medicated finisher diets on the day of Maxiban® removal. Performance parameters included body weight (BW), body weight gain (BWG), feed intake (FI), feed conversion (FC), and mortality, which were measured on days 18, 25, 28, 31, 34, and 40. Until day 34, birds on the control diet had lower (P=0.05) BW and BWG than the groups receiving Maxiban®, but no differences existed by day 40. Feed intake only differed between day 0 and 25 between the control and the group receiving Maxiban® to day 28 (P<0.05). At day 40, no differences in FC existed among any of the groups receiving Maxiban®, whereas birds on Maxiban® diets generally had better FC than birds on the control diet. There was no difference in mortality throughout the trial. Birds in this trial performed at or above Cobb performance standards, which indicated that the litter exposure to coccidia resulted in a mild infection. Results suggest that early withdrawal of Maxiban® caused no significant decrease in bird performance during a mild coccidia infection; however, results may vary with a more severe challenge.

**Key Words:** anticoccidial, withdrawal period, coccidiosis, performance, Maxiban®

#### 74 Identification and evaluation of candidate Bacillus probiotics (DFM) for use in commercial turkey feed. R. E. Wolfdene*, N. R. Pumford, M. J. Morgan, A. D. Woltenden, G. Tellez, and B. M. Hargis, University of Arkansas, Fayetteville.

As effective probiotic Bacillus spores are identified, these may offer advantages of in terms of stability, cost, and feed application over current...
75 Effects of probiotic administration during coccidiosis vaccination on performance in broilers exposed to field strain Eimeria: Comparison to monensin administration. A. Klein*1, J. Lee1, M. Farnell1, L. Oden1, S. Pohl1, K. Stringfellow1, M. Mohl2, R. Beltran2, G. Schatzmayr2, S. Fitz-Coy3, C. Broussard3, and D. Caldwell1, 1Texas A&M University, College Station, 2Biomin GmbH, Herzogenburg, Austria, 3Intervet/Schering-Plough Animal Health, Summit, NJ.

The objective of this investigation was to evaluate coccidiosis vaccination, with or without probiotic administration, for effects on broiler performance in the presence of field strain Eimeria during a 44 day pen trial. Cobb 500 males (n=3200) were placed in 64 pens (n=50) on built-up litter. The trial consisted of eight experimental groups: negative control, probiotic alone (water), probiotic alone (feed), vaccine alone, vaccine with probiotic (water), vaccine with probiotic (feed), ionophore (monensin), and ionophore with probiotic. Broilers in each experimental group (n=24) were placed in floor pens and exposed to field strain Eimeria oocysts through feed-based challenge on d 36. All broilers were subjected to necropsy on d 43 for assessment of gross and microscopic intestinal lesions. Broilers in vaccine, probiotic, and ionophore experimental groups were observed to have reduced (P<.05) gross lesion scores in the mid-intestine compared to negative controls. Reduced (P<.05) gross lesion scores in the lower intestine were also observed in vaccine alone and probiotic (water) groups. Broilers in all vaccinated and probiotic alone groups had reduced (P<.05) microscopic mid-intestine lesion scores as compared to the ionophore alone group. Broilers receiving vaccine with probiotic, as well as probiotic alone (feed), had reduced (P<.05) microscopic lower intestine lesion scores compared to broilers in negative control and ionophore groups. In general, broilers in the ionophore alone group were associated with higher (P<.05) microscopic mid and lower intestine lesion scores compared to vaccine alone, probiotic alone, and vaccine with probiotic groups. These observations suggest that the administration of probiotic during coccidiosis vaccination modulates the host response and improves intestinal health in broilers during clinical field strain Eimeria challenge.

Key Words: coccidiosis vaccine, probiotic, Eimeria, broiler, lesion development

76 Effects of probiotic administration during coccidiosis vaccination on lesion development in broilers exposed to field strain Eimeria: Comparison to monensin administration. A. Klein*1, J. Lee1, M. Farnell1, L. Oden1, S. Pohl1, K. Stringfellow1, M. Mohl2, R. Beltran2, G. Schatzmayr2, S. Fitz-Coy3, C. Broussard3, and D. Caldwell1, 1Texas A&M University, College Station, 2Biomin GmbH, Herzogenburg, Austria, 3Intervet/Schering-Plough Animal Health, Summit, NJ.

The objective of this trial was to evaluate live oocyst vaccination, with or without probiotic administration, for protection against clinical field strain Eimeria challenge. Experimental groups consisted of negative control, probiotic alone (water), probiotic alone (feed), vaccine alone, vaccine with probiotic (water), vaccine with probiotic (feed), ionophore (monensin), and ionophore with probiotic. Broilers in each experimental group (n=24) were placed in floor pens and exposed to field strain Eimeria oocysts through feed-based challenge on d 36. All broilers were subjected to necropsy on d 43 for assessment of gross and microscopic intestinal lesions. Broilers in vaccine, probiotic, and ionophore experimental groups were observed to have reduced (P<.05) gross lesion scores in the mid-intestine compared to negative controls. Reduced (P<.05) gross lesion scores in the lower intestine were also observed in vaccine alone and probiotic (water) groups. Broilers in all vaccinated and probiotic alone groups had reduced (P<.05) microscopic mid-intestine lesion scores as compared to the ionophore alone group. Broilers receiving vaccine with probiotic, as well as probiotic alone (feed), had reduced (P<.05) microscopic lower intestine lesion scores compared to broilers in negative control and ionophore groups. In general, broilers in the ionophore alone group were associated with higher (P<.05) microscopic mid and lower intestine lesion scores compared to vaccine alone, probiotic alone, and vaccine with probiotic groups. These observations suggest that the administration of probiotic during coccidiosis vaccination modulates the host response and improves intestinal health in broilers during clinical field strain Eimeria challenge.

Key Words: coccidiosis vaccine, probiotic, Eimeria, broiler, lesion development
of a challenge treatment. The challenged treatments (CON+, ROS+, RS+ and MAX+) were given a gavage at day 13 of a coccidia cocktail consisting of *E. acervulina*, *E. maxima*, and *E. tenella*. Four days later the birds were administered *Cl. perfringens*. Three of the diets were not challenged; their designation was CON-, ROS- and RS-. On day 28 the trial was terminated, at that time feed and surviving birds were weighed (BW). From these numbers feed conversion (FCR) was determined. Additionally on day 28, ceca were removed and *Cl. perfringens* was enumerated.

The weights at the end of the trial show that CON- (1.24 kg), RS- (1.25 kg) and MAX- (1.22 kg) had significantly higher BW than the other four treatments. Among those four treatments, ROS+ (1.02 kg) weighed the least. FCR was significantly better with ROS- (1.80) compared to the other seven, while CON+ (2.03) was determined to be the worst. There was no statistical difference detected with the *Cl. perfringens* counts among the treatments.

**Key Words:** essential oil, coccidiosis, *Clostridium perfringens*

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**ABSTRACTS OF PAPERS**

78 Immune response of broiler chickens fed different levels of arginine and vitamin E to a coccidiosis vaccine and *Eimeria* challenge. C. Perez-Carbajal1,2, D. Caldwell1, M. Farrell1, K. Strigfellow1, G. Casco1, S. Pohl1, A. Pro-Martinez2, and C. A. Ruiz-Feria*1, 1Texas A&I University, College Station, 2Colegio de Postgraduados, Montecillos, Mexico, Mexico.

One-day old chicks (n = 300) were vaccinated (Coccivac®-B) and divided into six groups to evaluate three levels of arginine (ARG) in the feed (1.44%, NA; 1.74%, MA; or 2.04%, HA) and two levels of vitamin E (VE, 40 or 80 IU/kg of feed, E40 and E80, respectively) in a factorial experiment. Birds were reared in floor pens and provided a corn-soybean basal diet and water ad libitum. At d 14, all chickens were orally challenged with a mixture of *Eimeria* field isolates (*E. acervulina*, *E. maxima*, and *E. tenella*). At d 9, 14, 22, and 28, serum samples were collected to measure antibody levels (IgG, IgA, and IgM isotypes; ELISA). In vitro heterophil (HOB) and monocyte (MOB) oxidative burst was measured at d 21 from cells isolated from peripheral blood. Lesion scores (LS) at the upper (UI) and middle intestine (MI) were determined at d 21 and 31. Levels of IgG were not affected at d 9, but at d 14 birds fed the E40-MA or E80-MA diet had the highest IgG levels; at d 22, birds fed the E80-MA or E80-HA diet had the highest IgG levels; whereas at d 28 birds fed the E80-MA diet had the highest IgG levels. The IgA concentration was not affected at d 9 or 28, and was not consistently affected at d 14; but at d 22 IgA levels were highest in birds fed the E40-NA feed. The IgM concentration was not affected at d 22; was lower in birds fed NA levels irrespective of VE level at d 9 and 14; but at d 28 IgM levels were higher in birds fed the E40-NA feed or the E80-MA feed. The HOB was lower in the E40 diets, but was increased when combined with the MA and HA levels, whereas birds fed the E80 diet had a high HOB irrespective of ARG level. Similarly, birds fed the E80 diet had high levels of MOB, which was not further improved by ARG, whereas birds fed the E40-MA diet had the highest MOB response. The LS were different at d 21, but at d 31 birds fed HA diet had lower LS in the UI than birds fed the MA diet, and birds fed the E80 diets had lower LS than birds fed the E40 diets. These results indicate that ARG and VE play complementary roles on the immune response against *Eimeria* infections.

**Key Words:** broilers, arginine, vitamin E, coccidiosis, immune response

79 Prophylactic and therapeutic supplementation with caprylic acid reduces enteric *Campylobacter jejuni* concentrations in young chickens. D. J. Donoghue*1, F. Solis de los Santos1, I. Reyes-Herrera1, J. H. Metcalfe1, K. Venkitanarayanan2, P. J. Biore1, and A. M. Donoghue3, 1University of Arkansas, Poultry Science Department, Fayetteville, 2University of Connecticut, Department of Animal Science, Storrs, 3Poultry Production and Product Safety Research Unit, ARS, USDA, Fayetteville, AR.

*Campylobacter* is one of the most commonly reported bacterial causes of human food-borne illness and epidemiological evidence indicates poultry and poultry products as significant sources of human *Campylobacter* infection. Caprylic acid is an 8-carbon fatty acid, naturally found in bovine milk, and a food-grade compound. Although caprylic acid has shown to be bactericidal against several microbial pathogens, *in vitro*, it has not been tested in the control of *C. jejuni* in chickens. A series of studies were conducted to evaluate if caprylic acid reduced *Campylobacter* in birds before being infected (prophylactic efficacy) or after colonization (therapeutic efficacy). For prophylactic efficacy, four replicate experiments (n=40/experiment) were conducted feeding either 0.7 or 1.4% caprylic acid and negative and positive controls in 10 d old birds. Chicks were challenged with five *C. jejuni* strains 3 d post hatch. The 0.7% dose produced the greatest reduction in *Campylobacter* (approx. 2-3 logs). To test for therapeutic efficacy, three replicate experiments (n=60/experiment) were conducted using doses of 0.35, 0.7, 1.4, 2.8% caprylic acid and negative and positive controls in 15 d old birds. Chicks were challenged with five *C. jejuni* strains 3 d post hatch. When caprylic acid was fed for 3 d prior to collection the 0.7% and 1.4% doses exerted the greatest therapeutic efficacy by reducing *Campylobacter* approximately 3-4 logs. The use of caprylic acid, a natural and safe feed additive shows the potential to reduce this significant human pathogen in poultry.

**Key Words:** *Campylobacter*, caprylic acid, enteric colonization, chickens, pathogens

80 Characterizing compensatory effects of silymarin on gos- sypol toxicity in lines of chickens divergently selected for humoral immune response. S. R. Blevis*, R. M. Lewis1, D. J. Blodgett2, M. Ehrich2, and P. B. Siegel1, 1Virginia Polytechnic Institute and State University, Blacksburg, 2Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg.

Corn is a main constituent of U.S. poultry diets. Rising corn prices have caused the poultry industry to seek alternative feeds. Cottonseed meal (CSM) offers an alternative due to its high protein content. Although CSM could not replace corn due to its low energy content, it is a sensible substitute for soybean meal. Replacing soybean meal with CSM would offset corn costs. Feeding CSM is problematic because it contains gossypol, a hepatic toxin. If a feed additive protecting chickens from gossypol’s harmful effects could be identified, CSM could be used in poultry diets. A possibility is silymarin, an extract from milk thistle seeds. Silymarin is used to treat hepatic disorders. White Leghorn male chicks from two lines divergently selected for humoral immune response were housed 3 to a cage. Seventy-two 4-wk old chicks from each line were used. Cages were randomly assigned 1 of 4 diets: 1000 ppm gossypol (G), 1000 ppm silymarin (S), 1000 ppm gossypol and 1000 ppm silymarin (GS), or a control (C). Blood samples were collected at the start of the experiment and weekly thereafter. Hematocrits and gamma-glutamyl transferase activity were determined. Body weight and feed intake were recorded weekly. After 4 wk, chickens were killed by cervical dislocation, and livers were collected. Liver homogenates were
assayed for quinone reductase activity. Liver slices were preserved in 10% buffered formalin for histological analysis. Lines did not differ significantly in their response to diet for any of the physiologic measures considered. Body weight and feed intake were depressed (P < 0.01) in G and GS treated chicks. Gossypol and GS treated chicks had higher lipidosis scores (P < 0.01) as well as increased quinone reductase activity (P < 0.01) than C. Furthermore, gamma glutamyl-transferase activity was increased (P < 0.01) in G and GS treated chickens compared to C and S treated chicks. At least at the amount included in these diets, silymarin did not ameliorate the toxicity of gossypol.

**Key Words:** liver toxicity, gossypol, silymarin, enzyme activity level, chicken

81 Effects of mycotoxin contaminated diets and Mycofix® Select on Leghorn performance characteristics. K. A. Jessen*, D. J. Caldwell¹, J. Coppedge¹, L. Oden¹, S. Pohl¹, A. Klein², R. Beltran², G. Schatzmayer², T. Applegate³, and J. T. Lee¹, ¹Texas A&M University, College Station, ²Biomin GmbH, Herzogenburg, Austria, ³Purdue University, West Lafayette, IN.

The current experiment was conducted to determine the effect of mycotoxin-contaminated diets [aflatoxin (AFLA) and deoxynivalenol (DON)] and dietary inclusion of Mycofix® Select, on layer hen performance during a 10-week trial. The experimental design consisted of a 4 x 2 factorial with four toxin levels: control, low (0.5 PPM AFLA + 1.0 ppm DON), medium (1.5 PPM AFLA + 1.5 ppm DON), and high (2.0 PPM AFLA + 2.0 ppm DON) with or without the inclusion of Mycofix® Select. Three hundred and eighty-four 25-week-old laying hens were randomly assigned to one of the eight treatment groups. Birds were fed contaminated experimental diets for a six week phase of toxin administration followed by a four week recovery phase, when all birds were fed mycotoxin free diets. Twelve hens from each treatment were subjected to necropsy following each phase. Relative liver and kidney weights were increased (P < 0.05) at the medium and high toxin levels following toxin administration. Mycofix® Select reduced (P < 0.05) relative liver and kidney weights following the recovery period. High toxin decreased (P < 0.05) feed consumption and egg production during the toxin period. Mycofix® Select increased (P < 0.05) egg production during the first two weeks of the toxin phase. Medium and high levels of toxin reduced (P < 0.05) egg weight following the toxin phase. An interaction existed between toxin and Mycofix® Select inclusion with regard to feed conversion (g of feed/g of egg). High inclusion level of toxin increased feed conversion compared to the control diet, while Mycofix® Select inclusion reduced feed conversion to a level comparable to the control. These data indicate that Mycofix® Select can reduce and/or eliminate adverse effects of mycotoxins in peak-performing laying hens.

**Key Words:** layer, mycotoxin, egg production, feed efficiency, afla-toxin

82 Comparing post-molt body weight and egg weight with two protein and five energy levels. P. L. Ruzsler*, C. L. Novak², and D. M. Denbow³, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Land O’Lakes Purina Feed, Kansas City, MO.

In a trial to determine how to control egg weight and body weight in molted hens, 180 hens were full fed a low nutrient (FFLN) molt diet and 18 hens (controls) were molted with a 4-day fasting method. This was a second molt at 132 weeks-of-age for these hens. Each treatment was replicated 6 times with 3 hens per replicate. On the 29th day of the molt, 5 of the FFLN treatment groups were placed on a 12% CP layer diet and 5 groups were placed on a 14% CP layer diet, each with energy ranging from 2,750 to 2,882 Kcal ME/kg by increments of 26 Kcal. The control hens were fed a 15.5% CP/2,822 Kcal ME/kg layer diet. Energy had no effect on any of the measured parameters. However, the hens on the highest energy levels tested, 2882 & 2854 Kcal/kg, compared consistently different numerically from the rest. They consumed the least amount of feed, experienced the lowest levels of production and laid the heaviest eggs. There were no differences between the 14% CP group and the control group. However, the hens fed the 14% CP diets laid 7.6% more total eggs than the hens fed 12% CP (74.9% vs. 67.1%), weighted 182g more (1823g vs. 1641g), and laid heavier eggs (68.5g vs. 65.7g). During the period of egg production above 50% from 7 to 32 weeks they consumed an average of 11.6g more feed per hen per day, 119.9g vs. 108.3 g respectively. When economically comparing the feed ingredient costs for 14% CP layer diet vs. 12% CP layer diet resulting in feed costs of $230 vs $210/ton respectively, it shows that the 12% layer diet was better. The results using data from this study show a $0.97 lower feed cost per hen for the 12% CP layer diet or a savings slightly more than the feed cost for producing 2 dozen eggs. This study showed that the lower level of crude protein fed resulted in a lower body weight and produced lighter eggs more economically.

**Key Words:** egg weight, body weight, energy, protein, economics


Three experiments were conducted to test the effectiveness of Optiphos® phytase in corn-soybean meal diets fed to laying hens during various ages of the laying cycle. The first experiment evaluated the effect of Optiphos® on first cycle layers from 32-62 weeks of age. Six treatments were replicated four times using 14 hens. Treatments consisted of a negative control diet containing 0.105% nonphytate phosphorus (NPP), positive control (0.45% NPP), marginal NPP level (0.20%), and supplemental Optiphos® at 150, 250, or 15,000 FTU/kg added to the negative control. The second experiment evaluated the enzyme in late pre-molt diets, and also, in post-molt diets from 68-88 weeks of age. Five treatments were replicated five times with 14 hens. Pre-molt diets contained 0.38% NPP, 0.48% NPP, and 0.28% NPP supplemented with 150, 750, or 1,500 FTU/kg Optiphos®. Post-molt NPP levels were increased by 0.06% NPP in each diet. The last experiment evaluated Optiphos® near the end of the second laying cycle at 112-117 weeks of age. Five treatments were replicated five times using 14 hens. Diets contained 0.43% NPP, 0.53% NPP, and 0.33% NPP supplemented with 150, 1000, or 2000 FTU/kg Optiphos®. Measurement parameters included hen-day egg production, egg weight, egg mass, egg shell quality, feed consumption, feed efficiency, tibia ash, and concentration of P in the excreta. In the first experiment, all production parameters were greatly reduced (P < 0.05) by the 0.105% NPP treatment, and this treatment was terminated at 40 weeks of age due to low egg production (less than 50%). None of the measured production parameters were affected by the other dietary treatments except that P in the excreta was significantly reduced for all phytase treatments when compared to the 0.45% NPP treatment. Dietary treatments had no consistent effects on any measured parameter in Experiments 2 and 3. This study indicated that Optiphos® improves P utilization and reduces P excretion in laying hens at various stages of the egg production cycle.

**Key Words:** phytase, phosphorus, egg production

An experiment was conducted using 672 Hy-Line W-36 hens (69 wk of age) to evaluate if limit feeding varying levels of DDGS with corn (C), wheat middlings (WM), and soybean hulls (SH) would affect postmolting performance of laying hens in a nonfeed withdrawal molt program. Treatments consisted of feeding hens a 47% C:47% SH diet (C:SH) ad libitum for 28 d (positive control). Hens on the other seven treatments were limit fed 65 g/hen/d for 16 d, then fed 55 g/hen/d for 12 d. Treatments 2 and 3 were fed 49% C:35% WM or SH:10% DDGS [(C:WM:10DDGS), (C:SH:10DDGS)]. Treatments 4 and 5 were given 49% C:25% WM or SH:20% DDGS [(C:WM:20DDGS), (C:SH:20DDGS)]. Treatments 6 and 7 were fed 47% C:47% DDGS (C:DDGS) and 47% WM:47% DDGS (WM:DDGS). Hens on treatment 8 were fed a high 94% DDGS diet. At the end of the 28 d molt period, all hens were fed a 16% CP corn-soybean meal layer diet and production performance was measured for Weeks 5 to 26. Body weight (BW) loss ranged from 7% (C:DDGS and DDGS) to 25% (C:SH). Hens fed the C:WH:10DDGS and C:SH:10DDGS lost 13 and 20% BW, respectively. Also, hens fed the C:WM:20DDGS, C:SH:20DDGS and WM:DDGS diet lost 11, 14, and 13% BW, respectively. Hens fed the control diet had the lowest (P<0.05) feed intake during the molt period. Feed consumption during the molt period (Weeks 1 to 4) was similar between the C:WM:10DDGS, C:WM:20DDGS, C:SH:20DDGS, C:DDGS, WM:DDGS, and DDGS diets. No consistent differences were observed among treatments throughout the postmolt period for egg production and egg weights. In fact, no treatments reached 0% egg production during the molt period. This study shows that feeding DDGS diets at levels of 65 g/hen/d for 16 d followed by 55 g/hen/d for 12 d during the molt period did not cause hens to totally cease production. However, long term production performance was not different than feeding a C:SH diet. These results suggest that lower levels of feeding DDGS may be needed for nonfeed withdrawal molt programs.

Key Words: molting, laying hens, DDGS


The experiment was conducted with 360 one-day-old Avian commercial broilers to study the effects of dietary cinnamon extract (CE), garlic extract (GE) and yucca extract (YE) on growth performance and serum biochemical parameters in broilers. The chickens were randomly divided equally into 4 treatment groups, each group with 3 replications, and received the same basal corn-bean diets included a starter from 1d to 21d and then a grower until 42 d, added with recommended dose 250 mg/kg CE, 25 mg/kg GE and 10 mg/kg YE to relevant group, respectively. The birds were kept in a stainless steel net coop each replication with 24 h light and received feed and water ad libitum. At 21 d and 42 d of age, 6 chicks were respectively picked out from every group and were bled to collect serum samples and intestinal samples for laboratory analysis. The results showed that the average daily gain (ADG) of CE, GE and YE group were increased by 7.20% (P<0.05), 3.43% (P>0.05) and 4.89% (P<0.05), feed gain ratio (F/G) was improved by 9.71% (P<0.05), 3.40% (P>0.05) and 3.40% (P>0.05) compared with the control, respectively. At 21 d of age, the content of serum urea nitrogen (SUN) and serum uric acid (SUA) and the activity of serum xanthine oxidase (SXO) in CE group were reduced by 35.17% (P<0.01), 13.73% (P<0.01) and 16.33% (P<0.05) compared with the control, respectively. At 42 d of age, SUN and SUA level and SXO activity were lowered by 24.35% (P<0.01), 15.49% (P<0.05) and 23.09% (P<0.01), respectively. The SXO activity in CE group was decreased by 14.86% (P<0.01) and 15.34% (P<0.01) compared with GE and YE group, respectively. Also, adding CE, GE and YE into broiler diets resulted in lower UN and UA level of intestinal contents. It is clear that CE significantly decreased the SXO activity and SUA levels more than GE and YE, especially in the latter period, thereby it may play a more important role in improving the growth performance of broilers.

Key Words: cinnamon extract, broiler, growth performance, serum urea nitrogen, serum uric acid

86 Effect of using zeolite in the broiler diet on reducing Salmonella and on production performance. M. M. Mashaly*, S. F. Al-Zenki1, A. Y. Al-Nasser1, A. E. Al-Saffar1, M. E. Al-Bahouh1, F. K. Abdullah1, and G. G. Ragheb1, 1Kuwait Institute for Scientific Research, Safat, Kuwait, 2Pennsylvania State University, University Park.

Broiler Salmonella contamination is a problem for the poultry industry and the consumers. A viable strategy is to reduce the levels of Salmonella at the farm level and implement good manufacturing practices at the processing plant. In the current study, zeolite was used in the broiler diet to reduce broiler Salmonella contamination. This is because zeolite is known to have the ability to lower ammonia emission which could result in a decrease in Salmonella contamination. Therefore, the objectives of the current study were to evaluate the effect of using zeolite in the broiler diet on both reducing Salmonella in broilers and on production performance.

One hundred and twenty broiler chicks were placed in each of 36 floor pens. The pens were divided into four groups of nine pens each and were used for one of four treatments. These treatments included the control group, and either 1, 1.5, or 2 % zeolite added in the feed. This study was repeated both in the summer and winter season. The prevalence of Salmonella on the chicken body and in the ceca was determined at 7, 21, and 35 days of age and at the processing plant. In addition, body weight, feed consumption was recorded at 7, 21, and 35 days of age and feed efficiency was calculated.

In addition to reducing Salmonella contamination at the farm, it was found that treatments significantly (p<0.05) reduced Salmonella contamination at the processing plant, both in the summer, from 33% (control) to 8% (mean for treated groups) for the carcass and from 20% to 13% for the ceca and in the winter season from 13% to 4% for the carcass and from 22% to 5% for the ceca. It was also found that in the winter season, feed efficiency was significantly (p<0.05) better in the treated groups (1.766, mean for the treated groups) than in the control group (1.980). However, feed efficiency was similar in all four groups during the summer season. It can be concluded that using zeolite in the feed can be beneficial in both reducing broiler Salmonella contamination both at the farm and at the processing plant and improving production performance at least in the winter season.

Key Words: broilers, zeolite, Salmonella, production performance
87 An investigation on valine to lysine ideal ratios in corn-soybean meal diets for Cobb vs. Cobb 500 male broilers from 21 to 42 days of age. J. Berres¹, S. L. Vieira*¹, E. Nogueira², D. M. Freitas¹, M. M. Cortes¹, J. M. Pena¹, and R. Barros¹, ¹Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil, ²Ajinomoto Brazil, Sao Paulo, SP, Brazil.

This study evaluated live performance, carcass, abdominal fat and commercial cuts yields of broilers fed corn-soybean meal diets with increasing digestible valine to lysine levels from 21 to 42 days of age. One thousand five hundred and seventy-five Cobb vs Cobb 500 male broilers were raised with the same commercial mash feed until 21 days of age. Seven treatments with 9 replications of 25 birds each were used afterwards to 42 days. These had a basal corn-soybean meal all vegetable diet with 1.10% of digestible lysine formulated without CP restriction (17.57% CP) and a known deficient digestible lysine to valine ratio (0.59) supplemented with synthetic amino acids to reach the following ratios with digestible lysine: methionine + cystine: 0.75; threonine: 0.67; isoleucine: 0.67, arginine: 106 and tryptophan: 0.17. Six diets having graded suplementations of L-valine were then produced to create the following valine to lysine ratios: 0.64, 0.69, 0.74, 0.79, 0.84 and 0.89. Statistical analysis was conducted to evaluate differences between treatments. Body weight gain, feed conversion rate and abdominal fat yield data were submitted to linear and quadratic regression analysis and 95% of asymptote levels were utilized as level which maximized responses. Feed intake, percent mortality, carcass and commercial cut yields were similar between treatments. However, a valine to lysine ratio of 59% negatively affected body weight gain and feed conversion, which were maximized at 0.745 and 0.755 digestible valine to lysine ratios, respectively. Abdominal fat yield was reduced until reaching a ratio of 0.78 digestible valine to lysine.

Key Words: broiler, valine, amino acid

88 Broiler responses to low protein corn-soybean meal diets supplemented with valine, isoleucine, glycine and glutamic acid. J. Berres¹, S. L. Vieira*¹, E. Nogueira², R. Barros¹, P. X. Silva¹, F. V. Furtado¹, and J. A. Meira¹, ¹Universidade Federal do Rio grande do Sul, Porto Alegre, RS, Brazil, ²Ajinomoto Brazil, Sao Paulo, SP, Brazil.

Two thousand and sixteen Ross x Ross 308 male broilers were fed corn-soybean meal diets supplemented with valine (Val), isoleucine (Ile), glycine (Gly) and glutamic acid (Glu) in a 4 phase feeding program (1 to 7, 7 to 21, 21 to 35 and 35 to 42 d of age). Live performance and post-slaughter responses were evaluated. These amino acids (AA) were supplemented to meet same ratios to lysine (Lys) and/or crude protein (CP, by L-Glu supplementation) levels provided by an industry standard control diet formulated without CP restriction and maintaining recommended Gly+Ser to Lys ratios; Other treatments were constituted by individual or associated synthetic AA suplementations, with consequent less limiting and non-essential AA profile changes, as follow: L-Val; L-Val and L-Gly; L-Val and L-Glu; L-Val, L-Gly and L-Glu; L-Val and L-Ile; L-Val, L-Ile and L-Gly; and L-Val, L-Ile, L-Gly and L-Glu. Therefore, eight treatments with 9 replications of 28 birds were used. An anova and Tukey test at 5% probability was used to determine statistical differences between treatments. No differences on feed intake and mortality were observed, but benefits on body weight gain and feed conversion occurred when Gly and Glu were supplemented. Improvement due to Gly supplementation were mainly observed on early phases of broiler growth, whereas with diets supplemented with Glu occurred throughout the entire period of study. Carcasses, wings and cage yields were similar between treatments. Breast meat yield was higher when broilers were fed with all these AA compared with those fed only Val supplemented diet. Isoleucine supplementation demonstrated importance on breast meat yield. Leg quarters were heavier to the control diet in relation to the other treatments, with exception to the Val and Val plus Gly supplemented treatments. Individual Val and Ile superimpositions negatively affected broiler performance and meat yields responses. Advantages in body weight and feed conversion were clearly seen with Gly and Glu supplementation.

Key Words: broiler, low protein, valine, isoleucine, glutamic acid

89 Reduction of feed costs through use of the Missouri ideal turkey protein. J. D. Firman*, University of Missouri, Columbia.

In a previous trial, the Missouri Ideal Turkey Protein was fed in comparison with an industry average diet. Minor depressions in growth were noted in the Ideal ratio diet, that were overcome with 5-10% amino acid additions in that trial. Based on these data, this trial was performed similarly, but with minor changes in amino acid levels to reflect our best estimate of which amino acids were deficient in the original trial. The trial consisted of 4 treatment groups in a randomized block design with 8 replicate blocks of 25 toms per treatment. Treatments included a control high protein diet, an ideal protein based diet (Missouri Ideal Turkey Protein), the ideal protein diet +5% addition of amino acids and the ideal protein diet + 10% addition of amino acids. Birds were raised under standard husbandry conditions. No significant differences in performance between any of the treatments occurred, indicating that the changes made overcame any minor inaccuracies in our Ideal Ratio for turkeys. Significant cost savings are seen with these diets that range from 7-10% for the Ideal diet. Carcass yield data are shown in Tables 3-4. No differences were seen in any measures at 18 weeks. At 21 weeks there were no significant differences noted, but numerically lower pectoralis major values were seen in the ideal and ideal +10% diets. This was not seen in several previous trials and is not believed to be significant.

Key Words: turkey, ideal protein, performance, amino acid, reduced protein

90 WITHDRAWN.

91 Effects of reduced crude protein, amino acid balanced diets on performance and economics in a large-scale commercial laying hen flock. H. K. Burley*, 1 P. H. Patterson¹, and M. A. Elliot², 1The Pennsylvania State University, University Park, ²A & E Nutritional Services, Lititz, PA.

Recent increases in laying hen feed prices have renewed interest in reducing costly dietary crude protein (CP) levels to lower feed costs. This study investigated this dietary strategy under commercial conditions. The objective was to establish if reduced CP, amino acid (AA) balanced diets could maintain hen performance while reducing feed cost and/or increasing farm revenue. Three groups of 16,920 Lohmann LSL Lite laying hens were fed isocaloric, AA balanced diets with low (A), medium (B), or high (C) levels of CP. Diet C was formulated with
typical commercial levels of CP and diets B and A with ~0.75% and ~1.50% less CP than diet C, respectively. Diets were corn-soybean meal based and least-cost formulated weekly. Hens were fed diets ad libitum from 18 to 51 wks of age. Monthly data collected included feed AA and CP analysis, hen body wt (BW), egg wt (EW), albumen height (AH), Haugh units (HU), yolk color (YC), and shell strength (SS) and thickness (ST). Egg income (EI), feed consumption and prices were used to calculate weekly feed cost (FC) and EI minus FC. Statistical analysis was done with SAS version 9.1 using Tukey’s mean comparisons with p-values <0.05 deemed significant. Diets proved to be isocaloric and AA balanced; however, diets B and A averaged 1.53 and 1.98% less CP than diet C, respectively. BW and EW tended to be lowest for diet A (non-significant). Hen day egg production averaged 87.9, 87.4 and 87.1% for diets A, B, and C, respectively. AH, HU, YC, SS, and ST did not differ by diet. Diet A mean weekly EI per hen was $0.0022 and $0.0024 less than for diet B and C, respectively. However, diet A and B mean weekly FC per hen was $0.0092 and $0.0074 less than for diet C, respectively, and diet A and B mean weekly EI-FC was $0.0068 and $0.0072 greater than diet C, respectively. Therefore, use of reduced CP, AA balanced diets on a commercial scale could be economically beneficial without losing egg production or quality.

Key Words: crude protein, hen performance, economics

92 Comparison of amino acid digestibilities using three different methods. E. J. Kim*, C. M. Jacobs, P. L. Utterback, and C. M. Parsons, University of Illinois, Urbana.

The objective of this study was to determine amino acid (AA) digestibility of various feedstuffs (corn, soybean meal (SBM) and meat and bone meal (MBM)) using the precision-fed cecctoemized rooster assay (PFR), the standardized ileal assay (SID), and a newly developed precision-fed chick assay (PFC). For the PFR, cecctoemized roosters were precision-fed approximately 30 g of feed sample and excreta were collected 48 hours post-feeding. For the SID, 16 day-old chicks were fed a semi-purified diet containing the feed samples from 17-21 d, with ileal digesta collected at 21 d. For the PFC, 22 day-old chicks were precision-fed 10 g of sample mixed with chromic oxide and ileal digesta were collected at 4 hours post-feeding. Apparent digestibilities were similar for SBM and MBM between the SID and PFC assays, with values for corn being lower for the SID than the PFC assay for a few AA. Digestibility coefficients were standardized using a nitrogen-free diet (NFD) for the SID and PFC assays and using fasted roosters for the PFR assay. Standardized AA digestibility values for SBM were generally higher than those for corn and MBM. There were generally no consistent differences in standardized AA digestibility values among assays and values were in general agreement, particularly for MBM and MBM. The one exception was that standardized values for some AA in corn were higher for the PFR than for the PFC and SID assays. The results of the study indicated that all three assays are acceptable for determining the AA digestibility of feed ingredients for poultry.

Key Words: amino acid digestibility methods, roosters, chicks


Guanidino acetic acid (GAA) is synthesized in the liver and kidney from arginine (ARG) and glycine. It is subsequently methylated by S-adenosylmethione to creatine. Several bioassays were carried out to determine the capacity of GAA to spare dietary ARG. Crossbred chicks were fed ARG-deficient casein-dextrose (0.86% ARG) or corn-corn coproduct-soybean meal (1.0% ARG) basal diets during 9-d battery feeding trials involving 5 pens of 4 chicks per treatment. The first assay showed that the casein diet was markedly deficient in Arg and would elicit marked (P<0.01) responses in both weight gain and gain/feed to added ARG, GAA or creatine. The optimal level of added GAA was 0.12% of the diet, but this level of GAA or 1.0% supplemental creatine•H2O did not improve growth performance when added to the diet made adequate in ARG. An assay was then completed involving 7 graded doses of supplemental ARG in the casein diet containing either 0 or 0.12% added GAA (14 total diets). Gain and gain:feed responses to ARG were quadratic (P<0.01), and the ARG quadratic x GAA interaction was not significant (P>0.10). Thus, responses to GAA in this assay were similar in chicks fed either deficient or adequate levels of ARG. The diet based on corn, corn gluten meal, distillers dried grains with solubles, and soybean meal produced gain/feed responses (P<0.05) to 0.25% added ARG, 0.12% GAA or 0.15% creatine•H2O, and the responses to these additions were similar. These results demonstrate that 0.12% supplemental GAA, like creatine, produces consistent growth responses in young chicks fed ARG-deficient diets.

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Key Words: arginine, guanidino acetic acid, creatine, chick growth


Thevetia peruviana (yellow oleander) grows in temperate climate throughout the world and is abundant in the tropics where it is grown as an ornamental plant. The plant contains heart-active cardiac glycoside chemicals, which have been used to treat heart failure in China and Russia for decades, though scientific evidence supporting use is limited. Also, phototoxic extracts from thevetia seed contains antifungal properties and the seed yield oil for industry and soap making. The bark is a powerful anti periodic and febrifuge. Thevetia seed has a similar chemical composition to soybean seed and contain about 35% protein and 65% oil. However, cardiac glycoside, thevetin, has been found to be toxic to animal and man. Attempts to improve the nutritive value of thevetia were made by using various methods, however fermentation presented some advantages. Thevetia seed were subjected to fat extraction and natural lactic fermentation. One hundred and eight day old broiler chicks were offered diets with unfermented or 4 - 6 days fermented thevetia cake at inclusion level of 5 or 10%. The experiment was designed as a 3 × 2 factorial combination of fermentation periods and dietary inclusion levels of thevetia. Thus, there were six treatments with three replicates of six birds per replicate. Parameters measured include feed intake, growth rate, feed conversion ratio, nutrient retention, hematology and histopathology. Fermentation reduced the cardiac glycoside (thevetin) and gave about 20% improvement in broiler growth performance compared to unfermented cake. The retention of protein, fat and fiber in the diets of unfermented thevetia cake was reduced (p<0.05). Inclusion of fermented thevetia in the diet of broiler did not effects any significant change in the hemoglobin and red blood cell count. (p>0.05). Histopathology studies show inflammatory and degenerative changes in the liver and kidney of broiler fed unfermented thevetia diets. It appeared that the treatment could not eliminate the bitter taste.
associated with thevetia anti nutritional factors as the broiler consumed less than those on standard diet.

**Key Words:** thevetia peruviana cake, cardiac glycoside, fermentation, broiler, performance

95  **Effect of graded inclusion levels of wheat, corn and triticale dried distiller’s grains with solubles on growth performance and breast muscle weight in broilers.** M. Oryschak1, D. Korver2, A. Pishnami2, and E. Beltranena1, 2, 1Alberta Agriculture and Rural Development, Edmonton, AB, Canada, 2University of Alberta, Edmonton, AB, Canada.

Ethanol production in Canada is expected to increase dramatically in the near future in response to government mandated ‘green’ content in gasoline. This is likely to increase local inventories of dried distiller’s grains and solubles (DDGS). Replacing more expensive feedstuffs in broiler rations with DDGS might allow feed costs to be reduced while maintaining productivity. The effect of either 5 or 10% inclusion of wheat, corn or triticale DDGS was compared to a wheat-soybean meal control in a 42-d performance study. Diets were formulated to contain similar levels of AME, CP and digestible Lys and met or exceeded recommended concentrations for all other nutrients in the starter (d0-14), grower (d14-28) and finisher (d28-42) periods. Separate test diets were formulated for each period of the study and each was fed to a minimum of 4 pens of male and of female broilers in each of 4 blocks, in a randomized incomplete block design. Birds were weighed as a pen and feed disappearance measured on a weekly basis in order to allow average daily gain (ADG) and average daily feed intake (ADFI) to be calculated. Feed-to-gain (F:G) and gain-to-feed (G: F) ratios were subsequently calculated from weekly ADG and ADFI. Breast muscle weight (BMW) and percentage yield (BPY) were determined on d 37 by randomly selecting 5 birds from each pen, which were then individually weighed, euthanized and dissected to remove the breast muscles. Expected gender differences in ADG, F:G and weekly weights (WW) were observed between males and females in all 6 weeks of the study (P < 0.05). Treatment did not significantly affect WW, ADG, ADFI, F:G or G: F in the overall study (P > 0.05). Male BW was higher (428 vs. 385g) and BPY lower (19.2 vs. 18.8%) compared to females, but there was no effect of sex on either BW or BM. Our results suggest that wheat, corn and triticale DDGS can be successfully included at levels of up to 10% in practical broiler rations with no detrimental effect on performance, BW or BPY.

**Key Words:** DDGS, performance, broiler

96  **Predicting variations in amino acid digestibility of major co-products of the bioethanol industry.** C. Gady1, S. Virden2, P. Dalibard1, and P. A. Geraert1, 1Adisseo France SAS, Antony, France, 2Adisseo USA INC., Alpharetta, GA.

Distillers Dried Grains with Solubles (DDGS) are co-products issued from complex and evolving processes that influence their final quality. Main objectives of this study were to measure the nutritional variability among corn and wheat DDGS and to investigate to predict such a variability.

Sixty four DDGS samples (31 wheat DDGS and 33 corn DDGS) were collected from major bioethanol plants around the world. All samples were analysed for total amino acids (TAA) and were evaluated for standardized ileal amino acid digestibility (AAD) using caecectomized roosters. Additionally, all DDGS were analysed for their absorbance from 1100 to 2500 nm with a NIRSystem model 5000 (FOSS, Sweden). Prediction models were calculated correlating absorbances to both TAA and AAD.

Results showed important differences of quality, particularly in wheat DDGS. High coefficients of variation (CV %) were found for total lysine and cysteine concentrations (28 and 32 %) and all digestibility coefficients exhibited a high degree of variation. There were 57 points difference in lysine digestibility between the highest and the lowest qualities. The highest variations among corn DDGS were related to total lysine and lysine digestibility coefficients that ranged from 1.62 to 4.08 % CP and from 31 to 80% respectively. Results confirmed the high sensitivity of DDGS to heat damage occurring during the drying process.

Prediction models that were developed using Near Infrared Technology explained from 94.4 to 98.0% of the variability measured in TAA. Prediction models for AAD showed high correlations too, ranging from 0.85 to 0.93 depending on amino acid. Lysine digestibility which is one of the main issues in DDGS use, was then predictable within 5.2 digestibility points accuracy.

This study confirmed the need for better qualifying DDGS in order to decrease the risk in monogastric feed formulation. With respect to the wide variations measured among DDGS, the NIRS confirmed its capability to predict total and digestible amino acids for wheat and corn DDGS.

**Key Words:** corn DDGS, wheat DDGS, amino acid digestibility, near infrared spectroscopy, prediction


An experiment was conducted to determine the effect of different levels of camelina meal (CM) and flaxseed (FS) on egg production and body weight of two strains of laying hens. Two hundred and ninety four Hy-Line W36 (W36) and two hundred and ninety four Hy-Line Brown (Brown) hens were allocated to a completely randomized block arrangement of seven diets (7 replications per diet) for three consecutive phases (22-26, 26-30 and 30-34 wk). Treatments consisted of increasing levels of FS (1, 2 and 3%) and CM at 3 times more than the FS (3, 6 and 9 %) to equal the same dietary omega-3 levels as FS for phase-1. For phase-2 and phase-3, levels of both FS and CM increased 2 and 3 times compared to phase-1 to observe the cumulative diet effects. Body weight, hen-day egg production, feed consumption and feed conversion were measured at 26, 30 and 34 wk. Both W36 and Brown hens consuming the CM (6, 12 and 18%) in phase-2 and phase-3, levels of both FS and CM increased 2 and 3 times higher than those on standard diet. This is likely to increase local inventories of dried distiller’s grains and solubles (DDGS). A DDGS sample was then predictable within 5.2 digestibility points accuracy.

This study confirmed the need for better qualifying DDGS in order to decrease the risk in monogastric feed formulation. With respect to the wide variations measured among DDGS, the NIRS confirmed its capability to predict total and digestible amino acids for wheat and corn DDGS.
the strain. However, more than 12% CM caused significantly reduced performance of the birds both compared with the corn-soybean and FS diets. Flaxseed diets to 9% inclusion level had no negative impacts on hen performance within the time frames of this evaluation.

Key Words: camelina meal, flaxseed, layer, egg production, body weight


An experiment was conducted to compare the responses of young broiler chickens fed diets supplemented with flaxseed (FS) or camelina meal (CM) versus a corn-soybean meal control diet and the factorial effect of 150 ppm added dietary copper (Cu) on performance and processing yield. A randomized complete block design with a 2 x 3 factorial arrangement was used with seven replicates from hatch to 21 d of age (n = 294; 7 chicks per replicate). Neither performance nor processing yields were significantly influenced by the incorporation of dietary FS (10%) or CM (10%) compared to the control with no supplemental Cu. However, addition of Cu significantly increased body weight, and feed consumption of the birds fed the control diet throughout the entire study. The addition of Cu to the 10% CM diet increased body weight (P < 0.001) but no effects of Cu on feed consumption or feed conversion were noted at 21d. Birds fed the corn-soybean diet with 150 ppm Cu supplementation had greater carcass and parts yield (P < 0.05) than the corn-soy control, whereas adding Cu to the CM diets increased carcass yield (P < 0.05) and breast weight (P < 0.01) compared to the FS fed birds regardless of the Cu supplementation. A significant Cu by diet interaction was observed for carcass yield, weight, carcass parts and breast yield also. Data from the present study demonstrated that either 10% CM or FS can be used throughout the first 3 weeks for broilers with little detrimental effect on growth performance. Furthermore, these results suggest that the addition of Cu sulfate resulted in improved performance of birds fed the corn-soy control and 10% CM diets. Addition of 150 ppm Cu from Cu sulfate to diets containing 10% FS had no beneficial effect on growth performance to 21 d or processing yield.

Key Words: camelina meal, flaxseed, copper, broiler, performance

99 Influence of origin on nutritional and quality parameters of soybean meal. G. G. Mateos*,1, S. Sueiro2, M. Hermida2, P. G. Ribollar1, M. P. Serrador1, and R. Lázaro1,1Universidad Politécnica de Madrid, Spain, 2Laboratorio de Mouriscade, Pontevedra, Spain.

Soybean meal (SBM) is the most important protein source in poultry diets. Most published nutritional tables of ingredients differentiate only 2 types of SBM according to its crude protein (CP) content; regular SBM with 44% CP and high protein SBM with 47 to 48% CP. However, new available information indicates that origin might have an effect on the chemical characteristics and nutritional value of SBM. The present research (n = 262) was conducted to determine the influence of the origin of SBM (USA; Brazil, BRA; Argentina, ARG) on nutritional content and values of parameters used to measure protein quality. On DM bases, USA SBM (n = 134) had higher CP content (54.3 vs. 52.0 and 52.9%; P ≤ 0.001) and less NDF (8.7 vs. 10.6 and 11.8%; P ≤ 0.001) than ARG (n = 77) and BRA (n = 51) meals. Saccharose content was higher for USA and ARG meals than for BRA meal (7.3 and 7.6 vs. 6.8%; P ≤ 0.001). Also, USA SBM had more starchose + raffinose than ARG and BRA meals (7.7 vs. 7.1 and 7.0%; P ≤ 0.001). The USA and ARG meals had more phosphorus (0.76 and 0.79 vs. 0.68%; P ≤ 0.001) and potassium (2.57 and 2.54 vs. 2.17%; P ≤ 0.001) but less iron (119 and 129 vs. 193 mg/kg; P ≤ 0.01) than the BRA SBM. Also, the USA SBM had higher KOH solubility (87.5 vs. 81.8 and 84.9%; P ≤ 0.001), protein dispersibility index (19.8 vs. 16.8 and 15.1%; P ≤ 0.001), and trypsin inhibitor content (6.1 vs. 4.8 and 5.0 mg/g; P ≤ 0.001) than the ARG or the BRA meals. The amino acid profile varied with the source of SBM. The content of lys (3.34 vs. 3.14 vs. 3.21%; P ≤ 0.001), met+cys (1.56 vs. 1.47 vs. 1.52%; P ≤ 0.001), thr (2.12 vs. 2.04 vs. 2.07%; P ≤ 0.001), and of the 5 key amino acids (P ≤ 0.01) where higher for the USA SBM than for the BRA SBM, with the ARG SBM being intermediate. Based on these results, it is concluded that the nutrient composition and protein quality parameters favor the utilization of USA soybean meal over the South American meals in poultry diets.

Key Words: soybean meal survey, protein quality, nutritional value

100 The effect of dietary canola meal on productivity of three commercial laying hen strains. T. D. Knezacek*, A. K. Ward, J. P. Dahiya, K. V. Schwean-Lardner, and H. L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

Canola meal (CM) is a high quality protein source with an excellent amino acid balance for poultry. However, the level of CM inclusion is often limited in laying hen diets due to evidence of a reduction in feed intake and egg size, and an increase in hen mortality with the use of higher levels. Part or all of these effects may relate to amino acid digestibility and/or the level of glucosinolates in CM. Knowledge and use of amino acid digestibility in feed formulation and much lower levels of glucosinolates in CM suggest that there may be no need for a limit on the use of CM in laying hen diets. The objective of this research was to determine the effect of graded levels of low glucosinolate CM, up to complete replacement of soybean meal, on the performance of laying hens. Wheat-based diets were formulated on a digestible amino acid basis with 4 levels of CM (0 to 16.7%) and fed to 3 commercial laying hen strains, Lohmann Brown (LOH), ISA Brown (ISA), and Lohmann LSL (LSL). Rations were fed from 19 to 59 wks of age, with egg weight, specific gravity and feed intake measured at 4 wk intervals. Overall, level of CM inclusion had no effect on hen body weight gain, feed intake, feed to egg mass ratio, egg weight or egg specific gravity. Hen-day egg production was also not affected by CM but hens fed all diets including CM laid numerically more eggs than those fed the wheat-soybean meal control diet (P=0.0512). Although not statistically significant, hens fed the highest level of CM had the highest mortality (P=0.0933). Hen-day production and mortality were similar for all strains, but there were significant differences amongst genotypes for egg shell quality traits. There were no interactions between level of CM inclusion and bird strain. In conclusion, complete replacement of soybean meal in laying hen rations with CM did not affect hen performance but the effect of high levels of CM on mortality requires further investigation.

Key Words: brown-shelled layers, canola meal, egg production
101 Effects of the addition of whole sorghum on the productive and digestive responses of broiler chickens. S. Gómez*, M. L. Angeles, M. A. Islas, and V. Mondragón, CENIDFYMA - INIFAP, Colón, Querétaro, México.

An experiment was carried out to evaluate the productivity, breast yield, ileal digestibility of nutrients, organ weights, mucine production and the activity of malatase and sacarase on the mucosa of the small intestine of broiler fed diets in which 20% whole sorghum was included. Birds were allocated individually and were kept on the experiment during 28 days, from 20 to 48 days of age. There were four treatments given by the combination of 2 diets based either on ground sorghum or corn (GS or GC) and the inclusion of 20% ground or whole sorghum (20GS or 20WS). The average daily weight gain, feed intake, feed conversion ratio and breast yield were similar among treatments. However, the ileal digestibility of dry matter (P < 0.05) and energy (P < 0.10) were lower for 20WS. The weight of the proventriculus and gizzard were greater for 20WS (P < 0.05). The amount of total acid mucines (ug of Alcian blue), the acid mucines present per square centimeter per g of the mucosa and the acid mucines per g protein were greater for GS. The total maltase activity was higher for GS-20GS than for GS-20WS (diet and form interaction, P < 0.05). In summary, the results indicate that the ileal digestibility of dry matter and energy were lower and the concentration of acids mucines was greater on the small intestinal mucosa of broiler chickens when 20% whole sorghum was included, however there was not any negative effect on growth performance and breast yield. The results suggest that is feasible to include up to 20% whole sorghum in the ration of finisher broiler chickens as a mean to reduce the cost of feed processing.

Key Words: broiler chickens, whole sorghum, growth performance, nutrient ileal digestibility, mucosal enzymes

102 Chemical composition and energy metabolizable values of the cassava (Manihot esculenta Crantz) products for Japanese quails. F. S. de A. Cunha1, C. B-V. Rabello2, S. B. P. de Lima1, T. S. de Lima1, E. M. F. de Arruda1, and F. G. P. Costa2, 1Universidade Federal Rural de Pernambuco, Recife, PE, Brazil, 2Universidade Federal da Paraíba, Areia, PB, Brazil.

This study was conducted to evaluate the chemical composition and determine the values of apparent metabolizable energy (AME) and apparent metabolizable energy corrected by nitrogen balance (AMEn) of cassava root, leaf of the cassava plant and the branch of the cassava plant. Initially considered was the composition of ingredients and their contents of dry matter (DM), crude protein (CP), mineral matter (MM), ether extract (EE), crude fiber (CF) neutral detergent fiber (NDF) and acid detergent fiber (ADF). After, one metabolism assay was conducted with Japanese quail (Coturnix japonica) with twenty days of age, using the method of total excreta collection. 160 birds were allocate in cage system and distributed in a completely randomized design with four replicates and ten birds per experimental unit. The experimental treatments consisted of a reference diet and three other diets composed of 70% of reference diet and 30% of each food test. The assay lasted for 8 days, 4 days of adaptation and 4 days for excreta collection. The chemical composition of the cassava products were: 86.40, 1.82, 2.36, 1.00, 6.99, 4.23 and 3.10% for cassava root; 3.53, 22.48, 3.31, 55.63, 41.63 and 18.39% leaf of the cassava plant and 85.11, 19.52, 5.90; 2.46, 61.81, 42.49 and 24.35% for the hay stems of the cassava plant, for DM, CP, MM, EE, NDF, ADF and FB, respectively. The values of AME and AMEn were: 3,306 and 3,058 kcal/kg for cassava root; 1,626 and 1,373 kcal/kg for leaf of the cassava plant; and 1,524 and 1,448 kcal/kg for branch of the cassava plant, respectively.

Key Words: alternative feeds, chemical composition, digestibility, quail, metabolizable energy

103 Penetration of Salmonella enteritidis through the yolk membrane in eggs from six genetically distinct commercial lines of laying hens. R. K. Gast*, D. R. Jones1, K. E. Anderson2, R. Guraiy1, J. Guard-Bouldin3, and P. S. Holt1, 1USDA-ARS, Egg Safety and Quality Research Unit, Athens, GA, 2North Carolina State University, Raleigh.

Infected laying hens can deposit Salmonella enteritidis inside developing eggs and thereby transmit disease to humans. Although deposition of S. enteritidis inside yolks is less common than deposition in the albumen or on the yolk (vitelline) membrane in naturally contaminated eggs, migration across the membrane to reach the nutrient-rich yolk contents could lead to extensive bacterial multiplication. Previous studies using in vitro egg contamination models determined that penetration into yolks to produce significant growth can occur during storage at warm temperatures, but not when eggs are refrigerated. The present study used an in vitro egg contamination model to assess the ability of small numbers of S. enteritidis to penetrate the vitelline membrane and multiply inside yolks of eggs laid by six genetically distinct commercial lines of hens during 24 hours of storage at 30°C. Eggs from each line were tested at four different hen ages by inoculation of approximately 100 cfu of S. enteritidis onto the outside of the vitelline membranes of intact yolks in plastic centrifuge tubes and then adding back the albumen into each tube before incubation. Overall, the frequency of penetration of S. enteritidis into the yolk contents of eggs from individual lines of hens ranged from 30% to 58% and the mean concentration of S. enteritidis in yolk contents after incubation ranged from 0.8 to 2.0 log10 cfu/ml. For both of these parameters, values for one hen line were significantly higher than for two other lines, but no other differences were observed. Hen age did not have a significant effect on egg yolk penetration by S. enteritidis. These results indicate that opportunities for the migration and growth of small initial numbers of S. enteritidis to attain more dangerous levels inside contaminated eggs during storage at warm temperatures can vary with different lines of laying hens.

Key Words: Salmonella enteritidis, eggs, penetration, yolk membrane, hen lines

104 Occurrence of white striping in chicken breast fillets in relation to broiler size. L. J. Bauermeister1, A. U. Morey1, E. T. Moran1, M. Singh1, C. M. Owens2, and S. R. McKee1, 1Auburn University, Auburn, AL, 2University of Arkansas, Fayetteville.

A phenomenon referred to as white striping has become a concern to some poultry producers in regards to the visual quality of chicken breast fillets. This study was designed to determine if there was any relationship between the severity of the white striping, the growth of the broiler and the meat quality characteristics. Broilers, Ross 708 straight run, (n=1280) were randomly placed in a completely randomized block design on the
day of hatch. Chicks were fed basal diets (2 x 2 x 2 factorial arrangement) consisting of a Corn Soy Diet or a Corn Soy diet with meat and feather meal. Broilers were grown out under normal rearing conditions and were conventionally processed using a hard scald (62.7°C for 45 s) at 6 wks (n=640) and 8 wks (n=640). Of the birds processed, only the males (n=320 at 6 wks, n= 320 at 8 wks) were used to determine the occurrence of white striping. Live weight and fillet weight were recorded and fillets were ranked visually (1 = normal fillets, 2 = mild white striping, 3 = moderate white striping and 4 = severe occurrence of white striping) based on severity of white striping for each breast fillet. To determine if the quality of the breast fillets were affected by the white striping, tenderness, cook-loss and Hunter L*a*b* color of the breast fillets were measured using fillets from each ranking (1-4). Diet treatments had no effect on severity ranking. However, severity of white striping increased with increasing live weight and fillet weights. In addition, the severity of the white striping increased between the 6 wk processing period and the 8 wk processing period. There were no differences observed in tenderness, cook-loss or color based on the ranking of severity of white striping. This study suggests that there is a relationship between the size of the bird and the severity of the white striping of the breast fillets, but the severity of white striping has no impact on meat quality.

Key Words: white striping, breast fillet, meat quality, quality defects, broiler size

105 Acid solubilization process of mechanically separated turkey meat (MSTM) with the aid of citric acid and calcium ions: Effect on the polar and neutral lipid classes. Y. V. Hrynets*, J. Chan, Y. Xu, and M. Betti, University of Alberta, Edmonton, AB, Canada.

Lipid oxidation is one of the major factors limiting the use of MSTM proteins for the production of further processed poultry meat products. Polar lipids (PL) membranes being rich in polyunsaturated fatty acids (PUFAs) are considered to be the primary substrates for lipid oxidation as compared to neutral lipids (triaclyglycerol; TAG). Thus, if polar lipid membranes are removed from MSTM, the stability of the isolated proteins could be increased dramatically. The experiment was conducted to determine the combined effect of citric acid and calcium ions on polar and neutral lipids removal from MSTM. Mechanically separated turkey meat was homogenized and treated with different concentrations of citric acid (0, 2, 4, 6, 8 and 10 mmol/L) and calcium ions (0 and 8 mmol/L) at pH 2.5. After homogenization, myofibrillar proteins were recovered by centrifugation and precipitation at the isoelectric point (pH 5.2). The entire experiment was replicated 3 times resulting in 36 extractions (3 x 6 x 2). Total fat, PL and TAG content were determined in the extracted proteins. Data were analyzed as 6 x 2 factorial analysis of variance. Means were separated by using HSD Tukey’s adjustment. Strong interactions (P < 0.0001) were found for total lipid content. In general, all the combinations removed an average of 90.3% of the total fat from MSTM, ranging from 83.4 to 94.7%. The lowest amount (1.14%) was found by using 4 mmol/L citric acid with no calcium added. No significant effect of calcium was observed in either PL or TAG. In contrast, citric acid significantly (P = 0.011) affected polar lipid content of protein extracts. The highest removal was observed with addition of 2 mmol/L (95.1%). No significant effect of citric acid was observed for neutral lipids. The results indicated that addition of citric acid may improve the oxidative stability of proteins isolated from MSTM.

Key Words: calcium chloride, citric acid, lipid oxidation, mechanically separated turkey meat (MSTM), myofibrillar proteins


Due to an increase in food safety regulations, water usage in the poultry industry, specifically during broiler processing, has been relaxed. In addition to the increase in water usage per bird, the amount of waste-water pollutants (i.e., suspended solids, fats, oils and grease and nitrogen), have increased as well. Regional water shortages, tightening environmental discharge regulations, and changing municipal policies on water availability and cost make water conservation and reduction of waste load discharge more important now than ever before. A written survey was recently conducted on water use and waste handling patterns in broiler processing plants in the State, which was then followed up by water audits at selected plants. The written survey indicated that water use in broiler processing plants was 6.17 gallons per bird. One common problem observed during the audits was that water continued to run through processing equipment during breaks and lunch periods. The most common recommendations based on the water audits were (1) to add cut-offs on the gooseneck faucets used in the inspection area, (2) turn off water to equipment (pickers, bird washers, evisceration equipment, etc.) and (3) to use dry clean-up rather than washing solid products down the drain.

Key Words: audit, poultry, processing, survey, water

107 WITHDRAWN.

108 Role of hen efficiency in the transfer of omega-3 PUFA to table eggs. S. Nain* and R. A. Renema, University of Alberta, Edmonton, AB, Canada.

This study explored potential linkages between metabolic efficiency, intestinal length and morphology, and transfer of omega-3 polyunsaturated fatty acids (n-3 PUFA) to the egg. Core temperature telemetry devices were surgically implanted into 20, 56 week old Lohman White Leghorn laying hens. Energetic efficiency was determined through calculation of residual MeM (RMEm), which was the difference between observed and predicted maintenance requirements relative to ME intake. This was used to score hens as Efficient and Non-efficient. Birds were then provided an n-3 PUFA enriched diet containing 17% Linpro (extruded flax product). Egg traits were determined and yolks collected at 0d and 14d, and egg lipid profile determined by GC analysis. At 14d, birds were sacrificed to collect gut length and histomorphometric indices.

Efficient hens had a 92.2% rate of lay compared to 88.4% in Non-efficient hens. The n-3 PUFA enriched ration resulted in yolk size declining from 31.5% of the egg at 0d to 29.3% at 14d. By 14 d, concentration of n-3 PUFA (particularly C18:3 n3) had risen while both n-6 PUFA and de novo synthesized fatty acids were reduced (P<0.0001). Hen efficiency did not affect changes in n-3 PUFA content between 0d and 14d. However, Efficient birds had more C18:3 n3 than the Non-efficient birds at 14d (0.278 vs. 0.225 g/egg). Efficient hens had wider (P=0.04) and longer (P=0.08) villi and therefore a greater absorptive surface area/ villi (0.151 mm2) than in Non-efficient birds (0.108 mm2) (P=0.03). Gut length did not affect change in n-3 PUFA, although eggs from short-gut birds had more n-3 PUFA than for longer-gut birds (P=0.03) at 14d. Birds with lower feed intake had a lower concentration of n-3 PUFA in the egg (P=0.07). Increased feed intake led to increased liver
weight ($r=0.51, P=0.015$) and also occurred in smaller birds ($r=-0.47; P=0.029$); Likely reflecting the demands of egg production. Increased metabolic efficiency was associated with increased n-3 PUFA concentrations in the egg.

**Key Words:** laying hen, metabolic efficiency, omega-3 PUFA, gut histology, enrichment

### 109 Validation of a simple screening procedure to estimate contaminant concentration in processed poultry.

I. Reyes-Herrera1,2, J. H. Metcalfe1, P. J. Blore1, M. J. Schneider2, and D. J. Donoghue1, 1University of Arkansas, Fayetteville, 2USDA-ARS-ERRC, Wyndmoor, PA.

The Federal Government monitors food products, including poultry, to detect and prevent unsafe residues (e.g. drugs and pesticides) in the food supply. Monitoring procedures often require analysis of specific marketable tissues (e.g. muscle). A potential alternative is to evaluate residue concentrations in blood samples, which are often easier and less expensive to obtain and analyze. Also, collecting blood at the processing plant does not require carcass destruction and would characterize the presence of residues in the entire flock as opposed to individual samples. Data from our laboratory show that quantitation of residues in blood is a reliable predictor of concentrations in muscle tissues for another antibiotic (enrofloxacin). To determine if this relationship is consistent for other antibiotics, the pharmacokinetic relationship between blood and muscle was evaluated for oxytetracycline (OTC). In this study, 5-wk-old broiler chickens (n= 144) were divided in 2 treatment groups and dosed with either a low or high dose of OTC (800 or 8,000 mg). Blood and breast muscle samples were collected from 6 birds/group at 0, 1, 3, 6, 12, or 24 h during the dosing period and then every 12 h during the withdrawal period for up to 60 h post-withdrawal. Using a quantitative bioassay, OTC was detectable within 1 h of dosing, reaching its plateau phase at 12 h for both groups (low dose 50 and 141 ppm; high dose 504 and 526 ppm, muscle and blood respectively) and had a higher persistence in muscle than serum during the withdrawal period. Levels in blood were consistently lower than those in muscle and maintained an approximately 1:5 blood:muscle relation. Thus, determination of antibiotic residues in blood is a simple and effective means to predict whether residue concentrations in muscle exceed the FDA’s imposed tolerance level for OTC in poultry muscle tissue.

**Key Words:** oxytetracycline, residues, muscle, pharmacokinetic, poultry

### 110 Effects of feeding distillers dried grains with solubles (DDGS) to commercial laying hens: I. Egg characteristics and consumer acceptability.

R. E. Loar II*1, M. W. Schilling1, C. D. McDaniel1, C. D. Coufal1, S. R. Rogers2, K. Karges3, and A. Corzo1, 1Mississippi State University, Mississippi State, 2Cal-Maine Foods, Jackson, MS, 3Poet Nutrition, Sioux Falls, SD.

This study evaluated the effects of feeding incremental levels of DDGS on egg characteristics. Five different levels of DDGS (0-32%) were fed to second cycle Bovans White laying hens for a period of 15 weeks. On two separate occasions, eggs were collected and analyzed for Haugh units and CIE L*a*b* (instrumental color). Sensory panelists (n=100) were asked to rate eggs from 0, 16, or 32% DDGS diets on a nine point hedonic scale for texture, flavor, and overall acceptability. Once during the study, eggs (n=241) were analyzed for shell strength via instron. Treatments were replicated 6 times with each replicate consisting of 5 cages (2 birds/cage; 10 birds/replicate). The study was a randomized complete block design, and Fisher’s protected LSD test was used to separate treatment means. There were no interactions observed between egg collection week and treatments, therefore data were pooled. Color evaluation of eggs showed that increasing DDGS levels in the diet led to a darker (L*) yolk (P<0.003) that was also more red (a*) (P<0.0001). Egg shell strength data was not different (P>0.05) among treatments. Eggs from hens fed the 8% DDGS treatment exhibited a lower Haugh unit score when compared to eggs from the 24% and 32% DDGS treatments, with the 0% and 16% DDGS treatments intermediate (P<0.05). Sensory evaluation results indicated no difference (P>0.05) in texture, but eggs from DDGS fed hens received slightly higher ratings from panelists for flavor and overall acceptability (P<0.05). However, eggs from all treatments received mean scores between like-slightly and like-moderrately on the hedonic scale and would be acceptable to most consumers. Panelists were also able to detect a difference (P<0.10) between eggs derived from the 0% and the 32% DDGS treatment, with eggs from the 16% DDGS treatment being intermediate. Data suggest no negative effects in egg characteristics with increasing DDGS dietary levels. In fact, sensory evaluation results suggest that there may be slight improvement in consumer acceptability of eggs derived from hens fed DDGS in the diet.

**Key Words:** DDGS, Leghorns, eggs, flavor, texture

### 111 Evaluation of recombinant Salmonella expressing the flagellar protein FliC for enhanced immune responses in commercial turkeys.

C. J. Kremer*1, K. M. O’Meura1, S. L. Layton2, B. M. Hargis2, and K. Cole1, 1The Ohio State University, Columbus, 2University of Arkansas, Fayetteville.

*Salmonella enteritidis* is one of the most common sources of human food-borne illness. This organism is often transmitted to humans from poultry products that may have been contaminated pre- or post-harvest. Previous research indicates that oral vaccination of poultry with live attenuated *Salmonella* can confer a high degree of protection to poultry flocks, thus decreasing the risk of infection in humans. The flagellar protein FliC has shown promise in creating an increased immune response and the ability to protect against challenge of wild-type *S. enteritidis*. Several novel attenuated strains of *S. enteritidis* were developed that expressed the FliC protein on the outer membrane protein lamB using the Red recombinase system in combination with overlapping extension PCR. Commercial turkey pouls were orally immunized with saline (Negative Control) or one of the following recombinant *Salmonella* strains (immunization dose: $10^6$-$10^9$ cfu/poult): ΔaroA/ΔhirrA SE, fliC(loop 4), M2e (loop 9) or ΔaroA/ΔhirrA SE, M2e (loop 9) on day-of-hatch and 21 days post-hatch to determine colonization and organ invasion. Blood samples were collected on days 7, 14, 21, 35 and 42 post-hatch to determine colonization and organ invasion. Blood samples were collected on days 7, 14, 21, 35 and 42 post-hatch to determine M2e-specific antibody responses. On day 3 post-inoculation the M2e only group exhibited 100% invasion of the liver and spleen compared to the FliC-M2e group, which exhibited only 50% invasion in the birds sampled. No marked difference in colonization of the cecal tonsils was noted at this time point. There were no significant differences observed between groups in M2e-specific antibody responses. Overall, both candidate strains were cleared from the liver, spleen, and cecal tonsils by day 35 post-inoculation. In summary, the vaccine candidate strains appear to be effective in stimulating host immune responses and may provide lasting protection against challenge when compared to the wild-type parent strain.

**Key Words:** *Salmonella*, FliC, colonization, immune, response

The industry trend towards early deboning has led to the need to explore the impact on meat quality including interactions of strain and gender. An experiment was conducted using broilers of four different high yielding commercial strains chosen because of their common use in big-bird production. Of each strain, 360 birds were commercially processed at 59, 61, and 63d of age in two replicates per day. Breast fillets were harvested at 2, 4, and 6 h postmortem (PM). Muscle pH and color (L* a* b*) were measured at time of deboning and at 24 h PM. Fillets were cooked to 76 C and cook loss was calculated, followed by Meullenet-Owens Razor shear (MORS) analysis. Muscle pH significantly decreased over time as aging prior to deboning increased. L* values significantly increased as aging time increased; the fillets deboned at 6h PM had the highest L* value, followed by 4 h, and then 2 h PM. At 24 h, the fillets deboned at 6 h still had the highest L* compared to those deboned at 2 or 4 h PM. Color a* values significantly increased as deboning time increased, and b* values significantly decreased with aging time when measured at 24 h PM. There was variation in color due to strain. Strain 2 had the highest L* values and low a* and b* values. Fillets deboned at 2 h PM had significantly higher cook loss than fillets deboned at 4 or 6 h PM, but there was no difference in cook loss due to strain at any deboning time. Fillets deboned at 2 h had higher MORS energy (indicating tougher fillets) than fillets deboned at 4 h or 6 h PM. Fillets deboned at 4 h PM also had higher MORS energy than fillets deboned at 6 h PM. At 2 h PM, there were no differences in tenderness due to strain, but differences due to strain were observed at 4 and 6 h PM. There was no difference in L*, a*, b* (24 h PM), or cook loss due to gender. Fillets of males had significantly higher MORS energy (tougher) when deboned at 2, 4, and 6 h PM than those of females; however, there was no difference in pH pertaining to the different genders. The results of this study suggest that deboning time, gender and strain can have impacts on meat quality.

Key Words: strain, debone hour, pH, color, tenderness

Ultrasonic bath marination of broiler breast meat. D. P. Smith*, North Carolina State University, Department of Poultry Science, Raleigh.

Two replicate trials were conducted to determine the effect of using an ultrasonic bath for marinating broiler breast meat. Twelve butterfly fillets per each trial (n=24) were collected from a commercial processing plant and trimmed of connective or fat tissue. One of the fillet pairs was marinated in a solution (91% water, 6% salt, and 3% polysphosphate) for 20 min in an ultrasonic bath (UB) while the other paired fillet was marinated by still soaking (SS) for 2 h. Fillets were held 18 h to determine drip loss and cooked to an internal temperature of 80°C. Marination pickup, drip loss, cook yield, and Alto-Kramer (AK) shear were measured. Marination pickup was significantly (P< 0.05) higher for SS than UB (4.8 vs. 2.2%, respectively), but SS had higher drip loss than UB (2.2 vs. 1.1%). Higher cook yield was observed with SS (88.7%) than UB (84.2%). No difference in AK shear was found due to method, as SS averaged 3.7 and UB averaged 3.4 kg shear/g of sample. The UB method did not improve marination pickup, cook yield, or AK shear compared to the SS method.

Key Words: broiler breast meat, marination, ultrasonic bath, cook yield, shear

Effect of dietary balanced protein and metabolizable energy level, age and sex effects on broiler breast meat quality. B. L. Schneider*, M. Betti2, M. J. Zuidhof2, R. A. Renema2, and V. L. Carney1, 1Alberta Agriculture and Rural Development, Edmonton, AB, Canada, 2University of Alberta, Edmonton, AB, Canada.

Fluctuation in dietary ingredient price or availability can result in changes to broiler diet formulations. To determine the effect of protein and energy level on breast meat functional properties, 432 Cobb x Avian 48 broilers were raised on one of 9 diets with one of 85, 100, 115% of breeder recommended protein and one of 94, 97 or 100% of breeder recommended energy levels. Color (CIE L* a* b*) and pH at 24 h post mortem, drip losses, cooking losses and Alto-Kramer shear (kg Force/g) at 72 h post-mortem were measured on 16 birds (8/sex) per dietary treatment at 3 processing ages (36, 52 and 56 d). Lightness (L*) values (p=0.0199) of the 94% group were lower than the 100% ME treatment (54.05 vs 55.39, respectively); the 97% treatment was not different from either group (54.52). Yellowness (b*) values decreased (p<.0001) as ME level increased (6.53, 5.43 and 4.75, respectively). Increasing DBP level from 85 to 115% of recommended levels decreased b* values (p<0001; 6.07, 5.63 and 5.02, respectively).
Neither ME nor DBP level affected pH at 24 h post mortem, drip or cooking losses or Allo-Kramer shear.

Female broilers exhibited lighter breast meat (p<0.0001) and higher drip loss (p=0.0031) than males (55.26 vs 54.05 and 3.5% vs 3.1%, respectively). Lightness values at 36 d were lower (p<0.0001) than those measured at 52 and 56 d (53.15 vs 55.16 and 55.64). Drip loss was lowest (p=0.0145) in the 56 d group compared to 36 and 52 d broilers (3.17 vs 3.34 and 3.36%, respectively). Allo-Kramer shear values were lowest (p<0.0001) at 36 d compared to the 52 and 56 d broilers (3.80 kg Force/g vs 4.11 and 4.22, respectively).

The breast meat functional properties tested in this project were unaffected by treatment. Despite similar pH at 24 h post-mortem, drip and cooking losses and Allo-Kramer shear values across treatments, muscle color was the factor most affected by altering DBP or ME levels. Ultimately both age at processing and sex of broiler had a greater influence on broiler breast meat quality than the dietary treatments.

Key Words: dietary balanced protein, metabolizable energy, broiler, meat quality, color


A six site study across the United States and Canada was conducted and pooled to evaluate the effects of feeding ractopamine-HCl (RAC) for the final 7 days (d) or 14 d on tom and hen meat quality as measured by ultimate 24-hour pH, Minolta L* (star), and Kramer Shear Force. A randomized complete block design with location as a blocking factor was conducted at each site. Treatment design consisted of two factors: duration (7 d and 14 d) and RAC (0, 5, 9, and 13 ppm). Diets were formulated to contain industry average levels of lysine (total) and metabolizable energy for the finishing phase (as fed); 0.99% lysine and 1,567 kcal/pound of feed for toms; and 0.96% lysine and 1,572 kcal/pound of feed in hens. Selection of individual birds for meat quality analysis was performed via the following procedure: three replicates per site were randomly selected with two birds from each pen (8 pens per replicate) selected. This resulted in 48 birds per site over six sites totally 288 birds per gender undergoing meat quality analysis. Following completion of the treatment phase, feed was withdrawn for about 4 hours (hrs) and then toms were transported for at least 4 hrs. Toms were either 20 wks of age (14 d duration) or 21 wk of age (7 d duration) at the start of the treatment. Hens were either 15 wks of age (14 d duration) or 16 wks of age (7 d duration) at the start of the treatment.

Results of these studies demonstrated that feeding ractopamine-HCl (5-13 ppm) had no negative impact on meat quality as measured by ultimate 24-hour pH, Minolta L*, and Kramer Shear Force. Specific meat quality measured values will be presented for toms and hens, 7 day duration and 14 day durations and the following four doses: 0, 5, 9, and 13 ppm RAC. Additional studies are ongoing and will be reported as results are finalized.

Key Words: ractopamine-HCl, meat quality, Minolta L*, ultimate 24 hour pH, Kramer shear force

117 Improvement of muscle oxidative stability and processing yield in relation with dietary methionine sources. Y. Mercier†, C. Berri‡, E. Baeza‡, T. Bordeau‡, P. Chartrin‡, F. Mercerand‡, and P. A. Gereart‡, 1Adisseo France S.A.S., Commentry, France, 2INRA, Nouzilly France.

The aim of this work was to compare the effect of dietary methionine sources (DLM/HMTBA) used separately or in combination, on technological traits of broiler Pectoralis muscle (PM). 672 male Ross broilers were distributed in three different treatments: DL-Methionine (DLM, Rhodimet NP99®), DL-methionine hydroxy-analogue (HMTBA; Rhodimet AT88®) and a 50% DL-Methionine + 50% DL-Methionine hydroxy-analogue (Met-Mix). Broilers were fed a wheat-corn-soybean meal based diet with soya oil as the unique lipid source.

42-d feed conversion ratio did not differ significantly between treatments. Meat quality parameters (pHu, color L*a*b*) and drip loss have been measured on Pectoralis major muscles. Moreover, Napole yield (curing-cooking yield) and lipid oxidation (TBA-RS) were determined at D3, D6 and D9 after slaughter.

No significant differences between treatments were observed on breast meat yield, thigh meat yield, fat pad and color parameters at D1. Conversely, a significantly higher pHu value (p<0.001) was observed with Met-Mix treatment compared to respectively DLM or HMTBA treatment (6.03 vs 5.94 and 5.98). Moreover, Met-Mix treatment showed significantly lower drip loss (p<0.05) than other treatments (0.75 vs 0.92%). The Napole yield appeared also significantly higher (p<0.05) in Met-Mix treatment compared to respectively DLM or HMTBA treatments. Napole yield was significantly (p<0.05) reduced with HMTBA and Met-Mix treatments suggesting a reduced lipid oxidation until 6 days after slaughter compared to DLM treatment.

The present results demonstrate that dietary methionine supplementation with either only hydroxy-analogue, for lipid oxidation, or combination methionine and hydroxy-analogue can significantly improve meat quality and technological properties of broiler Pectoralis muscle.

Key Words: DL-methionine, DL-HMTBA, meat quality, TBARS, napole yield
Aflatoxins (AF) are a class of mycotoxins that impair poultry health and performance by causing immune suppression, liver damage, and changes in serum chemistry. The toxic effects of AF can be efficiently counteracted by some adsorbents. The aim of this study was to investigate fully characterized clay adsorbents in a feeding trial with broiler chickens to correlate in vitro and in vivo AF detoxifying efficacy. A completely randomized design was used with 4 replicate pens of 5 chicks assigned to each of 10 dietary treatments from hatch to 21 days. Dietary treatments evaluated included a negative control diet (no AF), a positive control diet (2 mg/kg AF), and 8 treatment groups receiving 2 mg/kg AF and 0.5% of one of 8 adsorbents. Results of in vitro experiments ranked the adsorbents as ‘good’ (6 bentonites, R, MB, B7, M32, M34, M5), ‘average’ (bentonite C2) or ‘poor’ (zeolite Z08). Compared with the negative control, AF caused lower (P<0.05) feed intake (FI) and body weight gain (BWG). The addition of the ‘good’ bentonites prevented (P<0.05) the reduction in FI and BWG caused by AF. Adsorbent C2 prevented the reduction in FI (P<0.05) but did not completely prevent the reduction in BWG. Adsorbent Z08 was not effective in reducing or preventing the effects of AF on FI or BWG. Similarly the ‘good’ adsorbents prevented the decrease in serum albumin, serum globulin and serum total protein caused by AF. Aflatoxin caused an increase in relative liver weight (LWT) and relative kidney weight (KWT). Adsorbents R, B7, M5, M23 and M34 prevented (P<0.05) the increase in LWT caused by AF. Adsorbents R, MB, B7, M5 and M23 prevented (P<0.05) the increase in KWT observed in chickens fed AFB alone. Adsorbents C2 and Z08 were not able to diminish the negative effects of AF on LWT and KWT. The ability of adsorbents to ameliorate AF toxicity in poultry basically correlated with the in vitro findings meaning that ‘average’ and ‘good’ adsorbents did not (Z08) or only partially (C2) protected against AF in vivo. However, several in vitro tests are required to differentiate amongst ‘good’ AF adsorbents.

Key Words: aflatoxin, adsorbent, detoxification, aflatoxicosis, mycotoxin binder


Because of pending and current regulations, the poultry industry is searching for alternatives to growth promoting antibiotics which may include plant-derived supplements which may prevent or lessen the severity of coccidiosis. Therefore, a 2 x 2 experiment (8 pens/treatment, 26 birds/pen) was conducted with 2 doses of a coccidial vaccine (1X or 5X; Paracox® 5 administered at 1 d of age) with or without supplementation (125 g/100 kg) with a phytogenic feed additive containing essential oils from oregano, anis and citrus peel (Biomin®P.E.P. 125 poultry). Within each pen, 13 birds received the coccidial vaccine while the remainder was naturally infected through recycling of oocysts in the litter. One of the naturally infected birds/pen was euthanized for histological evaluation of the mid-ileum morphology while 5/pen were collected for determination of apparent digestible energy, nitrogen, and mucin content from ileal digesta. The higher (5X) dosage of the coccidial vaccine resulted in an 11% reduction in crypt depth (P<0.05), but there was no effect on villius length or number of goblet cells (P>0.05). The dosage of coccidial vaccine had no effect on the apparent digestibility of energy or nitrogen. At Paracox® 1X dosage, birds fed the phytogenic feed additive had 12% longer villi than the control fed birds (P<0.05) with 30% more goblet cells, and 23% more goblet cells per 10 microns villius length (P<0.05). Neither coccidial vaccine dosage nor phytogenic supplementation influenced ileal mucin content (concentration or per unit of feed intake). Birds fed the phytogenic feed additive at a Paracox® 5X dosage had 4% less apparent digestible energy (P<0.05), however at the Paracox® 1X dosage there was no effect of the phytogenic feed additive (P>0.05). In conclusion, the dosage of coccidial vaccine can have an influence on the crypt depth and supplementation of the diet with a phytogenic additive increased villi length and goblet cell density.

Key Words: broiler, coccidial vaccine, intestinal morphology, plant-derived supplement

Micro encapsulation increases carvacrol stability during pelleting and premix and feed storage.

Carvacrol (CA), the active compound of oregano, is widely used in poultry nutrition for its antimicrobial activity. The influence of micro encapsulation technologies on CA recovery during the feed production process was studied. The CA formulations were: silica (SI), fat with a large particle size (HYB), modified starch (MS), maltodextrin (MA), arabic gum combined with maltodextrin (MAG) or maltrodextrin coated with either salts (MAS) or with fat (MAF). Encapsulates were produced using adsorption (SI), spray granulation (MA, MS, MAG), spray cooling (HYB), or their combination (MAS, MAF). Encapsulates were then blended into mineral premixes and meal feeds. Unblended encapsulates

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118 Efficacy of characterized adsorbents to ameliorate the toxic effects of aflatoxin B1 in broiler chicken. G. Schatzmayr*, D. Schatzmayr1, D. R. Ledoux2, A. J. Bermudez2, and G. E. Rottinghaus2, 1BIOMIN Research Center, Tulln, Austria, 2University of Missouri, Columbia.

Plant-derived essential oils influence intestinal morphology during a coccidial vaccine challenge. N. Reisinger1, T. Steiner2, S. Nitsch2, G. Schatzmayr1, and T. J. Applegate*, 1BIOMIN Research Center, Tulln, Austria, 2University of Missouri, Herzogenburg, Austria, 3Purdue University, West Lafayette, IN.
were stored at room temperature for 20 wks, premixes were stored at 20 or 40°C for 3 and 5 wks. Meals were expanded at 120°C and then pelleted (75°C). Pelleting stability was checked and samples of meals and pellets stored at 25 or 40°C for 3, 6 and 20 wks. Results were analyzed using GLM procedure of SAS. The CA recovery was determined with in-house validated analytical methods. Under the most stringent condition for mineral premixes (40°C for 5 wks), CA recovery was greater (\( P < 0.01 \)) for MAG, MAS and MA (100, 97 and 97%, respectively) than for MAF (91%), with lower recovery from HYB, SI and MS (\( P < 0.01, 74, 72 and 70% \), respectively). Pelleting stability was higher (\( P < 0.001 \)) for MS, MAG and HYB (97, 96 and 96%, respectively) than for MA, MAF, MAS and SI (89, 87, 86 and 81%, respectively). After 6 weeks at 25°C, CA recoveries in meal feed were higher (\( P < 0.001 \)) for MA, MAG, MAS, MS and MAF (100, 100, 100, 97, 97%, respectively) than for HYB and SI (91 and 84%, respectively). Under the same conditions, recoveries in pellets were higher (\( P < 0.001 \)) for MA and MAG (100 and 98%, respectively) compared with MAF, MAS, MS, HYB and SI (94, 93, 92, 92 and 90%, respectively). These results show that micro encapsulation method and formulations of CA are important determinants of its recovery during feed production.

**Key Words:** carvacrol, microencapsulation, stability, plant extracts

### 122 Effects of functional oils on chickens challenged with coccidiosis. A. E. Murakami\(^1\), L. M. G. Souza\(^1\), J. C. Faveri\(^1\), and J. Torrent*\(^2\), \(^1\)Universidade Estadual de Maringá, Maringá, PR, Brazil, \(^2\)Oligo Basics Ltda, Cascavel, PR, Brazil.

A commercial mixture of functional oils (Essential, Oligo Basics Ltda., Cascavel, PR, Brazil), exposed to coccidiosis, was supplemented to evaluate its effects on chickens before and after a coccidiosis challenge. A total of 1500 male chicks of one day of age were sorted by weight and randomized among 50 floor pens with 50 chicks per pen. Treatments were: Control (C), Essential at 1.5 kg/ton not challenged (ELN) and challenged with coccidiosis (ELC) and Essential at 2 kg/ton not challenged (EHN) and challenged with coccidiosis (EHC). At 14 days of age, treatments C, ELC and EHC were challenged with approximately 100000, 30000 and 75000 oocysts/bird of Eimeria acervulina, Eimeria maxima and Eimeria tenella, respectively. At 14 days of age, weight gains were higher (\( P < 0.01 \)) and Feed: Gain ratios lower (\( P < 0.01 \)) for the ELN, ELC, EHN and EHC treatments compared to the C treatment (323 g, 331 g, 339 g 320 g and 235 g, respectively for weight gains; 1.24, 1.23, 1.22, 1.25 and 1.39, respectively for Feed: Gain ratios). Mortality in post seven days challenge reached 13.66% in the treatment C and was higher (\( P < 0.05 \)) than in the other treatments where it ranged between 2 and 3%. For the challenged treatments, intestinal lesion score evaluated seven days post-challenge, was lowered (\( P < 0.05 \)) in the anterior intestine and cecum by the Essential supplementation independent of the level of supplementation (1.63 and 1.87 vs. 2.60 in the anterior intestine; 1.20 and 1.30 vs. 2.30 in the cecum for C vs. ELC and EHC). Gains Weight from 14 to 42 days of age was decreased by the coccidiosis challenge (\( P < 0.05 \)) and improved by Essential supplementation (\( P < 0.05 \)) but not by level of supplementation. No differences were seen in feed efficiencies between 14 and 42 days of age. In conclusion, functional oils improved growth parameters and intestinal lesion scores in chickens after a coccidiosis challenge.

**Key Words:** functional oils, lesion scores, performance

### 123 Effect of yeast cell wall fractions on health, performance and white blood cells profile of broiler chicken. A. Ganner*\(^1\), S. Nitsch\(^2\), S. Schaumberger\(^1\), T. Applegate\(^3\), and G. Schatzmayer\(^1\), \(^1\)BIOMIN Research Center, Tulin, Austria, \(^2\)BIOMIN Holding GmbH, Herzberg, Austria, \(^3\)Purdue University, Department of Animal Science, West Lafayette, IN.

The trial objective was to investigate the efficacy of a product containing yeast cell wall fractions on health status, performance and white blood cell profile of broiler chicken.

With a quantitative microplate based test assay binding of *E. coli* F4 and *S. typhimurium* to the yeast cell wall fractions was analyzed; binding amounts up to 10^4 CFU/mg were noted. A subsequent feeding trial with the respective cell wall product was conducted. In a 35 day study 450 1-d-old mixed sexed broiler were distributed to 3 experimental groups with 8 replicates (26 birds/pen): control group A, group B (1 kg yeast product/t feed) and group C (2 kg yeast product/t feed). In the course of the trial a positive influence was observed by yeast cell wall supplementation. Live weight (1570 g) and daily weight gain (43.8 g) were improved in group B (1 kg/t) compared to the control group A (1381 g live weight, 38.4 g/d, respectively; \( P < 0.05 \)). Group C (2 kg/t) also showed improved final body weight (1415 g) and daily weight gain (39.4 g). FCR was also improved (group B: 1.82; group C: 1.75) when
124 Assessment of Saccharomyces cerevisiae fermentation product in broiler breeder diets. L. Araujo*1, C. Araujo1, D. Moore2, R. Upton2, C. D. McDaniel1, H. M. Parker1, and M. T. Kidd1, 1Mississippi State University, Department of Poultry Science, Mississippi State, 2Diamond V, Cedar Rapids, IA.

This study investigated the use of a Saccharomyces cerevisiae fermentation product in broiler breeder diets. Forty-eight Cobb 500 hens were randomly allocated into two treatments: control or a control diet plus Diamond V XPC™ (1.5 lbs/ton). All dietary treatments were supplied in mash form. Breeders were provided treatments from 24 to 39 wk of age. Breeders were housed in a floor pen facility with 16 pens (3 hens/pen; 8 replications/treatment). Each pen was equipped with 1 feeder, nipple drinkers, and 1 nest. Hens were inseminated before eggs were collected (150 eggs per treatment) and set at 32 and 39 wk of age. Characteristics examined were egg production, specific gravity, fertility, hatchability, and chick quality parameters such as dehydration, small navels, large navels, open navels, wet chicks, wicks, and red hocks. Egg production was evaluated from 24 to 32 and 39 to 39 wk of age. Weight and specific gravity were measured at 29 and 37 wk of age on eggs collected over a three day period. Breeders receiving the control diet showed lower egg production than breeders fed XPC (P < 0.05) for both periods. However, egg weight, specific gravity and mortality were not different between treatments (P > 0.05). The percentage of small navels was lowest in chicks from breeders fed XPC (P < 0.05). Feeding breeder breeders XPC demonstrated increased fertility, hatchability, and hatch of fertile eggs (P < 0.05) for all periods. Other chick quality and hen performance characteristics were not influenced by dietary treatments. Overall, when compared to the control diet, it appears that XPC increased fertility and hatchability, as well as improved chick quality.

Key Words: broiler breeder, fertility, hatchability

126 WITHDRAWN.

127 Comparison of autoinducer-2 inhibition by saponin rich gua extracts and other commercial saponins. R. Kakami*, P. Jesudasan, S. D. Pillai, and C. A. Bailey, Texas A&M University, College Station.

Saponin rich extracts from guar meal have recently been shown to exhibit antimicrobial and autoinducer-2 inhibition like activities. Bacterial cells communicate amongst each other using signaling molecules termed autoinducers, a process that has been termed quorum sensing. The autoinducer-2(AI-2) molecule produced by bacteria is considered to be a universal signaling molecule as it influences gene expression in a variety of bacteria. Natural and man-made products that can modulate AI-2 activity may have therapeutic value. The objective of this study was to compare AI-2 inhibition by saponin rich gua extracts and other commercially available Yucca and Quillaja saponins. The luminescence-based response of the reporter strain Vibrio harveyi BB 170 was used as the basis for determining AI-2 activity. Conditioned media (cell free supernatant) from E. coli#5 (a prolific AI-2 producer) was used as a positive control. Freeze dried 100 % methanol extracts of guar meal, Yucca and Quillaja saponins were tested for AI-2 inhibition. The 100 % extract showed an average inhibition of 79.5±1.02 % at a concentration of 1 mg/ml (compared with positive control). The Yucca and Quillaja saponins respectively showed an average inhibition of 62.7±2.5 % and 68.3±1.9 % at the same concentration. AI-2 inhibition by these saponins was further analyzed by increasing the levels of concentration. Average inhibition by 100% methanol extract from guar meal was increased to 89.4±1.2 % at a concentration of 5 mg/ml and to a 93.1±0.9 % at a concentration of 10 mg/ml. The Yucca saponins could inhibit AI-2 to a

compared to the control (2.02). Mortality was higher in group A (5.33%) compared to the trial groups (B: 2.62%; C: 4.47%).

Blood samples (1/pen) were taken on d 35. Leukocytes were enhanced in both trial groups (B: 13.45 g/L; C: 12.85 g/L) in comparison to the control (A: 12.15 g/L) (P<0.05). Monocytes were more than doubled in comparison to the control (P>0.05); however lymphocytes were not affected.

Our results clearly indicate that yeast cell wall fractions are able to enhance bird performance and to modulate the immunological blood profile.

Key Words: broiler, yeast cell wall, blood profile


Broiler chicken companies producing antibiotic-free chicken require alternative products for necrotic enteritis (NE). Freeze-dried Lactobacillus reuteri (L. reuteri NHL2; FINELACT™ Poultry, Calpis Co. Ltd, Tokyo, Japan; 10⁶ cfu/bird), an intestinal colonizing and lactic acid producing bacteria of chicken origin, can be administered via drinking water during exposure to pathogenic Clostridium perfringens (Cp). Based on successful mortality reductions (approximately back to normal) in 12 commercial broiler flocks diagnosed with NE due to Cp in Japan, a broiler chicken trial was conducted using an NE challenge model (developed by Southern Poultry Research, Inc., Athens, GA) in battery cages. There were 8 chicks/cage and 8 replicate cages per treatment. Treatments included: 1 & 2) non-medicated uninfected (NUC) or Cp infected (NIC) controls, 3) virginiamycin (Stafac®, Pfizer Animal Health, New York, NY) 15 g/ton and Cp infected (VIT), 4) daily L. reuteri NHL2 and uninfected (LIT), 5) daily L. reuteri NHL2 and Cp infected (LIT), and 6) daily L. reuteri and Cp infected (d9LIT). Each infected treatment bird was dosed with ~5,000 oocysts of Eimeria maxima in inoculum on d 14 and with Cp at ~10⁶ cfu/ml broth once daily on d 19, 20, and 21. The NE intestinal lesion scoring was done on d 22 using 3 birds/cage (0-3, least to most severe). The 0-28 d BW gain was greatest and feed conversion ratio (FCR) lowest for the NUC and LIT groups. Lesion scores were lowest for NUC, VIT, LIT, and LIT groups. The NE mortality % were equivalent for VIT, LIT, and d9LIT groups. The L. reuteri NHL2 given daily by water from 0-28 d to Cp challenged broiler chicks produced best BW gain and FCR, with lesion score and NE mortality % equivalent to virginiamycin at 15 g/ton of feed. Further research is needed with broiler chickens to determine minimum doses and days of L. reuteri NHL2 administration to help ameliorate effects of necrotic enteritis caused by pathogenic Cp.

Key Words: broiler chicken, Clostridium perfringens, Lactobacillus reuteri, necrotic enteritis, virginiamycin

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level of 70.9±3.4% and 76.2±2.8% at the concentrations 5 mg/ml and 10 mg/ml respectively, whereas the average inhibition by Quillaja saponins was 74.7±2.3% and 81.2±1.7% at the concentrations 5mg/ml and 10mg/ml respectively. Saponin rich extracts from guar meal have shown higher inhibition levels compared to commercially available Yucca and Quillaja saponins. Understanding the mechanism behind AI-2 inhibition by saponin rich guar extracts could open doors to use guar saponins to control microbes in poultry feed and other formulations.

**Key Words:** guar saponins, yucca and quillaja saponins, autoinducer-2, inhibition

### 128 Net effect of an acute phase response: Alleviation with probiotic supplementation.

Z. Jiang*,1, G. Schatzmayr1,2, M. Mohner1,2, and T. J. Applegate1,1

Purdue University, West Lafayette, IN, 2Biomin Research Center, Tulln, Austria.

The acute phase response (APR) is characterized by inflammation, fever, and altered organ metabolism resulting in muscle catabolism and anorexia. Therefore, a 1 wk growth experiment was conducted to examine whether dietary supplementation of a multi-strain probiotic (PoultryStar®) would alleviate growth suppression and anorexia caused by lipopolysaccharide (LPS)-induced APR. The experiment was designed with 4 treatments (n=8 cages/treatment; 6 birds/cage) starting at 14 d of age. Prior to (0-14 d of age) and for the experiment (14-21 d of age), male broiler chicks were fed diets devoid or were supplemented with 1.7 x 108 cfu/kg probiotic. At 14 d of age, birds fed the diet devoid of probiotic diet was further divided into 3 treatments: an unchallenged positive control (PC), LPS challenged negative control (LPS-NC), and pair-fed to LPS-NC. The probiotic-fed birds were also then challenged with LPS. The LPS (E. coli O55:B5) was injected intra-peritoneally 4 times at 48h intervals at 1mg/kg BW. The LPS challenge dramatically depressed BW gain from 14 to 21 d of age by 22% (P < 0.001). However, 41% of growth depression was attributable to factors other than feed intake reduction when compared with the pair-fed treatment. Probiotic supplementation recovered 17% of depressed growth (vs. LPS-NC: P=0.068), but this improved growth was not due to improvements in feed intake (P=0.47). However, recovery of feed intake of the probiotic+LPS birds occurred 48 h earlier than the LPS-NC birds. Growth depression induced by LPS administration resulted in a relative feed intake (RFI; vs. PC) of 0.83. In conclusion, APR (induced by LPS administration) diverted a large portion of consumed nutrients from tissue accretion and dietary probiotic supplementation lessened these growth-depressing effects.

**Key Words:** inflammation, short-chain fatty acid, butyrate

### 130 The effect of Grobiotic-P, Temulose, and lactose fed for short time periods on growth performance and cecal microbial populations in young chicks.

C. M. Jacobs* and C. M. Parsons, University of Illinois, Urbana.

The current study was conducted to evaluate the effects of short-term feeding of Grobiotic-P (GB), Temulose, and lactose on growth performance and cecal microbial populations of bifidobacteria, lactobacilli, *Escherichia coli*, and *Clostridium perfringens* in young chicks fed corn-SBM diets. The GB is a prebiotic-type product that contains dairy and yeast fractions and dried fermentation extracts (International Ingredient Corporation, St. Louis, MO) and Temulose is a prebiotic-type product that contains a high concentration of mannan (Temple Inland, Diboll, TX). Four experiments were conducted using New Hampshire X Columbian chicks, and a fifth experiment was conducted using Ross X Ross commercial broiler chicks. In Experiment 1, GB was added at a 3 or 6% inclusion level and was fed for 1, 3, or 21 days post-hatch. In Experiments 2 and 3, 5% GB was fed for 1, 2, 3, or 7 days post-hatch. In Experiment 4, 5% GB, 0.5% Temulose, and combinations thereof were fed for 3 or 7 days post-hatch. In Experiment 5, 5% GB or 1% lactose from Dairylac-80 (International Ingredient Corporation) or pure lactose was fed for 3, 7, or 21 days post-hatch. In Experiments 3 and 5, weight gain was increased (P<0.05) for chicks fed 5% GB or Dairylac-80 for 7 d. Feed intake from 0 to 7 d was significantly increased by feeding 3 or 5% GB and 5% GB in combination with 0.5% Temulose. Based on selective plate culturing, there was a significant linear increase (P<0.05) in lactobacilli populations as GB was included in the diet for 0, 2, and 7 d post-hatch. Based on quantitative PCR, bifidobacteria populations were significantly increased (P<0.05) for some GB treatments. The current studies indicate that GB, Temulose, and lactose fed for short time periods may increase weight gain, feed intake, and cecal lactobacilli and bifidobacteria populations.

**Key Words:** chicks, short-term feeding, microbial populations, prebiotic, temulose
131 In-ovo feeding and dietary NUPRO® enhances triiodothyronine activity and morphological maturation of the small intestinal epithelium of turkey embryos and poults. D. V. Bohórquez*, N. E. Bohórquez2, and P. R. Ferkets, 1North Carolina State University, Raleigh, 2Zamorano University, Tegucigalpa, Honduras.

Intestinal development during the perinatal period is critical for post-hatch survival and growth of poults. Triiodothyronine (T3) hormones are major regulatory peptides that modulate intestinal development and feeding behavior. In-ovo feeding (IOF) at 23d of incubation (23E) and post-hatch dietary supplementation of yeast-extract nucleotides (NUPRO®, Alltech Inc., KY) has been shown to enhance the morphological development and digestive capacity of the intestinal mucosa, but this has not been associated with T3 activity. Three hundred Nicholas turkey 23E embryos were injected with 0.8ml of a saline or IOF solution into the amnion. Hatched poults from these 2 incubation treatments were fed diets supplemented with 0% or 3% NUPRO®, resulting in 4 treatments arranged as a 2X2 factorial. Each treatment was replicated by 6 cages of 10poults/cage. Body weights (BW) and feed intake (FI) were evaluated at 1, 4, 8 and 12d. Jejunum tissue samples for histomorphometrical analysis and serum for T3 activity analysis (radioimmunoassay) were taken at 24E, 26E, hatch, 4, 8 and 12d. The IOF poults had greater (P<0.05) villus surface area than controls at 24E (20270 vs. 15468μm²), 26E (41113 vs. 35499μm²) and hatch (58502 vs. 49663μm²). IOF poults also had higher (P<0.001) T3 activity than controls at 26E (11.3 vs. 8.67ng/μl) and hatch (4.26 vs. 2.9ng/μl). No treatment effects were observed on jejunum histomorphometric measurements at 4, 8 and 12d. A significant IOF*NUPRO® interaction effect at 12d showed that either IOF treatment alone or NUPRO® supplementation of controls increase T3 activity levels. This treatment response on T3 activity was positively correlated with 12d BW and 1-12d FI, even though histomorphometrical differences dissipated with age. In-ovo feeding turkey embryos at 23E enhances the morphological maturation of the small intestinal epithelium prior to hatch and increases appetite and growth post-hatch, perhaps through up-regulation of T3 activity, especially when a nucleotide-rich source such as NUPRO® is included in the diet.

Key Words: turkey, in ovo feeding, intestinal development, T3, yeast-extract nucleotides

132 Justifying phyto genetic feed additive matrix values in conjunction with exogenous feed enzymes. L. K. Worley*, S. A. Loop, C. K. Gehring, K. R. Beaman, and J. S. Moritz, West Virginia University, Morgantown.

The US animal feed industry currently faces tremendous hurdles concerning dietary cost. Increased cost has motivated nutritionists to maximize nutrient availability of feed ingredients. Exogenous enzymes, in part, aid in decreasing diet cost; however, alternative products, such as phyto genetic feed additives, may have potential to replace or work in conjunction with feed enzymes. In order for phyto genetic feed additives to assist nutritionists in decreasing diet cost, matrix values must be determined and implemented in feed formulation. However, research demonstrating matrix values for phyto genetic feed additives is sparse to nonexistent. This study evaluates proposed matrix values for a commercially available phyto genetic feed additive and assesses nutrient sparing when the product is combined with commercial phytase, carbohydrase and protease. Assessment was determined on 4-21 day broiler performance. Dietary treatments included a basal, basal with phyto genetic product matrix value, basal with phyto genetic product matrix value and phyto genetic product, and similar treatments evaluating the phyto genetic product matrix with exogenous enzyme products. Proposed phyto genetic matrix values were 32 kcal/kg metabolizable energy, 0.03% lysine, 0.02% TAA, 0.02% threonine, 0.07% calcium and 0.07% available phosphorus. Decreasing the basal diet by the proposed phyto genetic matrix values decreased broiler live weight gain and increased feed conversion ratio (P<0.05). However, when the same diet included the phyto genetic feed additive, live weight gain and feed conversion ratio were restored. The proposed matrix values of the specific phyto genetic feed additive tested were justified. The application of the phyto genetic product matrix was not additive or synergistic with matrix values of exogenous enzymes. Further research is necessary in order to fully understand the interaction between phyto genetic feed additives and exogenous enzymes.

Key Words: phyto genetic additives, matrix values, exogenous enzymes, live weight gain, feed conversion


Medicinal plants may act as beneficial feed and water additives in livestock.

This research work was designed to study the effect of application of aloe vera juice through drinking water on broiler performance, carcass characteristics, health status and sensory assessment.

One hundred day old broiler chicks belonging to single hatch were weighed and randomly allotted into five treatment groups. The chicks were provided with uniform floor, feeder and waterer space and were reared under standard management conditions throughout the experimental period of eight weeks. Aloe vera juice was applied through drinking water in four treatments T2, T3, T4 and T5 according to the concentrations of 15, 20 25 and 30 cm³ per dm³ of water respectively, while T1 was the control without aloe vera inclusion. The idea was to carry out further study on higher concentration of aloe vera. Result of the experiment showed that the final weight and weekly weight gain were significantly (p< 0.05) increased by the aloe vera supplementation. The trained sensory assessors were able to detect differences (p< 0.005) in dressing percentage, breast and gizzard weight among treatments. The trained sensory assessors were able to detect differences (p< 0.05) in sensory characteristics between broiler meats from broiler fed control and those fed aloe vera supplementation. The result revealed that aloe vera improved the acceptability of broiler meat. There is also increase in blood protein. Aloe vera juice has no harmful effect on boiler health and performance even with higher concentration. Also, aloe vera might increase digestion and utilization when applied through drinking water.

Key Words: aloe vera, performance, drinking water, carcass

Key Words:
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134 Predicting variability in poultry excreta moisture and nutrient level by near-infrared reflectance spectroscopy. J. E. De Oliveira*, V. Larat, E. Hangoor, and T. A. Scott, Provimi Research and Innovation Centre, Brussels, Belgium.

Evaluations of poultry excreta composition can give not only an indication of digestive efficiency but supply a means of evaluating bird welfare and environmental impact. Near Infrared Reflectance (NIR) spectrometry technology has been extensively used to predict chemical and nutritional composition of feeds and feed ingredients in commercial operations. Our objective was to develop a rapid diagnostic tool using NIR to measure excreta moisture (i.e. wet litter) and to establish the prediction of nutrient excretion. A total of 216 samples of broiler chicken excreta were collected, homogenized and scanned in two NIR systems (FT and dispersive). They were also analyzed for moisture, nitrogen, mineral and fiber content by chemical assay. The nutrient composition was utilized to develop NIR calibrations utilizing the partial least squares method. For each calibration, a coefficient of determination (R²) and standard errors of cross validation (SECV) were calculated. Both NIR systems showed similar results and could accurately predict moisture (mean=71.6, SD=7.18, range=32.9-83.5, R²=0.97, SECV=1.12), nitrogen (mean=1.4, SD=1.8, range=0.8-2.8, R²=0.94, SECV=0.069), NDF (mean=7.03, SD=2.0, range=4.19-18.15, R²=0.91, SECV=0.54), potassium (mean=0.66, SD=0.18, range=0.39-1.57, R²=0.91, SECV=0.053), and phosphorus (mean=0.4, SD=0.16, range=0.18-1.67, R²=0.87, SECV=0.041) in fresh samples, but need to be improved for calcium (mean=0.54, SD=0.25, range=0.29-2.66, R²=0.72, SECV=0.062) and sodium (mean=0.09, SD=0.05, range=0.05-0.53, R²=0.57, SECV=0.017). Similar calibrations are being developed for other poultry species, and all values are being added to a database.

Key Words: excreta, wet litter, chemical composition, NIR

135 Characterization of turkey growth profiles through mechanistic modeling. V. C. Rivera Torres*1,2, P. R. Ferket1, and D. Sauvant2, 1Techna, Couéron, France, 2AgroParisTech, Paris, France, 3North Carolina State University, Raleigh.

A mechanistic and dynamic turkey growth model was developed to simulate turkey growth kinetics. In this study, experimental data of male and female growing turkeys of different strains were used to test the adaptability of the model and to determine different growth profiles. The compartments defined in the model corresponded to the protein, lipid, ash, and water content in carcass, viscera and feathers. Ash and water in carcass, viscera and feathers were allometrically described relative to protein. Circulating glucose and total amino acids constituted 2 pools, which enabled incoming and outgoing flows of each body compartment. Glucose constituted the source for energy metabolism, whereas total circulating amino acids corresponded to a transient pool for protein metabolism. Both protein and lipid fractional rates constituted the driving force of the model: the fractional rates of anabolism and catabolism of protein and lipid decreased exponentially until they reached a common asymptotic value, which corresponded to maturity. The fractional rates were fitted through experimental data published on broilers and turkeys. Feather growth was defined as an irreversible loss resulting from anabolic flows. The outputs of the model were defined as daily body weight, feed intake and the mass of the different compartments in carcass, viscera and feathers. The computations of the growth kinetics of the body compartments helped define different growth profiles. Protein and lipid deposition in the carcass constituted the main flows. The inflexion of protein deposition in viscera was observed before the corresponding inflexion in carcass. Protein deposition in the feathers should not be neglected because it reached higher values than protein deposition in the viscera. This model constituted a basis for the study of the effect of environment and diet on the response of growing turkeys.

Key Words: model, growth, metabolism, energy, protein

136 Quantitative analysis of microbial flora in cecum of coccidia infected broilers. A. Nalian*1, E. Oviedo-Rondón2, S. Dowd3, and A. Martynova-Van Kley1, 1Stephen F Austin State University, Nacogdoches, TX, 2North Carolina State University, Department of Poultry Science, Raleigh, 3Research and Testing Laboratory, Lubbock, TX.

Coccidiosis is considered to be one of the most economically important diseases in poultry. Coccidiosis causes mucosal damage and predisposes the birds to bacterial infections such as necrotic enteritis. In this study we examined the effect of coccidiosis infection on the microflora of broilers grown on diets supplemented with either antibiotic (BMD®) plus an ionophore (Coban®) or specific essential oil blends (Crina®). We collected DNA samples from the cecum of broilers before and after an infection with mixed Eimeria spp. (E. acervulina, E. maxima and E. tenella) and used a 454 FLX pyrosequencer and 16S universal primers to obtain quantitative profiles of the bacterial species present in each sample. Sequencing produced approximately 5,000 reads per sample. Taxonomic classification of sequences was done with rdClassifier and BLAST. Relative percent abundance and species richness of the identified taxa was calculated and analyzed using General Additive modeling and Principal Component analysis which showed that species composition was significantly correlated with average feed intake per group. We found that the unmedicated group, when infected with coccidiosis, sustained a complete collapse of micro-flora with the remaining three species being pathogenic. The essential oil blends showed a beneficial effect on micro-flora in post-infection samples where approximately 10 taxa were found. This is the first study to quantitatively investigate the effects of coccidia on broiler intestinal micro-flora. The methodology used proved effective in better understanding the effects of feed additives on intestinal micro-flora.

Key Words: coccidiosis, Eimeria, pyrosequencing

137 Influence of starter feed allocation on broiler performance and processing yield. J. P. Blake*, J. B. Hess, B. Saenmahayak, R. R. Thanissery, X. Dong, and A. L. Shaw, Auburn University, Department of Poultry Science, Auburn, AL.

A total of 1920 mixed-sex broiler chicks (Hubbard M99 x Cobb 500) were randomized among 64 floor pens (1.8 x 2.1 m) with 30 birds each. Eggs were obtained from 30-week-old breeders. Treatments were two levels of protein (22.0 or 23.5%) with 3087 kcal ME/kg for the starter diet provided at four allocation levels of either 0.454, 0.545, 0.636, or 0.726 kg/bird (1.0, 1.2, 1.4, or 1.6 lbs/bird). After the starter allocation was consumed, a grower diet (20% CP; 3186 kcal ME/kg) was fed through 28 days of age followed by a withdrawal diet (17.5% CP; 3219 kcal ME/kg).
kcal ME/kg) to 35 days of age for all treatments. Each of the 8 treatments was assigned to 8 replicate pens. Feed and water were provided ad libitum with 23 hours of light. Birds and feed were weighed at 14, 28, and 35 days to determine growth performance. Carcass yield (front and rear halves) was evaluated at 42 days of age for five broilers per pen.

Results indicate no significant effects (P>0.05) on bodyweight, bodyweight gain, feed consumption, or feed efficiency due to protein level or amount of starter allocation. Average 35-day body weight, feed consumption, and feed efficiency were 2.063 kg, 3.144 kg, and 1.52, respectively. Processing performance at 35 days of age was not significantly (P>0.05) affected by starter diet protein level or allocation amount. The weight or yield of chilled carcass, abdominal fat, front half, wing, breast, and tender were not significantly influenced (P>0.05) by treatment regimen. A decrease (P<0.05) in back half yield was noted for birds fed the two higher allocations (0.636 and 0.726 kg/bird) of starter feed regardless of protein level. Results indicate that higher protein and/or an increased allocation of starter feed failed to positively influence growth and processing performance in 35-day broilers.

**Key Words:** feed allocation, protein, broilers

### 139 Saturated and monounsaturated fatty acid metabolism in broilers: Effects of diet, age and gender

R. Poureslami*1, G. M. Turciniti2, K. Raes1, G. Huyghebaert3, and S. De Smel1, 1Ghent University, Melle, Belgium, 2Deakin University, Victoria, Australia, 3Institute for Agricultural and Fisheries Research, Melle, Belgium.

Using the whole-body (WB) fatty acid (FA) balance method, a study was conducted to estimate saturated and monounsaturated FA (SFA & MUFA) metabolism in broilers as a function of diet, age and gender. Four dietary fat sources (palm fat, P; soybean oil, S; linseed oil, L; fish oil, F) were added to a basal diet at 3% in addition to 5% palm fat. Mass ingestion, accumulation and excretion of FA were recorded in 2 subsequent periods; 7-21d and 21-42d of age. FA digestibility was measured, FA net intake (μmol) was calculated and the difference between FA intake and accumulation in the WB resulted in the overall appearance or disappearance of individual FA. The FA balance was computed following backward calculations along the SFA & MUFA metabolic pathway; the number of μmol of longer chain or desaturated FA that appeared was subtracted from the number of μmol of the previous FA in the pathway. Consequently, after balancing each FA, the number of μmol of longer chain or desaturated FA that appeared was estimated to elongase and Δ-9 desaturase activity, respectively. Net FA disappearance was considered as FA oxidation, while FA ex novo production was estimated by total net appearance. Eventually, the fate of individual FA was reported as percentage of FA net intake plus ex novo production. Diet and age affected deposition, elongation, Δ-9 desaturation, and oxidation of 12:0, 14:0, 16:0, 18:0, 20:0, 22:0, 16:1n-7, 18:1n-9, 18:1n-7, 20:1n-9 (P<0.05), while gender had no effect (P>0.05). FA deposition and oxidation was higher in P fed birds, while elongation and desaturation was higher in L fed birds compared to other dietary treatments (P>0.05). FA deposition, elongation and desaturation were higher in 21-42d, while oxidation was higher in 7-21d of age (P>0.05). On average, 5.5% of net intake and ex novo synthesized SFA & MUFA were oxidized and 94% deposited, of which 33% were elongated and 14% desaturated.

**Key Words:** fatty acids, metabolism, broiler

### 140 WITHDRAWN.

### 141 Effect of feed form and particle size on broiler performance

C. G. Chewning*, C. R. Stark, and J. Brake, North Carolina State University, Raleigh.

A study was conducted to evaluate the effect of feed form and particle size on broiler performance. Previous research has shown an improvement in feed conversion with pelleted broiler diets as compared to mash diets. However, research on particle size is not as clear as to the effect that particle size has on broiler performance. One advantage to a fine grind is better pellet quality and fewer fines at the feeder. The experiment was a 2 x 2 factorial of feed form (pellet and mash) and particle size (300 and 600 microns). A total of 1,024 broiler chicks, 512 males and 512 females, were randomly assigned to one of the four treatments with eight replicate pens per treatment. There were 32 birds per pen, 16 males and 16 females, and a total of 32 pens. Birds were fed corn-soy diets in either pellet (P) or mash (M) form. The starter P diet was crumbled; the grower and finisher P diets were fed as pellets. The corn was ground with a hammermill equipped with either a 7.9 mm or 1.6 mm screen.
to produce the two particle sizes. The average particle size in the 300 and 600 treatment diets was 267 and 570 microns, respectively. Pellet quality as measured by pellet durability index of the three P300 diets and P600 diets was 88% and 84%, respectively. Feed consumption and BW were determined at 14, 21, 35, and 44 d of age and adjusted feed conversion (AdjFCR) calculated by using the weights of all dead birds. The 44 BW of the male and female birds fed the pelleted diets were higher (3,228 and 2,616 g) as compared to the BW of the male and female birds fed mash diets (2,733 and 2,239 g), respectively. No difference was detected in BW due to particle size. The overall AdjFCR of birds fed the M300 P300 (1.94) and M600 (2.11) diets were poorer than the birds that received the pelleted diets. There was no difference in AdjFCR of birds fed the P300 (1.87) and P600 (1.84) diets. The results of the study confirm that broilers perform better when fed pelleted diets.

**Key Words:** mash, pellet, broilers, particle size, chicken

### 142 Increasing mixer-added fat improves exogenous enzyme efficacy and broiler performance


Reduction of added fat in broiler diets has been implemented to decrease diet cost. Although diets may be less expensive, there is potential for nutrient destruction because of greater frictional heat in the pellet die. In an effort to improve pellet quality, much of the added fat may be applied using post-pellet spray application and the amount of fat added in the mixer may become negligible. Thermal inactivation of exogenous enzymes and occurrence of non-favorable reactions (e.g., Maillard reaction, vitamin oxidation, etc.) may be abated by additional mixer-added fat (MAF). This study evaluated the effects of MAF (1, 2.5 or 4%) with or without exogenous enzyme addition (carbohydrase, protease and phytase), and at different conditioning temperatures (82.22 or 85°C), on feed manufacture and finisher phase broiler performance variables, and processing yields. Increasing MAF reduced the electrical energy usage required to manufacture broiler feed (P<0.0001). Feed intake and live weight gain were increased with enzyme addition (P<0.0001). Enzyme addition, conditioning temperature and MAF interacted in their effects on feed conversion ratio (P=0.0093). Overall, enzyme addition decreased feed conversion ratio, but the effect was greatest with 1% MAF and 82.22°C or 4% MAF and 85°C. Increasing MAF (P=0.0259) and conditioning temperature (P=0.024) reduced abdominal fat pad yield. Exogenous enzyme addition increased carcass yield (P=0.0433), but there was no difference in breast or dark meat yield due to any of the factors (P>0.05). It is likely that increased MAF improved exogenous enzyme retention and nutrient utilization by broilers. Subject to current fat prices, increasing MAF may reduce the total cost of broiler production, particularly when reduction of electrical energy usage is considered.

**Key Words:** mixer-added fat, nutrient destruction, enzyme efficacy, feed manufacture, broiler performance

### 143 Examining the relationship between pellet quality, broiler performance and bird sex

K. G. S. Lilly*, C. K. Gehring, K. R. Beaman, and J. S. Moritz, *West Virginia University, Morgantown.*

Pelleted feed increases weight gain and feed efficiency in comparison to mash feed. However, improvement in broiler performance is reliant upon pellet quality. The objective of this study was to explain variations of feed form on modern day broilers correcting for sex. Treatments were arranged in a 4x3 factorial design consisting of four variations of feed form and tested with either all males, all females or straight run pens of broilers. All feed was manufactured at West Virginia University’s pilot feed mill over a two day period. High quality pellets were created by running the mill at a slow production rate and utilizing a thick die (44.45mm x 4.83mm), high steam conditioning pressure (551.58kpa) and high steam conditioning temperature (93.3°C). In order to create variations in pellet quality, a portion of high quality pellets were ground with a roller mill to fine particle feed (finos) and mixed with intact pellets to create different pellet/fine compositions. Treatments consisted of high pellet quality (HPQ) 90:10, medium pellet quality (MPQ) 60:40, low pellet quality (LPQ) 30:70 and mash 0:100. Male and straight run broilers had decreased feed conversion when fed pelleted treatments (P<0.05). This effect was consistent when all birds were pooled together (P<0.05). Males fed HPQ had higher carcass weight than all other treatments (P<0.05). Female broilers fed HPQ had higher carcass weights than those fed mash (P<0.05). Straight run broilers fed HPQ and MPQ had higher carcass weight than those fed LPQ and mash (P<0.05). When all birds were pooled together, carcass weights improved significantly (P<0.05) when fed HPQ in comparison to all other treatments. An economic model using all data collected and feed costs set at $300/ton (multiplied by feed intake / carcass weight) found a savings of $0.0073 per pound of carcass weight when feeding HPQ versus mash.

**Key Words:** feed manufacturing, pellet quality, broiler performance, economic analysis, bird sex

### 144 Influence of main cereal of the diet and particle size of the cereal on growth performance and digestive traits of brown pullets from 1 to 120 days of age

M. Frihka¹, H. M. Safaa², D. G. Valencia³, M. P. Serrano¹, and G. G. Mateos*¹, ¹University Politécnica de Madrid, Madrid, Spain, ²Cairo University, Faculty of Agriculture, Egypt, ³Nutral S.A., Madrid, Spain.

A total of 864 brown-egg laying pullets was used to study the effect of the main cereal of the diet (corn vs. wheat) and mean particle size of the cereal (MPS; hammer milled to pass through a 6-, 8-, and 10-mm screen) on performance and digestive traits. The 6 diets (factorial 2 × 3) were based on soybean meal and contained 50% of either corn or wheat. All of the diets were supplemented with an enzyme complex with β glucanase and xylanase activity. Each treatment was replicated 6 times (24 pullets per replicate). No interactions between main cereal and MPS were found for any growth performance trait studied. Type of cereal did not affect pullet performance at any age. From 1 to 45 d of age BW gain was reduced (P<0.001) and FCR was impaired (P<0.05) as the MPS of the cereal increased. However, no effects on performance were observed after this age. Type of cereal did not affect relative weight (RW, g/kg BW) or relative length (RL, cm/kg BW) of any organ of the gastro intestinal tract at 45 d of age. However, the RW of the digestive tract and the RL of the small intestine (SI) increased with increases in MPS (P<0.05). At 120 d of age, dietary treatment did not affect gizzard pH or the RW of any of the organs of the gastro intestinal tract studied. However, the length of the SI was higher for pullets fed wheat than for pullets fed corn (P<0.01) and was reduced with increases in the MPS of the cereal (P≤0.01). We concluded that wheat can be used successfully at levels of up to 50% in pullet feeds from 1 to 120 d of age. The MPS of the cereal influences pullet performance during the first 45 d of life but not thereafter. It is recommended to grind the cereal of the feed used during the first period of life with a screen of no more than 8 mm.

**Key Words:** corn, wheat, mean particle size, brown-egg pullets performance, digestive traits

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Poult. Sci. 88 (E-Suppl. 1)
Single screw extrusion and enzyme supplementation improve nutrient digestibility in triticale dried distiller's grains and solubles for broilers. M. Oryschak¹, D. Korver², M. Zuidhof³, F. Hernandez¹, and E. Beltranena¹,². ¹Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ²University of Alberta, Edmonton, AB, Canada.

At present, wheat predominates as the feedstock of choice for Western Canadian ethanol plants. Triticale has potential to replace wheat as a feedstock for ethanol production, but little is known about the feeding value of triticale dried distiller's grains and solubles (DDGS) for broilers. The present study tested the effect of single-screw extrusion and enzyme supplementation on nutrient digestibility in triticale DDGS for broilers. Approximately 1100 male broilers housed in battery cages were fed one of 10 test diets either supplemented or without a multi-enzyme complex (Superzyme DDGS®) that included either 15 or 30% triticale DDGS (extruded or not) compared to a basal ration. All test diets included 2% Celite® as an indigestible marker. Each treatment was fed to a single test pen in each of the 5 blocks for a randomized complete block design, with pen as the experimental unit. In each 2-week period of the study, a basal ration was fed for the first 7 days and then a subset of birds was placed onto one of ten experimental diets for the next 7 days. At the end of each two week period, ileal digesta was collected from birds fed experimental diets and pooled by pen. Apparent ileal nutrient digestibility (AID) in test ingredients was estimated using the difference method, which compared digestibility in respective test diets to that in the basal ration. Complete amino acid (AA) profiles were developed for samples from the grower period (d28) to estimate AID. Extrusion resulted in modest improvements in AID of GE (0.51 vs. 0.46) and CP (0.69 vs. 0.67) in triticale DDGS (P < 0.05), but no impact on AID of Lys, Met or Thr (P > 0.05). In contrast, enzyme supplementation improved AID of GE, CP and all essential amino acids in triticale DDGS, with the exception of Arg and Trp (P < 0.05). These improvements included 11% and 20% increases in AID of GE (0.51 vs. 0.46) and Lys (0.66 vs. 0.55), respectively. Our results suggest that both extrusion and enzyme supplementation improve nutrient digestibility in triticale DDGS for broilers.

Key Words: DDGS, extrusion, enzyme, digestibility, broiler

Twin screw extrusion improves nutrient digestibility in wheat and corn dried distiller's grains and solubles for broilers. M. Oryschak¹, D. Korver², M. Zuidhof³, F. Hernandez¹, and E. Beltranena¹,². ¹Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ²University of Alberta, Edmonton, AB, Canada.

Dried distiller's grains and solubles (DDGS) is a co-product of ethanol production and has value as a cost-competitive ingredient for livestock feeding. While information is available on the feeding value of corn DDGS, published information for wheat DDGS from Western Canadian ethanol plants is scarce. The present study tested the effect of twin-screw extrusion on nutrient digestibility in wheat and corn DDGS in diets that included either 15 or 30% of each DDGS type (extruded or not) compared to a basal ration. Test diets included 2% Celite® as an indigestible marker and were fed to male broilers (~1100) group housed in test batteries subdivided into 5 blocks. Each treatment was fed to a single test pen in each block for a randomized complete block design, with pen as the experimental unit. In each 2-week period of the study, a basal ration was fed for the first 7 days and then a subset of birds was placed onto one of nine test diets for the next 7 days. At the end of each two week period, ileal digesta was collected from birds fed experimental diets and pooled by pen. Apparent ileal nutrient digestibility (AID) in test ingredients was estimated using the difference method, which compared digestibility in respective test diets to that in the basal ration. Complete amino acid (AA) profiles were developed for samples from the grower period (d28) to estimate AID. Extrusion and inclusion level were significant model components for all nutrients (P < 0.05). At 15% inclusion, extrusion improved AID of GE, Lys and Met in wheat DDGS by 27% (0.70 vs. 0.55), 34% (0.78 vs. 0.58) and 8% (0.90 vs. 0.85), respectively. Similarly, extrusion improved AID of GE, Lys and Met in corn DDGS (15% inclusion) by 45% (0.86 vs. 0.59), 28% (0.91 vs. 0.71) and 13% (0.96 vs. 0.85), respectively. Similar improvements in digestibility were observed for both DDGS types at 30% inclusion in the diet. Our results suggest extrusion is an effective strategy for improving AID of GE and AA, in particular Lys, in corn and wheat DDGS for broilers.

Key Words: DDGS, extrusion, broiler, digestibility

Economic modeling for optimizing broiler profitability on nutrient density. N. Sriperum*, G. M. Pesti, and M. E. Wetzstein, University of Georgia, Athens.

It has been stated that the goal of feed formulation should be to maximize profits. Associated cost minimization is a necessary condition for maximizing profits but by itself may not maximize profits. It has also been noted by several researchers, formulating diets to maximize profitability, rather than to maximize body weight gain or breast meat yield can increase the profitability of a broiler production system. Thus, formulating diets to minimize feed costs might not be the most cost effective means of maximizing profitability. Early approaches of applying economics to feed formulation focused on reducing feed cost per bird, per unit of meat or per unit of breast (Pesti et. al, 1986). The concept behind maximizing profitability through nutrition is to formulate the diet to maximize broiler profitability. This involves formulating diets to maximize profitability, rather than to maximize body weight gain or breast meat yield can increase the profitability of a broiler production system. Thus, formulating diets to maximize profitability should take into consider the concept of a 'most economical feeding level' versus the concept of 'requirement per se'. According to the reference paper, two diets were formulated based on digestible lysine (dLys) levels of 0.72 or 1.19%, which gave calculated CP levels of 15.02 and 22.53% respectively, although no crude protein minimum was specified. Feed ingredient prices from February 2008 and 2009 were used, which represents an elasticity of feed prices between high and low. The pricing scenario for 2009 predicted a higher dLys to maximize profits versus the situation from 2008. In general, when feed costs decline, it is more economical to feed a higher nutrient dense diet versus what was previously considered best. This emphasizes the point that formulation constraints should ideally be based upon economics and not just strict technical measurements.

Key Words: broiler, modeling, profitability, nutrient density
Environmental and Management III

148 Effect of rate of preincubation temperature increase on hatchability of broiler hatching eggs. O. Elibol*, M. Guçbilmez, and J. Brake, 1Ankara University, Faculty of Agriculture, Department of Animal Science, Ankara, Turkey, 2North Carolina State University, Department of Poultry Science, Raleigh.

This study investigated the effect of rate of preincubation temperature increase and broiler breeder flock age on fertile hatchability. In the trial 1 hatching eggs were obtained from Ross 344 male x Ross 308 female broiler breeders at 37 and 52 wk of age. Eggs were collected from the same flocks 4 wk later for trial 2 when the flocks were 41 and 56 wk of age. Eggs were collected from two different flocks at 34 and 47 wk of age in trial 3. Thus, there were younger (34-41 wk) and older (47-56 wk) flocks studied in each trial. All eggs were stored for 6 d at 18 C and 75% RH. Two preincubation treatments were applied with the eggs placed in two Petersime incubators that achieved the preincubation temperature of 26 C in either 1 h or 4 h. The total preincubation period from leaving the cooler to setting was 9 h. The eggs were then set in a single incubator that reached the incubation temperature of 37.8C in 8 h. In all trials each tray of 150 eggs constituted a replicate and 16 replicate trays (2400 eggs) were set per preincubation treatment at each flock age in each trial. Infertile and early deads (0-6 d) were identified by candling and removed at 14 d. At the time of removing the chicks from the hatchers, all unhatched eggs were opened and examined macroscopically to determine remaining embryonic mortality (middle (7-17 d) and late (18-21 d plus pipped)), and percentage fertile hatchability. Fertile hatchability was significantly better for the younger flocks. There were significant interactions of flock age X preincubation treatment for fertile hatchability and percentage early dead embryos because it was only the younger flocks that responded in a significantly positive manner to the more rapid rate of preincubation temperature increase. These data show that reaching the preincubation temperature faster reduced early embryonic mortality and increased fertile hatchability in younger flocks.

Key Words: broiler hatching eggs, hatchability, preincubation

149 Strain and incubation temperature effects on embryonic and post-hatch growth of broilers. K. Kroesen*, J. Anderson, and M. S. Lilburn, The Ohio State University, Wooster.

In a series of experiments, eggs from two broiler strains, a commercial strain (C) and a slow-growing heritage strain (BR) were used. In Experiment 1, egg weight at set was greater in the C (59.3 g) vs BR (55.6 g) lines. Embryo dry weight increased progressively in both strains from 1.44 g (BR) and 1.84g (C) at day 14 to 6.20 g (BR) and 6.39 g (C) at day 19, respectively. In Experiment 2, the eggs were incubated at 38.0 C and 38.5 C from 0 to 10 days and then half the eggs in each initial treatment were switched to the other temperature through 19 days. There were no significant strain differences in embryo dry weight on day 17 but in both strains, embryo dry weight was increased by initial exposure to 38.5 C. Whole embryo staining at 17 days allowed for the determination of strain and temperature effects on the length of the entire torso,ibia, and shank. The length of each of these skeletal components was significantly greater in C versus BR embryos. Exposure to the 38.5 C temperature from 0 to 10 days also resulted in a significant increase in tibia length in both strains but no consistent effects on overall torso or shank length.

Key Words: embryo, broiler, incubation, temperature


Less than optimal incubation temperatures have been demonstrated to have an effect upon the physiology of the embryo which can impact future performance of the broiler chick. The experiment used two incubation profiles, the first (SS) eggshell temperature (EST) was maintained at 37.5C. The second profile (LH) was similar to what one observes when eggs are in a multi-stage incubation system, the first 7 days EST was maintained at 36.5C, during the second 7 days at 37.5C and the remaining days at 39C. 3 breed crosses (B) from the same breeder were used. All eggs were individually numbered and weighed at the start of incubation and again at embryo sampling to determine conductance. Relative embryo weights without yolk (REW) were determined at day 13, 15, 17, 18, 19, 20 and at hatch (H). Relative liver weights (RLW) were determined at 15d, 18d and at hatch and glycogen (GLY) determination made at 15, 18d and hatch. Relative heart weight (RHW), GLY and right ventricle: left ventricle ratio (RV: LV) was determined at hatch. RBW for B was significantly different only at 15 and 19d, while RLW was different only at 18d. LH incubation profile demonstrated significantly lower REW at all days; significantly lower RLW at 15d (1.81 v 1.98%) and at H (2.55% v 2.80%). RHW was significantly less for LH (0.74% v 0.97%). The RV:LV ratio was significantly greater for LH than SS at 37.4 and 30.6% respectively, indicating potential pulmonary hypertension. This experiment demonstrates that the LH profile had serious effects upon the growth of the embryo and specific organ systems critical to the energy needs and viability of the embryo. The experiment demonstrates that incubation conditions can alter heart physiology and potentially impact the health of the hatching during grow out.

Key Words: incubation, embryo, pulmonary hypertension

151 Incubation temperature and vaccination effects on early post-hatch immune organ weight and yolk sac utilization in commercial broilers. J. Sottosanti*, A. Barri1, M. Wineland2, R. Dalloul1, and A. P. McElroy1, Virginia Polytechnic Institute and State University, Blacksburg, North Carolina State University, Raleigh.

Temperature stress during embryonic incubation can influence post-hatch performance, response to post-hatch stress, and development of immunocompetence. Vaccination in ovo or at hatch can induce physiological stress by necessitating an immune response in chicks, and response to vaccination may be impacted by other stressors. This study evaluated effects of incubation temperature and vaccination on post-hatch immune organ weight, yolk sac absorption, and yolk-free body weight (YFBW) in commercial broilers. Cobb 500 eggs were incubated with the following shell temperatures during early and late incubation: low (L:36.7°C), standard (S:37.5°C), and high (H:39°C). Eggs were incubated at S from E8-14, and combinations of L or S during early (E0-7) incubation and S or H during late (E15-21) incubation, yielding four incubation treatments: LH, LS, SH, and SS. Marek's (MDV) and Newcastle (NDV) vaccines were administered in ovo at E18 or by subcutaneous injection at hatch, respectively. Birds were selected from each of the four incubation groups and were administered no vaccine, MDV or NDV, or both vaccines (MDV+NDV) producing 16 treatments. Birds were weighed and yolk sac, bursa, thymus, and spleen were collected at d0, 2, 4, 10, and 14 post-hatch. There were no significant incubation effects on YFBW at d0. However, by d2 SH and SS groups had higher
Effects of maternal energetic efficiency on myofiber number of biceps femoris muscle of one-day-old broiler chicks. L. F. Romero1, M. J. Zuidhof2, F. E. Robinson2, A. Naenim2, and R. A. Renema2, 1Danisco Animal Nutrition, Marlborough, United Kingdom, 2University of Alberta, Edmonton, AB, Canada.

This study evaluated the effect of maternal broiler breeder (BB) energetic efficiency on egg and chick weights, and weight and total fibre numbers (TFN) of biceps femoris muscles of 1 d old chicks. The experimental design was a 2 x 2 factorial with 2 levels of maternal residual feed intake (RFImat; Low and High) and 2 levels of maternal residual ME intake (RMEmat; Low and High). RFImat was the difference between observed and predicted ME intake, and RMEmat was the difference between observed and predicted maintenance requirements relative to ME intake. Egg and chick weight were investigated in 214 chicks hatched from 32 59-wk old hens selected from a larger study. Biceps femoris muscle weights were assessed in 1 chick per hen, and myofibre number assessed in 1 biceps femoris muscle from 16 of these chicks representing hens with the greatest or least RFImat and RMEmat values. The least efficient hens (High RFImat x High RMEmat) produced smaller eggs (61.9 g; P=0.08) and smaller chicks (39.4 g; P=0.005) than the other sub-groups (66.0 to 67.4 g and 42.8 to 45.7 g, respectively). Similarly, chick yield from the least efficient hens was lower (63.8% of egg weight) compared to the other efficiency treatments (65.0 to 67.4%). Chicks from inefficient hens not only had fewer nutrients from the eggs to start off, but also a proportionally lower weight at hatch. Neither total nor relative muscle weights compared to NDV. While there was no interaction between incubation temperature and vaccination on the parameters measured, results suggest that early and late incubation temperature stress may negatively impact early BW and yolk sac absorption.

Key Words: incubation, vaccination, broiler

In ovo technology—Commercial trial to evaluate the site of vaccine delivery in day 18 embryonated chicken eggs. B. Hopkins1 and C. Williams2, 1Hopkins Consulting, Overland Park, KS, 2Pfizer Animal Health, Research Triangle Park, NC.

Site of vaccine delivery in ovo is critical to Marek’s disease (MD) vaccine efficacy. Application of MD vaccine on the air cell membrane (0% efficacy) or into the allantoic fluid (28% efficacy) has been shown to greatly reduce the protective index against MD challenge. The objective of the trial was to evaluate the quality of vaccine delivery under commercial conditions as measured by site of vaccine delivery in ovo.2 A standard protein staining dye was included in the vaccine diluent to elucidate the exact location of vaccine delivery within embryonated broiler chicken eggs at day 18 plus 10 hours of incubation. Comparisons were made between the two U.S. manufactured in ovo systems (Embrex® Inovoject® System, Pfizer Animal Health, Research Triangle Park, NC and the ManualJect® System, Avitech, Salisbury, MD). All eggs were incubated in Super J incubators (Jamesway™ Incubator Company Cambridge, Ontario) at two separate commercial hatcheries. Injections were completed at the same chronological embryonic age (18 days and 10 hours of incubation): however injections with each system were done on separate days. Eggs were evaluated immediately after injection to determine normal embryonic development and the exact location of vaccine delivery. Analyzed categories and results for site of injection included three classifications: correct site (amnion, embryo); incorrect site (air cell, allantois); and non-vaccinated. The correct in ovo site of vaccine delivery was significantly greater using the Inovoject System (95.3%) as compared to the ManualJect System (52.3%). Regardless of breeder flock source, the ManualJect System had significantly increased results in delivery to the incorrect in ovo injection sites (air cell, allantois, and air cell/allantois combination) than the Inovoject System (p<0.0001).

1. Wakenell et all. Effect of In Ovo Vaccine Delivery Route on Herpesvirus of Turkeys/SB-1 Efficacy and Viremia. Avian Diseases 2002; 46 (2) 274-280.

**Key Words:** in ovo, site of injection, amnion, embryo, allantoid

### 155 The use of distillers dried grains plus solubles as a feed ingredient on nutrient excretion and air emissions from laying hens.

W. Wu-Haan*1, W. J. Powers1, C. R. Angel2, and T. J. Applegate3,
1Michigan State University, East Lansing, 2University of Maryland, College Park, 3Purdue University, West Lafayette, IN.

The objectives of the current study were to evaluate the effect of commercial diets containing 0, 10, or 20% distillers dried grains plus solubles (DDGS) laying hens from 21 to 26 wk of age on emissions of NH3, H2S, NO, CO2, CH4, SO2 and non-methane total hydrocarbon (NMTHC), hen performance, as well as manure DM, N and P excretion. Hens (n= 640) were allocated, randomly to eight environmental chambers for a five-wk period (2 replicates of 0%; 3 replicates each of 10 and 20%). Average egg weight (50.6 g), egg production (85%), and feed intake (87.9 g/hen/d) were unaffected by diets (P > 0.05). A linear decrease in daily mass of NH3 and H2S emitted adjusted per kg N or S intake were observed (P < 0.01) as DDGS in the diet increased from 0 to 20%. Daily NH3 emissions from hens fed diets containing 0, 10, and 20% DDGS were 19.0, 16.2, and 14.7 g/kg N intake respectively. Daily H2S emissions from hen fed commercial diets containing 0, 10, and 20% DDGS were 2.9, 2.4, and 2.0 g/kg S intake, respectively. Daily emissions of CO2 were decreased linearly (P < 0.01) as inclusion of DDGS increased. No diet effects on emissions of NO, NO2, CH4, SO2, and NMTHC were observed (P > 0.05). There were no significant differences in manure DM excretion (60.7, 76.4, and 71.5 g/hen per day, respectively), N excretion (2.6, 2.5, and 2.7 g/hen per day, respectively), or P excretion (1.5, 1.8, and 1.9 g/hen per day, respectively) from hens fed commercial diets containing 0, 10 or 20% DDGS (P > 0.05). The results of this study demonstrate that 10 to 20% DDGS derived from ethanol production can be fed to laying hens with no effects on nutrient excretion and can potentially lower emissions of NH3 and H2S.

**Key Words:** ammonia, distillers dried grains with solubles, hydrogen sulfide, laying hens

### 156 Evaluation of char and active carbon for the reduction of ammonia volatilization from poultry manure.

C. Ritz*, A. Tasistro, B. Fairchild, and B. Bibens, University of Georgia, Athens.

Locally available biomass materials, such as peanut hulls or tree clippings, have the potential for use as raw materials for producing chars and active carbons. Chars have long been known to possess properties that make them valuable environmental tools. One such application is the adsorption of NH3. By properly activating the char, ammonia can be captured on its surface. Active carbon can be found in numerous products that make them valuable environmental tools. One such application is drinking water filtration and air purification. Chemical adsorption of ammonia is mostly due to its interaction with oxygen functional groups via hydrogen bonding. It is expected that chars used with poultry litter application will perform mostly based on their chemisorption capacity. The purpose of this study was to evaluate the effectiveness of char and active carbon on reducing ammonia volatilization from poultry manure when used as a surfaced-applied litter treatment. Char from peanut hull waste was produced by pyrolysis, wherein the material was heated to 400°C in the absence of oxygen for 30 minutes. The unamended peanut hull char (pH 9.20) and an acidified poultry litter char (53% sulfuric acid) were applied to replicate pens at rates of 50, 75 and 150 lbs per 1000 square feet. Broilers were raised in the pens at 0.75 square feet per bird to generate the manure ammonia. The unamended chars actually increased the release of ammonia an average of 14% over the control. The acidified char applied at the 50, 75 and 150 lb rates reduced overall ammonia release by 11, 25, and 35%, respectively over the control. The reduction in ammonia from the acidified char treatment is most likely due to litter pH reduction from the acid application and not from chemisorption by the carbon. Further investigation into the use of activated carbon products for ammonia control in poultry houses is warranted.

**Key Words:** broiler, ammonia, char, active carbon, pyrolysis

### 157 Litter nutrient estimates for broiler chickens.

J. P. Blake*, J. B. Hess, and K. S. Macklin, Auburn University, Department of Poultry Science, Auburn, AL.

Data was obtained from a series of seven consecutive experiments conducted over a 16-month period using the same broiler strain (Ross x Cobb) and corn-soybean meal starter (0.68 kg/bird; 22% CP, 3087 kcal/kg ME), grower (1.36 kg/bird; 20% CP, 3131 kcal/kg ME), finisher (1.81 kg/bird; 17.5% CP, 3197 kcal/kg ME) and withdrawal (c.a. 1.36 kg/bird; 16.5% CP, 3219 kcal/kg ME) diets. Four replicate pens (2.44 x 2.44 m) with 70 birds each represent data obtained from each experiment. New pine shavings (54.42 kg) were placed in each pen. Feed and water were provided ad libitum with 24 hr light. For each experiment birds and feed were weighed on day 21, 42 and 49 and amount of litter production was determined upon termination. Litter nutrient outputs were calculated on a dry matter basis for a single production cycle.

Seasonal differences (P<0.05) in growth performance occurred with ranges in live weight (2.75-3.38 kg), feed consumption (4.85-6.49 kg) and feed efficiency (1.74-1.93) for the seven experiments. Variations in seasonal and weekly differences occurred with overall averages presented. Nutrient output in kg/tonne (dry matter) was estimated at 35.6 N, 18.2 P, 22.9 K, 26.8 Ca, and 4.7 Mg. Trace mineral output in g/tonne of litter was estimated at 38 Cu, 926 Fe, 290 Mn, 281 Zn, and 5.42 kg Na. The amount of nutrients produced in kg/tonne of live weight on a dry matter basis was calculated as 12.9 N, 6.3 P, 8.2 K, 9.4 Ca, and 1.7 Mg. Trace mineral production was estimated in g/tonne of live weight as 13.9 Cu, 329 Fe, 104 Mn, 100 Zn, and 1.95 kg Na. Approximately 0.36 kg of litter dry matter was produced per kg of live weight. Litter moisture increased from an initial value of 10.5% for clean dry pine shavings to 15.1% for reused litter. The mircobiome of reused litter can affect the colonization and development of the simple, dynamic intestinal microbiome of the young chick. The objective of the study was to examine the effect of clean and reused litter on the ontogeny of intestinal tract microbiome in broilers over a 6-week growth cycle. Composite (10 random birds/sample) mucosal and cecal samples from birds reared on both clean and 2-year old reused
pine litter were collected at days 7, 14, 21, and 42. Litter samples were collected and pooled from multiple locations within the barn at the same times. Microbiome DNA was extracted from all samples using the RBB-C method. Community profiles were compared within sample type using PCR–DGGE. Diversity and community structure were further examined using clone libraries of the 16S rRNA gene for all sample types at day 7. Abundance of total Clostridium perfringens and C. perfringens type A (α toxin–producing) was quantified using specific real–time PCR. Results of DGGE indicated significant differences between the microbiomes of both litter types and of the ileum of birds raised on each litter type. As demonstrated in the 16S clone libraries, different samples (both mucosa and litter) have distinct microbiomes at day 7. Generic or α toxin–producing C. perfringens were detected in both the clean and reused litter at all the time points. No generic or α toxin–producing C. perfringens was found in the cecum of birds raised on the reused litter until day 42; however, both were detected in the cecum of birds raised on the clean litter by day 14. The results suggest that reused litter can delay the colonization of generic and α toxin–producing C. perfringens within the cecum. More studies are needed to examine the relationship between chemical conditions and the microbiome of litter and between the litter, intestinal microbiomes, and pathogens. The results may help broiler producers develop more cost–effective litter management strategies.

Key Words: broilers, ileum, cecum, Clostridium perfringens, litter

159 Litter depth and its effect on foot pad dermatitis. E. M. Shepherd*, B. D. Fairchild, and C. W. Ritz, University of Georgia, Department of Poultry Science, Athens.

High grade chicken paws have become one of the most profitable portions of the broiler carcass. The biggest cause of downgrades and condemnations of processed paws are from Footpad Dermatitis (FPD). This condition is characterized by inflammation and necrotic lesions on the plantar surface of the footpad. Litter depth in commercial broiler facilities can be variable depending on the frequency of cleanout and availability of materials to re-bed houses. Field observations suggest that as litter depth is decreased, paw quality is reduced. The objective of this study was to evaluate differing depths of litter on the incidence and severity of FPD. The experimental design consisted of 12 pens containing 31 birds each for a total of 372 birds. The four treatments consisted of 1, 3, and 5 inches of fresh litter and one with 2 inches of used litter. Litter moisture analysis, paw scores, bird weights, and feed consumption were taken weekly through six weeks of age.

Results from the study showed that paw quality at weeks 2 and 3 was better when litter was 3 inches or deeper as compared to the control and reused litter. Litter moisture decreased as litter depth increased. No significant differences were observed in body weight, feed conversion, or mortality when compared to litter depth. These results imply that there is a connection between increasing litter depth, decreasing litter moisture, and an improvement in paw quality. Field observations have indicated that paw quality is better on built up litter, but these results suggest that it may be more closely associated with litter depth. Houses that utilize built up litter programs tend to have deeper litter than houses that are cleaned out after each flock. By increasing litter depth, moisture holding capacity is increased which could result in better paw yields at the processing plant.

Key Words: footpad dermatitis, litter depth, broiler, moisture, paw scores

160 Trace element accumulation during litter treatment usage for broiler chickens. J. P. Blake*, J. B. Hess, and K. S. Macklin, Auburn University, Department of Poultry Science, Auburn, AL.

For three consecutive experiments, 1500 mixed-sex broiler chicks (Cobb X Ross) were assigned among 30 floor pens (1.8 x 2.1 m) containing once-used litter with 50 birds each. Experiment 1 was conducted February–March; Experiment 2, April–May; and Experiment 3, June–July. Birds received a corn-soybean meal starter (0.68 kg/bird; 22% CP, 3087 kcal/kg ME), grower (1.36 kg/bird; 20% CP, 3131 kcal/kg ME), and finisher (c.a. 2.27 kg/bird; 17.5% CP, 3197 kcal/kg ME) to 42 days of age. Treatments were control (CON); Poultry Litter Treatment (PLT), Poultry Guard (PG) or 50:50 All-Clear:PLT (ACPLT) at 100 lbs/1,000 ft² and liquid alum (A-7) at 30 gals/1000 ft² with six pens per treatment. Treatments were top-applied 24-hrs prior to placement with a 14-day downtime between experiments. Feed and water were provided ad libitum with 23 hr light. Litter samples were obtained initially, at experiment termination, and during litter reconditioning between experiments. Trace element levels are presented on a dry matter basis.

Specific treatment regimens resulted in increased concentrations of litter trace elements. As compared to CON, PLT contributed an increase in Na accumulation (10,546 vs. 6576 ppm); PG increased Al (1018 vs. 623 ppm) and Fe (1433 vs. 1176 ppm); A-7 increased AI to 2865 ppm as compared to CON (623 ppm). Initial levels of minerals such as P, Ca, and K; Cu, Fe, Zn, and Mn were 1.06, 1.99, and 1.56%; 22.4, 649, 217, and 219 ppm, respectively. At the end of the third experiment, levels were 2.16, 3.83, and 2.89%; 35.7, 1212, 409, and 397 ppm, respectively. Nitrogen composition following each experiment increased from 3.32 to 3.52 to 3.73%, respectively. Reconditioning of litter between experiments yielded an average reduction in nitrogen of 26.2 and 17.9% prior to the start of Experiment 2 and 3, respectively. Trace element loading of soils from prolonged application of poultry litter requires additional investigation to determine its detrimental effects on soil and water quality.

Key Words: trace element, litter treatment, broiler

161 Using mortality compost in vegetable production. C. Dunkley*, D. Cunningham, C. Ritz, and S. Rahjeev, 1University of Georgia, Tifton, 2University of Georgia, Athens.

A study was conducted to determine the effectiveness of composting to breakdown the carcasses of poultry mortality and destroy pathogenic microbes that may be present. The study was divided into two phases, the first involving the composting of daily mortality while the second used the composted material to amend vegetable plots planted with cabbage seedlings. Phase 1 was first conducted during the summer and then repeated during the winter to determine whether time of year had an effect on the temperature profile achieved or the length of time needed for the process to be completed. Daily mortalities from a broiler flock that was approximately 24 to 30 days old were collected from a producer and layered into a compost bin each day for four days. Samples were collected from the litter before it was placed in the bin and every other day for a week after the bin was compiled. Samples thereafter collected once per week until the process was completed. Samples were evaluated for microbial content. Temperature was taken and recorded from random points in the bins on a daily basis. For Phase 2 the finished composted material was used as a soil amendment in two vegetable plots. A third plot without compost material was used as the control. Soil samples were collected from each of the plots prior to application of the compost material after which cabbage seedlings were planted in each of
the plots. Vegetative and soil samples were collected and evaluated for microbial profile prior to planting and again at 1 wk, 3 wk, 7 wk, and at harvest. The summer compost had the highest temperature of 156°F on d9 during the primary phase while the winter compost had the highest temperature of 156°F on d42 during the secondary phase of the compost. The summer compost samples were salmonella negative from d2 of the trial but mixed bacterial colonies remained for the duration of the study. The vegetative samples showed coliform levels up to 2.6 log10/gm at wk3. The results show that while winter composting can effectively breakdown poultry carcasses summer compost is more efficient.

Key Words: compost, mortality, broiler, microbes, vegetable

Genetics

162 Ascites-resistant and susceptible broiler lines express different genes in their right ventricles. R. L. Taylor, Jr.*1, M. E. Chapman2, R. F. Wideman, Jr.2, N. B. Anthony2, and C. M. Ashwell3, 1University of New Hampshire, Durham, 2University of Arkansas, Fayetteville, 3North Carolina State University, Raleigh.

Inadequate pulmonary vascular capacity in fast-growing broilers promotes susceptibility to pulmonary arterial hypertension (PAH) and subsequent pulmonary hypertension syndrome (PHS, ascites). Lower pulmonary vascular capacity requires the rightventricle (RV) to boost pulmonary arterial pressure (PAP) to maintain sufficient circulation to the lungs. Elements that raise cardiac output, lower pulmonary vascular capacity, or elicit pulmonary vasconstriction comprise possible contributors to PAH. Yet, factors that initiate PAH remain unknown. To profile RV gene expression, we used ascites-resistant (RES) and susceptible (SUS) broiler lines selected using hyperbaric hypoxia, which have >10x differential ascites incidence. Tenth generation RES and SUS line male progeny were housed in environmental chambers with ad libitum access to feed and water. Beginning at d 45, ten birds of each line were injected i.v. with celluclose cardiotoxin to challenge the RV by increasing the pulmonary vascular resistance. PAP values were recorded for 60 min post-injection followed by sampling of the RV tissue from each bird. Extracted RNA was reverse transcribed to cDNA, indirectly labeled with either Cy3 or Cy5 and hybridized (including dye swap) to a focused 70-mer oligonucleotide microarray containing 320 genes. Each gene was spotted twelve times increasing sensitivity to detect sample group differences. Thirty-eight genes with differential expression were divided equally between the two lines. Interferon regulatory factor 2 (Irf2), phospholamban, glyceraldehyde-3-phosphate dehydrogenase, and heart and neural crest derivatives expressed protein 2 were among higher expressed genes in the RES Line. Genes in the SUS Line having higher expression included insulin-like growth factor binding protein 1, CD36 molecule (thrombospondin receptor), homeobox A13, and CD3d molecule. Heart development and ventricular cardiac muscle morphogenesis were biological processes related to the genes identified. Network analysis found that genes identified included biomarkers with 1) interact with Dominant White (I) to more completely inhibit black spots in the feathers of I/i birds and 3) to dilute chick down color with a characteristic white spot on the top of the head. The specific mechanism and corresponding genetic mutation eliminating pigmentation from alternating regions of the feather has not been identified. Previous work using tissue grafts has shown that the microenvironment of the feather follicle and corresponding melanocytes are responsible for the barring phenotype as opposed to a systemic or endocrine mediated defect. Two alternative but perhaps complimentary hypotheses for the mechanism behind the barring phenotype are that of the diffusible inhibitor of melanin synthesis (Nickerson, 1944) and the buildup of cytotoxic melanin biosynthesis products resulting in premature cell death (Bowles, 1988). Utilizing an F2 population derived from a single Black Polish male and a single Barred Plymouth Rock hen we have mapped the barring gene to a 680 Kb region on the distal end of the long arm of chromosome Z. The development of the F3 generation of this cross has enabled the fine mapping of the barring gene demonstrating a novel genetic mechanism of melanocyte regulation. The identification of the causal mutation of the barring variant allows for the selection of this potent pigmentation inhibitor which is otherwise undetectable in the Dominant White (I) and/or Recessive White (c) genetic background of today’s typical commercial flock.

Key Words: barring, pigmentation, melanocyte

163 Fine mapping of the sex-linked Barring gene within a 680 Kb region on chromosome Z. B. J. Dorshorst* and C. M. Ashwell, North Carolina State University, Raleigh.

First described as a sex-linked dominant gene by Spillman in 1908, barring (B) is a very familiar phenotype to most poultry breeders and scientists. The Barred Plymouth Rock breed is the standard example, exhibiting alternating white and black bars on the feathers covering the entire body. In addition to the primary phenotype barring has also been shown to 1) inhibit pigmentation in the dermis of the shank and beak 2) to interact with Dominant White (I) to more completely inhibit black spots in the feathers of I/i birds and 3) to dilute chick down color with a characteristic white spot on the top of the head. The specific mechanism and corresponding genetic mutation eliminating pigmentation from alternating regions of the feather has not been identified. Previous work using tissue grafts has shown that the microenvironment of the feather follicle and corresponding melanocytes are responsible for the barring phenotype as opposed to a systemic or endocrine mediated defect. Two alternative but perhaps complimentary hypotheses for the mechanism behind the barring phenotype are that of the diffusible inhibitor of melanin synthesis (Nickerson, 1944) and the buildup of cytotoxic melanin biosynthesis products resulting in premature cell death (Bowles, 1988). Utilizing an F2 population derived from a single Black Polish male and a single Barred Plymouth Rock hen we have mapped the barring gene to a 680 Kb region on the distal end of the long arm of chromosome Z. The development of the F3 generation of this cross has enabled the fine mapping of the barring gene demonstrating a novel genetic mechanism of melanocyte regulation. The identification of the causal mutation of the barring variant allows for the selection of this potent pigmentation inhibitor which is otherwise undetectable in the Dominant White (I) and/or Recessive White (c) genetic background of today’s typical commercial flock.

Key Words: barring, pigmentation, melanocyte

164 High-throughput gene expression analysis of chicken intestinal intraepithelial lymphocytes (IEL) following oral feeding with carvacrol, cinnamaldehyde, and capsicum oleoresin. D. K. Kim*1, H. S. Lillehoj1, S. H. Lee1, S. I. Jang1, C. L. Keeler Jr.2, C. Ionescu3, and D. Bravo3, 1Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, Beltsville Agricultural Research Center, United States Department of Agriculture, Agricultural Research Service, Beltsville, MD, 2University of Delaware, Department of Animal and Food Sciences, Newark, 3Pancosma S. A., Research Department/Nutrition & Technology, Le Grand-Saconnex, Switzerland.

The present study was conducted to investigate the immunomodulatory effects of three dietary phytonutrients with known health promoting effects using functional genomics approach. Carvacrol, cinnamaldehyde and capsicum oleoresin are dietary phytonutrients with well-known anti-inflammatory or antibiotic effects. Broiler chickens were fed standard and cayenne oleoresin diets supplemented with carvacrol, cinnamaldehyde and capsicum oleoresin, and their intestinal lymphocytes were examined for changes in immunity-related gene expression using an avian intestinal intraepithelial lymphocyte microarray (AVIELA). When compared to untreated controls, carvacrol-fed chickens showed the altered expression of 190 (64 up-regulated, 126 down-regulated) mRNAs, and cinnamaldehyde led to changes in gene expression of 235 (84 up, 151 down) mRNAs.
In the case of capsicum, altered expression was observed in 657 (272 up, 385 down) transcripts after 7 days intake compared with untreated controls. Among >2.0-fold up- and down-regulated genes in carvacrol, cinnamaldehyde or capsicum treated groups, most changes occurred in the genes associated with ‘protein metabolism and modification’. The genes involved in ‘signal transduction’ and ‘nucleoside, nucleotide and nucleic acid metabolism’ also showed significant modulation in all three groups fed phytonutrients. In the genes altered by capsicum, the highest scored molecular network indexed using Ingenuity Pathways Analysis software included genes associated with inflammatory disease, immunological disease and gastrointestinal disease. These results indicate that feeding carvacrol, cinnamaldehyde and capsicum oleoresin induced changes in the local gene expression profiles that may be related to anti-inflammatory and antibiotic effects of these phytonutrients.

Key Words: carvacrol, cinnamaldehyde, capsicum oleoresin, microarray, chicken

165  Gene expression profiling among liver, bone marrow and kidney in broilers.  W. K. Chou*, X. Li, C. Bailey, and H. Zhou, Texas A&M University, Department of Poultry Science, College Station.

Our main interest is to elucidate molecular mechanism how vitamin D₃ (VD₃) affect variety of biological functions, including innate and cell-mediate immunity, and bone mineralization. Liver, bone marrow and kidney are the major organs to convert the pre-VD₃ to activate hormonal VD₃. Bone marrow is the classic target for VD₃. The objective of this study is to profile gene expression of liver, bone marrow and kidney in chickens using chicken 44K Agilent microarray. A total of 20 different broilers were randomly selected from 10 pens of birds (2 birds per pen). Total RNAs were isolated from liver, kidney and bone marrow collected at day 21. The samples were labeled with Cy3 or Cy5 with dye swap. Signal intensity from each gene was globally normalized using LOWESS by R program. A mixed model including tissue, dye, slide, array was used to identify differentially expressed genes between any two tissues at the 1% significance level. There were 12,887 genes (6359 genes up-regulated, 6060 genes down-regulated, respectively) between bone marrow vs. kidney, 14376 genes (7736 genes up-regulated, 5592 down-regulated, respectively) between bone marrow vs. liver, and 10876 genes (7736 genes up-regulated, 4559 genes down-regulated, respectively) between liver vs. kidney. Gene ontology analysis showed Wnt receptor signaling pathway functional group was significantly enriched by 3.42 fold from differentially expressed genes in the comparison between bone marrow vs. kidney. The complement activation and humoral immune response functional groups were also significantly enriched by 7.05 fold in the comparison between kidney vs. liver. This data lays the foundation for further investigation of the molecular mechanism of vitamin D₃ in broilers.

Key Words: chicken, genetic diversity, population structure, selection, inbreeding


Microsatellites (MS) are simple sequence repeats (SSR) in which short nucleotide motifs are repeated multiple times. Their distribution throughout genomes, often in non-coding regions, as well as their high level of polymorphism makes MS very useful as genetic markers. MS were originally identified by cloning and sequencing of repetitive elements and their flanking regions. This laborious technique identified approximately 1200 genetic markers that became the core used to develop early molecular-based chicken genetic maps. This existing MS marker set was limited as it did not cover all chromosomes, particular the microchromosomes, and many large chromosomal regions were poorly covered.

With the public availability of the chicken genome sequence, researchers now have tools to develop markers in targeted regions. The UCSC chicken genome browser (http://genome.ucsc.edu/cgi-bin/hgGateway) and Repeatmasker information were used to identify repetitive genomic elements. Primers to amplify these elements were designed using the program Primer3Plus (http://www.bioinformatics.nl/cgi-bin/primer3plus/primer3plus.cgi). To enable consistent genotype scoring, development focused on markers having repeat elements between two and five base pairs while avoiding single base pair repeats. Extensive testing and optimization assured production of robust PCR amplicons. More than 700 new markers have been added to all chromosomes, with emphasis on the smaller chromosomes. The markers were tested on DNA from 10 commercially utilized layer populations, representing both brown egg layer and white egg layer genetics. High polymorphism was noted with these markers possessing between 1 and 48 alleles with a mean of 6.4 alleles per marker. Four percent of the markers were monomorphic.
In most instances, the observed size range was similar to the size range predicted from the chicken genome sequence. All of these new markers have been submitted to GenBank with the prefix HYL.

**Key Words:** microsatellite markers, DNA, repetitive sequences, genetic polymorphisms

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**168 Characterization of Minos and piggyBac transposons as “gene-trap” mutagens in the chicken.** R. B. Beckstead*, B. Jordan¹, and M. Stark², ¹University of Georgia, Athens, ²Brigham Young University, Provo, UT.

The chicken is a well-established model system for studying vertebrate embryogenesis, but has not been extensively adapted to take advantage of modern genetic tools. In response to the newly published chicken genome, our lab is adapting genetic and molecular tools for use in the chicken to carry out a functional transposable element (TE) mutagenesis screen. Our long-term goal for this project is to identify candidate genes for economically important traits. Transposable elements that have been shown to function in other model systems were analyzed for use in chicken. We tested two different TE constructs based on Minos (Mi) and piggyBac (PB) transposons. The transposable element constructs for each TE system contained a strong splice acceptor followed by an IRES (internal ribosomal entry site) and an EGFP reporter gene flanked by inverted repeats specific to the transposable system used. Both systems use a cut and paste mechanism where the transposase excises the TE construct from the donor plasmid and inserts it randomly into the genome. In the event that the TE element inserts into an expressed gene the IRES-GFP reporter will be spliced into the subsequent mRNA allowing for GFP protein expression. Constructs were tested by electroporation of the TE donor plasmid and a plasmid encoding the transposase gene into chick fibroblast cell culture and two-day old chick embryo. We observed that both the Minos and piggyBac TE systems efficiently inserted into the chicken genome as visualized by GFP expression in both cultured cells and chick embryos. These results suggest that a transposon base gene-trap mutagenesis screen could be performed in the chicken.

**Key Words:** gene, transposon, chicken, Minos, piggyBac

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**169 Diversity of Mx gene variants in commercial chickens.** C. M. Ashwell*, C. Rot, and M. D. Koci, North Carolina State University, Raleigh.

Previous studies have demonstrated the Mx gene of mammals possesses antiviral properties against various viral pathogens including influenza virus. Subsequent studies demonstrated that chickens did express an Mx gene however this gene did not appear to have antiviral properties. More recent studies have demonstrated commercial and research lines of chickens contain numerous polymorphisms in their Mx and one variant in particular (G2032A) leads to a Ser631Asn amino acid change which is apparently capable of conferring antiviral activity to chicken Mx. Sequencing of 12 unrelated individuals from each of 9 commercial layer lines identified many segregating sequence variants in the Mx gene including the afore mentioned variant resulting in the Ser631Asn amino acid change. Upon completing the sequencing of all 13 exons as well as flanking sequence and the 5'-untranslated region, 5,039 bp of sequence was obtained from each of the 108 DNA samples for a total of 544,212 bp. In total, 23 sequence variant locations within Mx were observed in the 108 DNA samples. These 23 sequence variants included both synonymous and non-synonymous mutations, however there were only 11 distinct haplotypes segregating in the 9 lines. Of these haplotypes 4 have been observed by other groups reporting on Mx sequences of domestic and local breeds. 7 novel haplotypes were identified in the commercial layer lines. The novel haplotypes all include amino acid changes that may affect gene function and will be the subject of phenotypic evaluation for potential Mx effects on virus response in future studies.

**Key Words:** Mx, viral resistance, sequence diversity, avian influenza
Thursday, July 23, 2009

SYMPOSIA AND ORAL SESSIONS

Behavior and Well-Being

170  A comparative examination of rearing parameters for brown egg-type pullets grown for either range or cage production. K. E. Anderson*, North Carolina State University, Raleigh.

The U.S. Egg Industry has grown significantly in the past 50 yrs with alternative production systems such as cage-free or range egg production contributing heavily to the industry’s expansion within the last 10 yrs. Despite the increasing popularity of alternative management methods among consumers, there is a paucity of current research on the influence of alternative production methods on egg performance and egg quality characteristics. Presently, knowledge regarding alternative management methods and performance/quality records is based upon research conducted in the late 1940’s and early 1950’s, or is limited to specific genetically selected lines of poultry. Because pullets reared for range egg production must be reared in a manner which facilitates their learning the function of the many aspects of the range environment, it is imperative that pullets learn to properly use the range, roost and nests for egg production, and foraging behaviors to ensure productivity of the flock. This study utilized Hy-Line Brown Layers that were reared using two different systems depending on the production for which they were intended i.e. range or cage. The range birds were started in floor pens on litter at 929 sq cm/bird and then moved to the range at 12 wks of age to complete their rearing. The cage birds were reared in an environmentally controlled brood/grow cage system at 310 sq cm/bird. The birds were maintained on the same rearing dietary regimen, vaccination, and supplemental lighting program. The pullets reared in cages were heavier (P<0.05) by 93 g than their range counterparts. Total feed consumption was reduced (P<0.0001) when the pullets were reared on the range by 0.79 kg, which represents a 13.3% reduction. This reduction in feed consumption is most likely due to the replacement of the feed with foraged materials. There was no difference in flock uniformity between the range and cage-reared pullets. This data indicates that pullets reared on the range consume less formulated feed and thus have lighter body weights than their caged counterparts.

Key Words: chicken, range, cage, growth

171  Effects of degree of beak trimming on the behavior and feather condition of White Leghorn hens. T. Gabrush*, K. Schwean-Lardner, and H. L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

Three experiments were conducted to study the impact of degree of day-old beak trimming on behaviour and feather condition of White Leghorn hens. Pullets for the 3 experiments were derived from different hatcheries using different beak trimming techniques and with beak length modified as follows: Exp. 1- infrared (IF) using varying hole sizes (H, Shaver White); Exp. 2- IF with beak length modification using variable IF intensity (I, Lohmann LSL); and Exp. 3- hot-blade (HB) using varying hole sizes (H, Bovan CV20). Beak treatments included intact (C), mild (ML), moderate (MO), and severe (S) beak trimming. Pullets were housed in battery cages at 17 wks of age for a 40 wk production cycle (12 hens/rep; 6 reps/trt). Each experiment was analyzed as a CRD. Attempts to alter beak length were only successful for HB trimming which resulted in beaks being 14, 31 and 39% shorter than the C birds for the ML, MO and S treatments at 38 wks of age. IF trimming (I or H) resulted in beaks that were 30 to 36% shorter than the C trt regardless of severity of trim. Behaviour was monitored via scan sampling on 8 occasions between 0 and 55 wks. Behaviour was unaffected by IF (H or I) treatment at 1 d of age while the S treatment foraged less than the C chicks for the HB technique. At 3 and 16 wks an increase in object pecking was noted in both IF treated hens. During the laying period, some behaviours were affected by severity of beak trimming with the effect trim technique specific. More consistent effects were a decrease in drinking and aggressive behaviour, and an increase in object pecking with increased severity of trim regardless of technique. Feather condition at 38 and 60 wks of age was superior for beak trimmed birds in comparison to the C hens for all trim techniques, with the exception that it was not affected by trt in the IF-I hens at 38 wks. In conclusion, beak trimming and its severity affect bird behaviour in laying hens, and beak trimming, regardless of trim technique and severity, improves feather condition.

Key Words: beak trimming, infrared

172  Effects of degree of beak trimming on the performance of White Leghorn hens. T. Gabrush*, K. Schwean-Lardner, and H. L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

Three experiments were conducted to study the impact of degree of day-old beak trimming on the performance of White Leghorn hens. Pullets for the 3 experiments were derived from different hatcheries using different beak trimming techniques and with beak lengths modified as follows: Exp. 1 - infrared (IF) using varying hole sizes (H, Shaver White); Exp. 2 - IF with beak length modification using variable IF intensity (I, Lohmann LSL); and Exp. 3 - hot-blade (HB) using varying hole sizes (H, Bovan CV20). Beak treatments included intact (C), mild (ML), moderate (MO), and severe (S) beak trimming. Pullets were housed in battery cages at 17 wks of age for a 40 wk production cycle (12 hens/rep; 6 reps/trt). Each experiment was analyzed as a CRD. Attempts to alter beak length were only successful for HB trimming which resulted in beaks being 14, 31 and 39% shorter than the C birds for the ML, MO and S treatments, respectively, at 38 wks of age. IF trimming (I or H) resulted in beaks that were 30 to 36% shorter than the C trt regardless of severity.

Key Words: beak trimming, performance
of trim. Body weight was reduced for the HB-S hens at 20 and 38 wks of age but there was no effect at 60 wks. IF trimming did not affect 20 or 38 wk weights regardless of technique. MO and S treatments of the IF-I modification were lighter than other treatments at 60 wks. Hen-day egg production was not affected by severity of beak trimming in any experiment but hen-housed egg production was lowest for the C birds in all experiments. Higher mortality was due to increased cannibalism by C hens. Feed intake decreased in a linear fashion with increasing severity of HB trimming, but was not affected by trim severity in the IF-I hens and was lower for all hens trimmed with the IF-H technique. Severity of beak trimming did not affect egg weight or specific gravity in any experiment. In conclusion, beak trimming within the limits used in these experiments caused relatively minor effects on laying hen performance and can be considered acceptable from a performance standpoint.

Key Words: beak trimming, hot-blade, production, infrared

173 Potential for horizontal transmission of Salmonella and Campylobacter among caged and cage free laying hens. J. F. Hannah, J. L. Wilson, R. J. Buhr, N. A. Cox, L. J. Richardson, and J. A. Casor, University of Georgia, Department of Poultry Science, Athens, GA, USDA, Agricultural Research Service, Russell Research Center, Athens, GA.

Nine hens were inoculated orally and intravaginally with a marker strain of Salmonella and Campylobacter at 56 wk-of-age and housed in individual cages in isolation. Challenged hens were comngled with non-challenged hens 2 wk post-inoculation, at a ratio of 1 challenged hen per 4 non-challenged hens, in experimental colony cages (n=3), on all wire slats (n=1), or on all litter flooring systems (n=1). Comngled hens had access to the same feeding and watering systems and after 12 d challenged and non-challenged hens were euthanized. Ceca were aseptically removed from all hens, and the spleen, liver/gallbladder, and reproductive tract were aseptically removed from the challenged hens only. All samples were separately cultured by direct plating and enrichment for Salmonella and Campylobacter. Among hens housed in colony cages, Salmonella was recovered in one cage from 2/4 ceca of non-challenged cage mates. Campylobacter was not recovered from any of the challenged or non-challenged hens housed in cages. From hens housed on all wire slats, Salmonella was recovered from 2/3 ceca and 1/3 spleens from the challenged hens and from 2/12 ceca of non-challenged pen mates. Campylobacter spread minimally among hens housed on all wire slats with 1/3 ceca from challenged hens and 1/12 ceca from non-challenged pen mates being Campylobacter positive. Among hens housed on all litter floors, Campylobacter was recovered from 1/3 ceca of challenged hens and 7/12 ceca of non-challenged pen mates. Salmonella was not recovered from any of the challenged or non-challenged hens housed on all litter floors. All liver/gallbladder and reproductive tract samples were negative for both Salmonella and Campylobacter. With an increasing number of table egg producers transitioning to cage free systems, it is important to determine the impact housing systems have on the horizontal spread of Salmonella and Campylobacter among laying hens.

Key Words: horizontal transmission, cage free, Salmonella, Campylobacter, laying hens


The relationship between immune function and disease risk may be greatly influenced by an individual’s response to chronic stressors including those that are environmentally induced. Extensive husbandry systems such as range production have been regarded as less stressful for hens due to the more natural setting as opposed to the cage environment. Ultimately, stress heightens the risk for adverse health outcomes by suppressing the immune response thus leaving the host vulnerable to opportunistic disease. Measurements of stress-induced immune alterations have been conducted in poultry by utilizing hematological and immunological indices. To ascertain the effects of alternative layer housing management methods on humoral immune function, Hy-line Brown hens housed on range (n=15) or in conventional/battery style cages (n=20) were inoculated with a killed Newcastle vaccine. Blood serum samples were taken prior to injection and for three consecutive weeks following injection to assess antibody production. Antibody production was significantly higher in caged hens in comparison to free-range hens at pre-injection (1.69 ± 0.70 vs. 0.069 ± 0.069) (P<0.0001), and post-injection weeks 1 (2.26 ± 0.77 vs. 0.145 ± 0.25) (P<0.0001), 2 (8.00 ± 2.98 vs. 4.38 ± 2.94)(P<0.001), and 3 (9.24 ± 2.56 vs. 6.69 ± 3.86) (P<0.05). Additionally, caged hens exhibited a significantly higher level (P<0.0001) of total antibody production (5.30 ± 0.23) throughout the immune challenge compared to free-range hens (2.82 ± 0.26). Blood smears used to analyze heterophil/lymphocyte ratios as an indicator of stress further emphasized increased heterophilia in free-range hens compared to caged hens. This data demonstrates that the husbandry systems used to produce eggs can have a great influence on layer hens’ immune function in response to a killed Newcastle virus.

Key Words: humoral, immune, function, layers, husbandry


With the advent of Asian Flu, some depopulation practices of the past may not stand up to public scrutiny and should be reviewed and evaluated to determine if the practices are the best management procedures or there are better ways and means of conducting depopulation. The goal of this project was to evaluate new and approved methods of mass depopulation in order to develop recommendations for emergency situations involving whole flocks of layers and broilers. The methods currently approved by the AVMA (2001) are cervical dislocation, gassing with CO2, and recently, the use of foam for depopulation of highly pathogenic infectious disease outbreaks in poultry. In a series of trials, birds were exposed to various concentrations of CO2 gas, electrical stunning, and use of foam for signs of stress (corticosterone levels), time to cessation of bird activity, and behavior prior to death. CO2 gas for broilers and layers showed that groups of birds (24/group/three replicates) had cessation of movement by 5.5 and 5.0 minutes, respectively. Broilers and layers (8 birds/group/3 replicates) were able to be euthanized by electrocution by using 70 volt (30 sec; 90 mA/bird) and 55 volts (25 sec; 60 mA/bird), respectively. Broilers and layers (24 birds/group/3 replicates), once completely covered with foam, had cessation of movement within 2.5 and 2.7 minutes, respectively. No difference in corticosterone levels were found between depopulation treatments or between pre and post treatment blood collections. In conclusion, the positives and negatives of the various depopulation systems were examined and compared to the needs of the type of housing from backyard flocks to million bird
complexes. Housing type (floor versus cage), type of chicken (layer versus broiler), and bird age/size could determine the selection of the approved technique.

**Key Words:** depopulation, chickens, stress, behavior

### 176 Effect of age of lighting program initiation on broiler performance

H. L. Classen* and K. V. Schwean-Lardner, University of Saskatchewan, Saskatoon, SK, Canada.

Daylength is known to influence the growth and health of broiler chickens. Although it is generally accepted that adopting a shorter daylength lighting program at a younger age reduces mortality and leg weakness, research has not attempted to establish the optimum age to change from a continuous or near continuous brooding daylength to a shorter daylength. Two experiments were conducted to study the impact of initiating a shorter daylength at one of four ages on the production of broiler chickens. In each experiment, 5,568 day-old Ross x Ross 308 chicks were housed in one of eight environmentally independent rooms with two rooms assigned to each of four lighting treatments. Each room contained 12 pens with 6 housing males and 6 housing females. Room lighting consisted of 23L:1D until switching to 18L:6D at 1, 4, 7 or 10 d of age. Light intensity was 40 lux until all rooms were changed to 10 lux at 10 d of age, with lighting provided by incandescent bulbs. Changing the daylength caused a decrease in feed intake and growth rate over the subsequent 3 d regardless of age of change. During this 3 d period, there was a reduction in gain to feed ratio in comparison to those treatments without change. Broilers recovered from the initial slow down in growth associated with daylength change and final body weights at 39 d of age were unaffected by lighting treatment. Similarly, overall feed intake and gain to feed ratio were the same for all lighting programs. There were no overall differences in mortality but the effect of lighting program on losses from 10 to 39 d approached significance (P = 0.09) with mortality lowest for the 1 d of age change and increasing in a linear fashion with age of change. Broiler gender affected many traits but interactions between lighting program and gender were inconsequential. In conclusion, broiler performance is not affected by age of lighting program initiation.

**Key Words:** broiler, light, day length, photoperiod, growth

### 177 The effects of long-bright, increasing-dim, and shorter-bright split-dark lighting programs and strain on broiler mobility and stress

R. J. Lien*, J. B. Hess, and S. F. Bilgili, Auburn University, Auburn, AL.

To determine lighting program and strain effects on measures of mobility and stress, 40 male broilers of tray pack (TP) and high breast meat yield (BM) strains were placed by strain in each of two 1.5 by 3.7 m pens in twelve light controlled rooms. Four rooms were subjected to long-bright light (1-47 d, 23L:1D, 2 footcandles [FC]) (LB treatment). Four rooms were subjected to increasing-dim light (1-7 d, 23L:1D, 8-14 d, 12L:12D; 15-21 d, 14L:10D; 22-28 d, 17L:7D; 29-35 d, 20L:4D; 36-47 d, 23L:1D; 1 FC to 7 d & 0.25 FC thereafter) (ID treatment). Four rooms were subjected to a shorter-bright split-dark light treatment (SBSD) (1-47 d, 16L:4D:2L:2D & 2 FC). Sitting or standing on 15 cm high raised platforms (decking), the ability to climb onto raised platforms to feed, tonic immobility (TI), and heterophil:lymphocyte ratios (H:L) were determined at approximately 3 and 6 wk. Gait scores and latency to lie durations were determined during wk 7. Decking was inversely proportional to the photoperiods to which broilers had recently been exposed and was greater in the TP than BM strain at 3 but not 6 wk. Feeding on raised platforms was greater in ID and SBSD than the LB treatment at 3 wk, and did not differ due to treatment at 6 wk or strain at 3 and 6 wk. Neither TI nor H:L were influenced by light treatment or strain. Gait scores and latency to lie durations were worst in the ID, best in the SBSD, and intermediate in the LB treatment. Gait scores were better in the BM than TP strain; however latency to lie was unaffected by strain. Although lighting treatments tested in this study affected broiler mobility, different measures of mobility often yielded different results, and measures of physiological and psychological stress were unaffected.

**Key Words:** broiler, lighting, photoperiod, mobility, stress

### 178 Bone mineralization in four strains of male commercial broilers and its relationship to gait score

P. Y. Hester*, 1 P. N. Talaty, 1 and M. N. Katangba 2, 1Purdue University, West Lafayette, IN, 2Cobb-Vantress, Inc., Monticello, KY.

The objectives of the following study were 1) to evaluate changes in bone mineralization among 4 strains (strains A, B, C, and D) of male meat-type commercial broilers at market age and 2) to determine the relationship between bone mineralization and gait score at 6 wk of age. At 38 and 39 d of age, 360 birds were evaluated individually for gait score. Three male chickens/pen with good walking ability (gait score of 0 or 1) and 3 male chickens/pen with poorer walking ability (gait score of 3) were euthanized and individual BW determined. The left humerus, the left middle toe, and both drumsticks were retrieved for bone measurements to determine bone mineral density (BMD), bone mineral content (BMC), and bone size traits using dual-energy X-ray absorptiometry. The BMD and bone size traits were similar among strains at 6 wk of age. However, gait scores differed among genotypes with strain C having better gait scores than strains A and B but did not differ from strain D. The BMC and bone size traits did not differ between birds with good walking ability (gait score of 0 or 1) compared to those broilers of poorer walking ability (gait score of 3). However, birds with a gait score of 3 (poorer walking ability) had higher BMD (P < 0.05) and BW (P < 0.001) than males with a gait score of 0 or 1 (good walking ability). Within a strain, the correlation between gait score and BMD was NS except for strain D birds. Male broilers of strain D with better walking ability had decreased bone mineralization (r = 0.19, P = 0.03). Because there was a stronger correlation between gait score and BW for all strains (r = 0.38, P < 0.0001), it is believed that the low association between gait score and bone mineralization for strain D was mainly due to BW. In conclusion, bone mineralization was similar among strains of meat-type chickens, and it had little influence on the gait score of male broilers.

**Key Words:** bone mineralization, dual-energy X-ray absorptiometry, broiler, gait score, strains
179 Apparent metabolizable energy responses of male and female broilers from 36 to 47 d of age during a summer grow-out. W. A. Dozier, III*1, A. Corzo2, and H. A. Olanrewaju1. 1USDA-ARS, Mississippi State, MS, 2Mississippi State University, Mississippi State.

Feed ingredient costs have been a concern to the U.S. broiler industry. Some integrated operations have reduced apparent metabolizable energy (AMEn) values to decrease live production costs. Our laboratory has previously determined that 36 to 47 d feed conversion and caloric conversion were optimized with broilers fed diets formulated at 3,200 kcal/kg. Finishing broilers may respond to diets formulated to AMEn higher than 3,200 kcal/kg during a summer grow-out. This research evaluated performance and meat yield of broilers fed diets varying in AMEn. Ross × Ross 708 chicks were randomly distributed into 96 floor pens (48 pens of males and females, respectively) at 1 d of age and were fed a common starter and grower diets until 35 d of age. At 36 d of age, all pens were equalized with 15 birds (0.09 m²/bird) and fed the experimental diets until 47 d of age. Six dietary treatments ranging in AMEn from 3,140 to 3,240 kcal/kg in increments of 20 kcal/kg were fed to male and female broilers. During experimentation, ambient temperature set point was 25 °C. Broilers fed gradient additions of AMEn had linear increases (P ≤ 0.03) in BW, BW gain, carcass weight, total breast meat weight, and plasma free fatty acids. Increasing AMEn decreased (P ≤ 0.02) 36 to 47 d feed conversion and caloric conversion linearly. Optimum AMEn approximated 3,240 kcal/kg from 36 to 47 d of age based on BW gain, feed conversion, caloric conversion, and total breast meat weight. Linear AMEn × gender interactions (P<0.05) were observed for BW, BW gain, feed conversion, caloric conversion, carcass weight, total breast meat weight, and plasma T3. These results indicated that male and female broilers from 36 to 47 d of age subjected to moderate temperatures responded to higher AMEn than previous research with 36 to 47 d old broilers reared under thermonutral conditions.

Key Words: broiler, calorie, metabolizable energy


Feed allocation decisions for feed restricted broiler breeders are complex. Precise feed allocation decisions are important to ensure consistent metabolic rate and BW gains. Fluctuations in environmental temperature (T̄e) complicate feed allocation decisions because T̄e influences the maintenance ME (MEM) requirement, which in turn affects the ME available to support growth and development. An experiment was conducted to determine the impact of T̄e on the energy requirements of broiler breeder pullets. Eight hundred broiler breeder pullets were randomly allocated to 32 pens within 8 controlled environmental chambers. Four temperatures (15, 19, 23, and 27°C) were assigned randomly to duplicate chambers for four 2-wk periods from 10 to 18 wk. In each chamber, T̄e was recorded twice per hour, averaged, and adjusted (T̄e-21) so as to predict MEM requirements relative to room temperature. ME requirements for maintenance and BW gain were estimated using a mixed model, accounting for correlations between repeated measures within each chamber. Estimates were calculated from 4 BW and ME intake measurements per 2-wk period. The ME requirement for gain was assumed constant. The MEM requirement was 117.9 kcal/kg0.67-0.582 kcal/kg0.67 for every 1°C deviation from 21°C. The ME requirement for gain was 0.928 kcal/g. According to this model, broiler breeder pullets weighing 1.3 kg would require 147.8, 140.6, or 133.5 kcal/kg at 15, 21, and 27°C, respectively. This translates to feed (2,750 kcal ME/kg) intakes of 53.7, 51.1, or 48.5 g/d, respectively. Alternatively, birds fed 55 g/d of this feed at 15, 21, or 27°C would have enough ME available for growth rates of 3.8, 11.5, or 19.2 g/d. Substantial differences in theoretical growth rates at different temperatures on the same amount of feed demonstrate the importance of considering environmental temperature when allocating feed to broiler breeders.

Key Words: feed allocation, broiler breeder pullets, feed restriction, energy requirements, environmental temperature

181 Cocciidiosis mediated lesion score effects on calorific cost at 5 age intervals throughout the broiler grow-out. R. G. Teeter*1, A. Becker1, C. Brown1, M. Singh1, C. Broussard2, S. Fitz-Coy2, J. Radu2, and L. Newman2. 1University of Alberta, Edmonton, AB, Canada; 2University of Saskatchewan, Saskatoon, SK, Canada.

A metabolic chamber experiment was conducted utilizing Cobb × Cobb males to evaluate coccidiosis impact and immunity development initially quantified by lesion score. Two groups of birds were reared in coccidiosis-free environments with one vaccinated at hatch (Coccivac-B) and the other maintained as naive to coccidiosis. Birds were selected from the two backgrounds at 5 weekly intervals for chamber placement. The 5 challenge periods consisted of an oral dose of sterile saline or a mixture of 3 Eimeria species administered as oocysts to naïve birds at 14, 21, 28, 35, and 42 days. Variables examined six days post challenge included live weight, FE, gross lesion scores (upper small intestine: USI; mid small intestine: MSI; ceca: C), heat production (HP) and body composition. Metabolic costs of coccid challenge included appetite suppression, maintenance energy elevation, excreta calorie elevation and reduced live weight gain, FE and ration net energy (P<.05). Though coccidiosis challenge occurring early in the production cycle had energy cost, birds exposed late (35, 42 days) exhibited higher costs (P<.05). Effective calorific value (ECV) places calorific density equivalents upon nutritional and nonnutritional factors. In this study coccidiosis mediated lesion scores 6 days post oocysts challenge exhibited marked (P<.01) deleterious impact upon ECV. Lesion score 1 and 2 reduced the dietary energy value from an initial 3,200 Kcal/Kg ration by 125 and 596 Kcal for 800 g broilers and by 625 and 2,277 Kcal/Kg for 3000 g birds, respectively. Lesion score cost far exceeded consequences for inadequate lighting program and poor pellet quality. Calorimetry data substantiated the lesion consequence with increased maintenance energy need, heat production and malabsorption. Results demonstrate the importance of time dependency on coccidiosis control.

Key Words: broiler, Eimeria, coccidiosis, energy, malabsorption


We studied the effects of type of fiber and level of inclusion in the diet on productive performance of broilers from 1 to 21 d of age. There were 10 experimental treatments; a control diet based on rice, soy protein concentrate, fish meal, and soy oil that contained 3,212 kcal AMEn/kg, 1.40% total Lys, and 1.61% crude fiber (CF), and 9 extra diets arranged...
factoring with 3 fiber sources (OH, oat hulls; SBP, sugar beet pulp, and PH, pea hulls) and 3 levels of fiber inclusion (2.5, 5, and 7.5%). The fiber source was included at expenses (wt/wt) of the basal diet. Therefore, fiber inclusion increased CF content and decreased AME	extsubscript{m} and essential amino acid content of the basal diet. Each treatment was replicated 6 times and the experimental unit was a cage with 12 chicks. The ADG, ADFI, and feed to gain (F:G) were recorded per replicate at 7, 14, and 21 d of age. No interactions among main effects were observed. The inclusion of up to 5% of an additional fiber source improved ADG (P < 0.05) and F:G (P < 0.05) but no effects were observed for ADFI. A further increase in additional fiber to 7.5%, reduced ADG and impaired F:G (P < 0.05) with respect to 2.5 or 5% fiber inclusion but performance of birds fed 7.5% fiber was similar to that of birds fed the control diet. The beneficial effects of fiber inclusion on broiler performance were more pronounced with PH than with OH or SBP (P < 0.05) probably because of the higher starch (17.2%) and CP (11.2%) of this ingredient. We conclude that the inclusion of up to 5% fiber, to increase the CF content of the diet from 1.61% of the control diet to 2.42–3.50%, improves performance growth of broilers. However, a further increase of fiber to 7.5% impaired ADG and F:G with respect to the 5% level of inclusion. The beneficial effect of fiber was more pronounced with PH than with OH or SBP. Thus, young broilers have a minimal requirement of dietary fiber (2.42 to 3.50% CF depending on type) for maximal growth.

**Key Words:** oat hulls, sugar beet pulp, pea hulls, broiler performance

### 183 Performance, AME and ileal amino acid digestibility of broilers fed corn-soy diets supplemented with a multi-enzyme complex containing xylanase, amylase and protease. L. F. Romeros	extsuperscript{1}, V. Ravindran	extsuperscript{2}, P. L. Utterback	extsuperscript{3}, and C. M. Parsons	extsuperscript{3},

Danisco Animal Nutrition, Marlborough, United Kingdom, 2Massey University, Palmerston North, New Zealand, 3University of Illinois, Urbana.

Four 21-d-performance and four 21-d-cohort digestibility trials were conducted to evaluate growth, feed efficiency, AME, and amino acid digestibility of broilers fed corn-soy diets supplemented with a multi-enzyme complex containing xylanase, amylase and protease (Avizyme 1502®; Danisco Animal Nutrition), as compared to a control diet. Each experiment consisted of two treatments: control and control plus the enzyme complex, with eight replicates per treatment. Amino acid digestibility (excluding tryptophan) was evaluated on a protein-free diet, and AME	extsubscript{m} was calculated for each experimental unit. Data were analyzed using the Mixed Procedure of SAS, with experiment as random term. Enzyme supplementation decreased feed per gain of broilers from 1.52 to 1.47 (P < 0.01), but had no effect on weight gain. Enzyme supplementation increased AME	extsubscript{m} by 102 kcal/kg (3.37%; P < 0.01) and ileal digestibility of 16 from 17 measured amino acids (P < 0.01) by an average of 2.8% versus the control. Of these amino acids, cysteine (+5.3%) and threonine (+4.2%) exhibited the greatest increments in ileal digestibility, whereas lysine exhibited the lowest (+2.0%). Digestibility of methionine tended (+1.0%; P = 0.06) to be increased by enzyme supplementation. The lower responses in lysine and methionine digestibility may be related to the fact that diets contained DL-methionine and lysine-HCl. These data suggest that improvements in feed efficiency caused by dietary inclusion of xylanase, amylase and protease are related to increments of energy and amino-acid digestibility. Accounting for differential effects of digestibility of methionine and lysine in diet formulation may be critical to capture performance effects from increased digestibility of other amino acids.

**Key Words:** broiler, enzyme, digestibility, amino acid, feed efficiency

### 184 Effect of adding different enzyme activities to high DDGS diets on hen performance. C. Ramirez	extsuperscript{1} and S. R. Fernández	extsuperscript{2},

GENA Agropecuaria S.A. de C.V., Acatic, Jalisco, México, 2DSM Nutritional Products México, El Salto, Jalisco, Mexico.

With the objective to evaluate the effect of feeding hens with different enzymes; both phytase & carbohydrase enzymes (designed to degrade non-starch polysaccharides (NSP) molecules), added to a diet with 15% DDGS, 1,344 40-week-old-Hy Line W36 hens were randomly allocated to 4 treatments with 8 replicates of 42 hens each (14 hen cages with 3 hens per cage). The birds were housed in an open hen house with curtains; feed & water were provided ad libitum. The trial lasted 8 weeks. The treatments were as follows: T1, basal sorghum-SBM-15% DDGS diet, added with Peniophora lycii phytase (PLP) with -0.1% Ca & Av P & -40 kcal/kg ME; T2, as 1 added with Ronozyme Blend 25, a mixture of B-glucanase, xylanase, & pectinase (RB25) to release 40 kcal/kg ME (80 kcal/kg total); T3, was a sorghum-SBM-15% DDGS diet added with RB25 and a higher amount of (PLP) expected to release 0.13% Ca & Av P as well as 102 kcal/kg ME; T4 was as diet 1 added with a mixture of B-glucanase, xylanase & cellulase (RVB) to release 65 kcal/kg ME (105 kcal/kg total). The data was analyzed as a CRD. When the ANOVA showed a statistically significant response the differences between means were analyzed by the LSD procedure. Egg production (%) T1, 81.4; T2, 83.5; T3, 80.8; & T4, 80.1, feed intake (g/h/d), T1, 100; T2, 101; T3, 101; & T4, 102, egg mass (g/h/d), T1, 51.6; T2, 52.7; T3, 50.9; & T4, 50.8, relative feed egg production cost (%), T1, 100; T2, 98; T3, 100; & T4, 101, and egg shell strength (g/cm²), T1, 3.423; T2, 3.679; T3, 3.408; & T4, 3.455, were not statistically (P > 0.05) affected by treatment. However, due to the response on egg production, feed conversion was significantly (P < 0.004) affected by treatment: T1, 1.944ab; T2, 1.916a; T3, 1.98bc; & T4, 2.019c. Showing the hens fed the Ronozyme Blend 25 treatment a better feed conversion than the ones fed T3 & T4.

**Key Words:** hens, DDGS, NSP enzymes, Peniophora lycii, phytase


University of Sao Paulo, Pirassununga, SP, Brazil.

This study was carried out to evaluate the effect of enzymatic complexes on performance of broilers fed corn-soybean meal diets. A total of 2,592 broiler chicks, Cobb-500 strain, were randomly distributed in seven treatments (Diet 1: corn-soybean meal positive control diet without enzymes; Diet 2: negative control diet with a 2% reduction from 1 to 21 days and 2.5% from 22 to 42 days, respectively in dietary energy (AME), amino acids (AA) and crude protein (CP) contents; Diet 3: negative control diet with a 4% reduction from 1 to 21 days and 5% from 22 to 42 days in AME, AA and CP contents, Diet 4: diet 2 plus 400 ppm of complex A (80.000 kNU of α amylase, and 140.000 FBG of β glucanase); Diet 5: diet 2 plus 500 ppm of complex B (80.000 kNU of α amylase, 140.000 FBG of β glucanase, and 100.000 FXU of xylanase); Diet 6: diet 3 plus 400 ppm of complex A; Diet 7: diet 3 plus 500 ppm of complex B) with seven replicates, except treatment 1 (six replicates) of 54 birds each. The feeding program adopted had two phases: starter (1 to 21 days) and grower (22 to 42 days). Body weight gain, feed intake, feed conversion and adjusted feed conversion to standard body weight of 2.5 kg for total phase (1 to 42 days) were evaluated. There were no effects of treatments on feed intake. Birds fed diet 5 showed best results for weight gain, feed conversion and adjusted feed conversion. It was concluded that the enzymatic complex B (α amylase, β glucanase and xylanase) when
added in the diet with a 2% and 2.5% reductions in AME, AA and CP contents for starter and grower phases, respectively, is efficient to restore performance when compared to birds fed positive control diet.

**Key Words:** amylase, glucanase, nutrition, poultry, xylanase

**186** Enzyme complex containing NSP-enzymes and phytase improves the performance of layers fed corn-based diet. M. Francesch1, A. Preynat*2, S. Virden3, and P. A. Geraert2, 1IRTA, Constanti, Spain, 2Adisseo France S.A.S., rue Marcel Lingot, France, 3Adisseo U.S.A. Inc, Alpharetta, GA.

The present experiment was conducted to investigate the benefits of a multi-enzyme complex (Rovabio® Max) containing carbohydrases (from Penicillium funiculosum) and phytase (bacterial 6-phytase) activities on the performance of layers.

Three basal diets based on corn and soybean meal were tested: one positive control (PC) diet formulated to be adequate in nutrient and two negative control with decrease in available phosphorus (AP, -0.15 pcnt point avP) and gradual decrease in energy (AME), (NC1, -50 kcal/kg and NC2, -85 kcal/kg) and protein (NC1, -1.5% CP and NC2, -3.0% CP). NC diets were supplemented or not with Rovabio® Max supplying 1,100 visco units of endo-β1,4-xylanase, 100 AGL units of endo-1,3β-glucanase, and 500 Phytase Units of 6-phytase per kg of feed.

675 Hy-Line laying hens were distributed into 5 experimental treatments, 9 replicates, 15 birds per cage. Laying performances were determined from 20 to 43 weeks of age by subsequent 4 wk period. Egg quality parameters were also determined for each 4-wk period.

Supplementation of the NC reformulated diets with the multi-enzyme complex significantly improved feed intake, laying rate, feed conversion and egg weight. Egg quality, as measured by Haugh units and eggshell strength was not different between NC+ Rovabio® Max vs PC diets. These results support that the dietary supplementation with a multi-enzyme complex containing NSP-enzymes and phytase is efficient in reducing the phosphorus (-0.15 pcnt point avP), energy (up to -85 kcal/kg) and protein (up to -3.0 % CP) specifications of a corn-based diets without performance losses.

**Key Words:** NSP-enzymes, phytase, layers, formulation matrix, egg quality

**187** Enzyme complex containing NSP-enzymes and phytase improves the growth performance and bone mineralization of broilers fed corn-based diet. M. Francesch1, A. Preynat*2, S. Virden3, and P.A. Geraert2, 1IRTA, Constanti, Spain, 2Adisseo France S.A.S., rue Marcel Lingot, France, 3Adisseo U.S.A. Inc, Alpharetta, GA.

The present experiment was conducted to investigate the benefits of a multi-enzyme complex (Rovabio® Max) containing carbohydrases (from Penicillium funiculosum) and phytase (bacterial 6-phytase) activities on the performance of broilers.

Five basal diets based on corn and soybean meal were tested: one positive control (PC) diet formulated to be adequate in nutrient and four negative control (NC1 to NC4) diets with gradual decrease in energy (AME), crude protein (CP), available phosphorus (AP) and total calcium (Ca): NC1 : -85 kcal/kg, -3.0 % CP, -0.15 pcnt point avP, -0.12 pcnt point Ca; NC2: -85 kcal/kg, -6.0 % CP, -0.15 pcnt point avP, -0.12 pcnt point Ca; NC3: -105 kcal/kg, -6.0 % CP, -0.15 pcnt point avP, -0.12 pcnt point Ca; NC4 : -85 kcal/kg, -3.0 % CP, -0.18 pcnt point avP, -0.14 pcnt point Ca. NC diets were supplemented or not with Rovabio® Max supplying 1,100 visco units of endo-β-1,4-xylanase, 100 AGL units of endo-1,3(4)-β-glucanase, and 500 Phytase Units of 6-phytase per kg of feed.

2268 day-old Ross male broilers were distributed into 9 treatments, 6 replicates, 42 birds per pen. Growth performances were determined at 21 and 38 days. Tibia mineralisation was also determined at 21-d.

Supplementation of the NC reformulated diets with the multi-enzyme complex improved feed intake, weight gain and feed conversion. 38-d bodyweight and feed conversion were comparable between NC1, NC2 and NC4 + Rovabio® Max to those observed in the PC group. Moreover, the bone mineralisation was fully compensated by Rovabio® Max supplementation. These results support that the dietary supplementation with a multi-enzyme complex containing NSP-enzymes and phytase is efficient in reducing the phosphorus (up to -0.18 pcnt point avP), energy (up to -85 kcal/kg) and protein (up to -3%) specifications of a corn-based diets without performance losses.

**Key Words:** NSP-enzymes, phytase, broilers, formulation matrix, growth

**188** Exogenous phytase alters the expression of nutrient transporters and markers of inflammation in the gastrointestinal tracts of broiler chickens. S. A. Adedokun*, O. A. Olukosi, O. Adeola, and K. M. Ajuwon, Purdue University, West Lafayette, IN.

The role of phytase in releasing phytate-bound phosphorus is well documented. Additionally, supplementation of phytase to poultry diet has been reported to improve ileal digestibility of nutrients. However, there is a dearth of information on the effect of phytase on the expression of active P and Ca transporters and intestinal inflammation. In this study, the role of phytase supplementation on the expression of intestinal P and Ca transporters and markers of inflammation was investigated using 3 diets containing 0, 500, or 1,000 FTU phytase/kg diet fed for 6 d to 42 d-old broiler chickens that were raised on deep litter until 42 d. The birds were fed diets that met or exceeded their nutrient requirement from 0-42 post-hatch. The basal diet (0 FTU phytase/kg diet) to which phytase (500 or 1,000 FTU/kg diet) was added was marginally deficient in available P. Expression level of intestinal P and Ca transporters and inflammatory markers (IL-6 beta and TLR4) were determined semi-quantitatively using the RT-PCR. Results from this study showed that intestinal P transporter was upregulated (P < 0.05) while Ca transporter showed a tendency (P = 0.069) to be upregulated with increasing level of phytase. Phytase addition resulted in decreased (P < 0.05) level of intestinal P transporter was upregulated (P < 0.05) while Ca transporter showed a tendency (P = 0.069) to be upregulated with increasing level of phytase. Phytase addition resulted in decreased (P < 0.05) level of intestinal P transporter and markers of inflammation in the GIT. Because all the diets contained the same level of all nutrients, we conclude that phytase in the diet of broiler chickens results in improved active P absorption and may also play a role in gut health and immunity.

**Key Words:** broiler, inflammation, intestinal transporter, phytase


A 42-day experiment was conducted to determine the effect of feeding high doses of phytase from both an E. coli source (EP) and a fungal
source (FP). Both phytases were added to basal negative control (NC) diets resulting in a commercial dose (500 FTU/kg) and higher doses of phytase (12, 26, 58, 130 and 292 times the commercial rate). Starter (S), grower (G) and finisher (F) rations for the positive control (PC) and NC diets were formulated to be identical (within phase) in nutrients with the exception of total and nonphytate P (nPP). The nPP levels of the PC and NC diets were 0.50, 0.40 and 0.40% and 0.30, 0.25 and 0.20% for the S, G and F rations, respectively. Performance (body weight:BW and mortality corrected feed conversion ratio: FCRc) were measured. Supplementation of the NC diets with commercial rates of both phytases resulted in performance numerically higher than but statically similar to the PC, validating current inclusion rates based on nutrient replacement. In contrast to commercial doses, supplementation of the NC diets with 12 to 292 times the commercial dose resulted in significant improvements in BW and FCRc in comparison to the PC fed birds. Supplementation of NC diets with the EP resulted in a 4.3 to 6.2% increase in BW with a subsequent improvement in FCRc of 1.5 to 3.0% over the broilers fed the PC diets. Supplementation of NC diets with the FP resulted in a 3.4 to 6.6% increase in BW with a subsequent improvement in FCRc of 0.9 to 2.1% over the broilers fed the PC diets. There were significant and consistent performance improvements over the PC fed broilers when high doses (above 12 times the commercial dose) of either phytase source were included in NC rations. Not only is this response consistent, it appears to have no deleterious effects on performance at rations at levels as high as 292 times current commercial doses. This increased performance and high level of safety, regardless of phytase source, suggests a tremendous opportunity to utilize these high doses of phytase to generate value beyond simple nutrient replacement in broiler rations.

Key Words: phytase, broiler, value

190 Performance, nutrient digestibility and expression of intestinal mucin RNA of 21 day old broiler chickens supplemented with 5000 FTU of phytase. B. S. Lumpkins*, 1, B. Humphrey2, G. Mathis1, and M. E. Persia3, 1 Southern Poultry Research Inc., Athens, GA, 2California Polytechnic State University, San Luis Obispo, 3Syngenta Biotechnology Inc., Research Triangle Park, NC.

Commercial broiler chickens were fed high concentrations of phytase to determine effects on broiler performance, nutrient digestibility and expression of intestinal mucin RNA. In total three treatments were evaluated. The first was a positive control (PC) diet that contained 21.4% CP, 3090 Kcal of ME, 0.90% Ca and 0.45% nonphytate phosphorus (nPP). A negative control (NC) diet was formulated to contain 21.4% CP, 3090 Kcal of ME, 0.90% Ca and 0.30% nPP. Treatments two and three consisted of the NC diet fed either alone or supplemented with 5000 FTU/kg of an E. coli phytase. All diets contained 0.25% Chromic oxide for use as an indigestible marker. Each of these three experimental diets was fed to 8 replicate pens of 6 Cobb x Cobb chicks from 1 to 21 days of age. Broiler chicks were housed in modified battery cages in an environmentally controlled room. Body weight gain and feed conversion ratio (FCR) were calculated for the 21 day period and birds were sacrificed on day 21 for ileal ingesta collection (samples were pooled by replicate group) and mucosal scraping from one bird per replicate pen. Mucosal scrapings were snap frozen in liquid nitrogen for storage before total RNA isolation, reverse transcription and quantitative real-time PCR for mucin mRNA abundance. Feeding the NC diet (without phytase supplementation) resulted in a 7.3% reduction in body weight gain and a 9.7% worsening of calculated FCR, validating the deficiency of the NC diet in comparison to the PC fed birds. Supplementation of the NC diet with 5000 FTU of phytase/kg diet not only returned the performance of the birds to that of the PC fed birds, it increased body weight gain by an additional 7.8% without altering FCR. Currently phytase is utilized at lower concentrations to replace inorganic phosphorus, but it appears that at higher concentrations phytase might be ameliorating more of the anti-nutritive effects of dietary phytate and allowing the birds to reach more of their genetic potential in comparison to birds fed a positive control diet.

Key Words: phytase, performance, broiler, nutrient digestibility, mucin RNA

191 Evaluation of a heat stable xylanase enzyme under typical feed industry manufacturing parameters. C. R. Stark*, 1 and C. Wyatt2, 1North Carolina State University, Raleigh, 2AB Vista, Chapel Hill, NC.

Recently, intrinsic thermo-tolerant feed enzymes that appear to withstand temperatures of up to 93°C have been developed. Heat tolerant enzymes can be added in the mixer, which improves the accuracy of the enzyme addition and eliminates the need for a post-pellet liquid system. The objectives of these experiments were to evaluate the mixing characteristics and thermo-tolerance of a xylanase (Trichoderma reesei; Econase® XT) product using typical feed processing parameters. A corn-soybean meal diet containing 3% poultry fat added in the mixer was used in the mixer uniformity and enzyme stability experiments. Experiment 1 evaluated the uniformity of xylanase in mixed feed at premix inclusion rates of 80, 100, and 150 g/ton after 3 min in a double ribbon mixer. Experiment 2 investigated enzyme recovery in feed after the pelleting process. The experimental treatments were conditioning temperatures of 85, 88, 91, and 93°C. The feed was conditioned for approximately 30 sec at each temperature and then passed through a 4.4 mm x 35 mm pellet mill die. There were 3 replicates per treatment. Samples of the meal and pellets were collected prior to conditioning and after cooling, respectively. Enzyme recovery was calculated. Results of the mixing study indicated that there was a uniform distribution of the premix as measured by xylanase activity in the finished feed. The coefficient of variation (CV) was 2.7%, 5.4%, and 6.2%, respectively, for the 80, 100, and 150 g/ton diets. Xylanase activity was 20,491 BU/kg in the mash and 18,676, 19,395, 18,558, and 18,755 BU/kg in the pellets at 85, 88, 91, and 93°C, respectively. Recovery rates ranged from 91 to 95%, with no significant difference between treatment temperatures. The results from this experiment indicate that the intrinsic thermo-tolerant non-coated xylanase enzyme can be uniformly distributed in feed and retain 90% of its activity after conditioning (93°C for 30 sec) and pelleting.

Key Words: mixing, pelleting, xylanase, enzyme, thermo-stability

192 Effect of feeding Peniophora lycii phytase combined with carbohydrase enzyme activities on hen performance. B. Fuente1, E. Avila1, E. Rosales2, S. Charraga2, and S. R. Fernández2, 1Universidad Nacional Autónoma de México, Mexico City, Mexico, 2DSM Nutritional Products México, El Salto, Jalisco, Mexico.

In order to evaluate the effect of different nutrient matrix values for the combination of Peniophora lycii phytase (PLP) and a mixture of B-glucanase, xylanase, & pectinase enzymes (Ronozyme Blend 25 (RB 25)), 480, 36-week-old-Bovans white hens were randomly allocated to 4 treatments with 4 replicates of 30 hens each (10 hen cages with
3 hens per cage). The birds were housed in an open hen house with curtains; feed & water were provided ad libitum. Treatment 1 consisted of a sorghum-SBM diet formulated to fulfill at 100% the Bovans white nutritional requirements, then treatments 2 to 3 were added with 111 ppm of PLP with the following nutrient equivalent values (01% Ca & Av. P. 40 kcal/kg ME, 148 ppm Lys, 102 ppm Met, & 148 ppm Thr) also, 300 ppm of RB25, were added to these 3 treatments, however, a different RB25 feed formulation matrix was applied to each diet, T2 RB25 nutrient equivalent values (NEV) were 35 kcal/kg ME; Lys, 252 ppm; Met, 123 ppm; Thr, 159 ppm; & Arg, 291 ppm (50% ME 100% AA). T3 RB25 NEV were 70 kcal/kg ME & AA values the same as T2 (100% ME 100% AA), T4 NEV were: 70 kcal/kg & 50% of AA values assigned to T2(100% ME 50% AA). The trial lasted 9 weeks; the data was analyzed as a CRD. When the ANOVA showed a statistically significant response the differences between means were analyzed by the LSD procedure. Egg production (%) T1, 89.1; T2, 89.1; T3, 87.3; & T4, 90.2, feed intake, feed conversion T1, 1.893; T2, 1.909; T3, 1.892; & T4, 1.869, & egg mass, were not statistically (P > 0.05) affected by treatment. However, relative feed egg production cost (%), T1, 100b; T2, 91b; T3, 86a; & T4, 86a was lower for treatments 3 & 4 compared to T1 & T2 (P < 0.001). Under the experimental conditions of the present trial the combination of Peniophora lycii phytase and Ronozyme Blend 25 allowed to keep the hen’s productive performance along with a more competitive relative egg production cost.

Key Words: hens, carbohydrase enzymes, Peniophora lycii, phytase

Pathology

193 Chemotherapy of coccidiosis in gamebirds. L. R. McDougald* and R. W. Gerhold, University of Georgia, Athens.

Anticoccidial drugs commonly available for other poultry were tested against recent field isolates of Eimeria in Chinese ringneck rheasants, the chukar partridges, and bobwhite quail. Recent field isolates of coccidia from each of the bird species were used for challenge of 2-3 week old birds in battery cages. Each treatment was replicated in 3 cages, with 10 birds/cage. The anticoccidial drugs were obtained from the manufacturer as premixes, and were mixed into game bird starter mash. The experimental design included an unmedicated, uninfected control and an unmedicated, infected control. In four battery tests with pheasants, 3 with chukars and 2 with quail we evaluated zoalene (125 or 150 ppm), diclazuril (1 or 2 ppm), decoquinate (33 ppm), salinomycin (66 ppm), lasalocid (125 ppm), robenidine (33 ppm), Rofenaid (125/75 ppm for sulfadimethoxine and ormetoprim) and semduramicin (25 ppm). Also, in bobwhite quail, we tested amprolium (250 ppm). The endpoints for efficacy were 1) weight gain 0-6 days postinoculation, 2) reduction in lesion scores in comparison with infected controls, and 3) fecal scores (diarrhea) in comparison with controls. Drugs with good efficacy in pheasants were rofenaid, robencine and lasalocid. Semduramicin and zoalene had moderate activity. In the chukar, rofenaid, robenidine, decoquinate, diclazuril and lasalocid had good efficacy. In the bobwhite quail, rofenaid and diclazuril (2 ppm) had good activity, while lasalocid, decoquinate and robenidine had moderate activity. Amprolium had no detectible activity in comparison with infected controls. There was no noticeable toxicity with any of the treatments in any bird species. These results showed generally poorer efficacy of some drugs, in comparison with earlier published tests, suggesting the possible emergence of drug resistance after extensive field usage.

Key Words: pheasant, chukar, quail, coccidia, anticoccidial

194 The effects of different Eimeria challenge methods on weight gain and lesion formation in broilers. S. Pohl*, J. Lee1, S. Anderson1, S. Fitz-Coy2, and D. Caldwell1, 1Texas A&M University, College Station, 2Intervet/Schering-Plough Animal Health, Summit, NJ.

The objective of this study was to examine the effects of direct or indirect routes of Eimeria exposure on body weight gain and intestinal lesion development in broilers. Challenge methods were administered on day of hatch (d0) or d7 post-placement. Broilers were challenged with 5,000 (d0) or 50,000 (d7) sporulated oocysts per bird of a mixed species inoculum of field strain Eimeria. In addition to a negative (non-challenged) control group, four challenge methods were evaluated on d0: litter spray, oral gavage, feed administration, and a seed:contact challenge model where 20% of placed broilers were inoculated. Methods evaluated on d7 were litter spray, oral gavage, and feed administration. Birds challenged on d0 were subjected to necropsy on d9, 16, and 23 while birds challenged at d7 were subjected to necropsy on d16 and 23 to assess gross and microscopic intestinal lesions. Body weights were obtained weekly and at each necropsy. Of broilers challenged on d0, lesions were more pronounced and consistent at necropsy on d9, 16, and 23 in oral and feed challenged groups, with peak lesion development occurring on d16. Body weights were not different among d0 challenged broilers on d9 or 16, but reduced body weight in all d0 challenged broilers was observed at d23. For d7 challenge methods, feed challenge and oral gavage resulted in higher and more consistent intestinal lesions on d16 and 23. Differences in broiler body weight among d7 challenge groups were not observed on d16, but on d23, depression in body weight was observed in feed challenge and oral gavage groups. These data suggest that selected Eimeria challenge methods may have a more pronounced effect on body weight gain and lesion development in broilers thereby allowing researchers to select the most appropriate methods for different experimental objectives.

Key Words: Eimeria, challenge method, broilers, lesion development, coccidiosis


Coccidial damage to the intestinal mucosa often leads to proliferation of Clostridium perfringens resulting in Necrotic Enteritis (NE). The objective of this study was to examine the association of various species of Eimeria to the production of NE. A battery study using 3 replicates of 8 birds per cage was conducted. The treatments were no coccidia (NC), E. acervulina (EA), E. maxima (EM), E. tenella (ET), and E. praecox (EP). Birds were coccidia challenged at 14 days of age. Each treatment was divided into Clostridium perfringens (CP) challenged on days 4, 5, 6, and 7 post coccidia challenge or no CP. The parameters measured were feed conversion, weight gain, necrotic enteritis (NE) mortality, and coccidiosis (0-4) and NE lesion scores (0-3). A significant
coccidiosis infection occurred with EA and ET with over 3.0 avg. lesion score. EM infection level was moderate (1.6 lesion score). E. praecox did significantly change the appearance of the intestinal tract (more fluid and white mucus) producing an avg. lesion score of 1.2. Except EP, all species significantly decreased weight gain. The EA, EM, and EP treatments plus CP had significantly higher feed conversions and lower weight gains (except ET) than related treatments without CP. EM, CP treatment had 22 % NE mortality. A much lower level of NE mortality occurred in the EA birds (6%). No birds died from NE in the No Cocci, ET, and EP, CP challenged treatments. These results imply that damage to the intestinal tract from EM, EA, and EP exacerbates the pathogenic effects of CP, leading to NE. Infections with EM greatly increased the probability of Necrotic Enteritis over the other species. This data does demonstrate that NE can occur but to a lesser degree with E. acervulina. No NE mortality occurred with E. praecox but performance was affected with CP. Even though this species is classified as a non-pathogenic Eimeria species, sub-clinical NE appears to be possible with E. praecox and under certain circumstance this can relate to performance losses.

Key Words: necrotic enteritis, Eimeria, Clostridium perfringens, coccidiosis, chicken

196 Bacillus licheniformis (GalliPro Tect) prevents necrotic enteritis and improves performance in broiler chickens. I. Knap*, B. T. Lund, and M. M. Jensen, Chr. Hansen A/S, Hoersholm, Denmark.

Bacillus licheniformis can prevent necrotic enteritis in C. perfringens challenge studies. To understand both the mode of action of the NE preventing effect of Bacillus licheniformis and the performance under non-challenge condition, new studies were performed.

Three C. perfringens challenge studies were carried out at Southern Poultry Research, Inc.; two cage studies and one floor pen study. In the studies different doses of Bacillus spores were tested from 8E+5 CFU/G to 8E+7 CFU/G. All challenge studies included a non challenged control group, challenged group without additive and a positive control with Virginamycin 15 g/t. Unmedicated commercial chicken feeds commonly available ad libitum throughout all trials. The Clostridia challenge was made using fresh C. perfringens broth culture given to the birds in 2 or 3 days. Weight gain, feed consumption, feed conversion, lesion scores, intestinal Clostridia counts and mortality were reported. In the non challenged study weight gain and FCR were measured.

In all challenged trials a significant effect was seen of using Bacillus licheniformis with regards to lesion score, mortality, weight gain and FCR. There was no significant difference between the Bacillus licheniformis treatments and the Virginamycin treatment with regards to mortality and lesion score. A dose of 1.6E+6 CFU/G feed seems to be optimal to prevent necrotic enteritis. In the non challenged trial a significant effect on feed conversion was seen. GalliProTect in starter and feed groups, were used for tissue protein extraction and conditioned media preparation. The later was done to find any secreted proteins that could form the basis of identifying downstream biomarkers. Proteins from tissue and media were extracted using a guanidine hydrochloride

Key Words: Bacillus licheniformis, necrotic enteritis, Clostridium perfringens, DFM

197 Gene expression in chicken and turkey tibia growth plates is affected by oxygen concentrations during the plateau stage of incubation. E. O. Oviedo-Rondón*1, M. Ashwell2, and M. J. Wineland3, 1North Carolina State University, Department of Poultry Science, Raleigh, 2North Carolina State University, Department of Animal Science, Raleigh.

Long bone development is altered by elevated temperatures (T) and low oxygen (O2) concentrations during the last four days of incubation. This developmental change has a negative impact in post-hatch leg disorders of broilers and turkeys. Genomics can help to understand these effects and determine markers for genetic selection of birds with lower susceptibility to leg problems. Proximal tissues collected from chickens and turkeys that were exposed to two O2 (17 and 23%) and elevated T (39°C) conditions during the plateau stage of incubation were analyzed for gene expression. Two strains of chickens with low (LG) and high (HG) eggshell conductance, and one turkey strain were evaluated. Tibia growth plates frozen in liquid nitrogen at time of collection were sectioned to obtain the prehypertrophic and hypertrophic zones. Chondrocyte RNA was isolated and quantitative real-time-PCR used to evaluate expression of 12 genes related to development of tibial dyschondroplasia (TD). These genes are Vegfr1, Vegfr2, Vdr, Tgfβ3, Pthrp, Mmp13, Mmp9, Ihh, Dlx5, ColX, ColII, and Hsf1a. Results indicated that the expression of the matrix metallopeptidases Mmp13 and Mmp9 were downregulated approximately 2-fold (P<0.06) in chickens and turkeys exposed to 17% O2 compared to 23% O2. The expression of collagen type X (ColX) was down-regulated 2.5-fold (P<0.05) in chickens of the LG strain. Hypoxia caused 1.3 fold down-regulation (P<0.07) in the gene expression of the vascular endothelial growth factor receptor 1 (Vegfr1) only in the LG chickens. In turkeys, the expression of Vegfr1, Vegfr2, and ColX tended to be down-regulated (P<0.08) in 17% O2. All genes affected by hypoxia during last 4 d of incubation are essential for the formation of the organic matrix of bones and vascularization prior to ossification. The expression of the remaining genes evaluated did not appear to be influenced by O2 and were not different (P>0.1) between these 2 strains of chickens. These findings confirm that incubation conditions have an impact on bone development and incidence of bone disorders such as TD.

Key Words: broilers, turkeys, gene expression, bone development

198 Proteomic changes in tibial head cartilage of chickens with tibial dyschondroplasia, a metabolic skeletal disease. K. S. Rasaputra*1,2, R. Liyanage1, J. O. Lay3, and N. C. Rath1, 1University of Arkansas, Department of Poultry Science, Fayetteville, 2USDA/ARS, Fayetteville, AR, 3University of Arkansas, Statewide Mass Spectrometry Lab, Fayetteville.

Tibial dyschondroplasia (TD) is a leg problem in meat type poultry that affects the proximal growth plate cartilage of tibia and tibio-tarsus and prevents their transition to bone. Identifying the birds susceptible to TD and understanding its mechanism is of interest in order to control the disease. Proteins form the basic structural and functional components of the cells and are likely to be affected by the disease. Therefore, the objective of this study was to find whether there are proteomic changes which occur as the result of the disease process. We used an experimental model of TD, feeding one week-old broiler chicks with thiram. Individual growth plate cartilages from 3 birds in each control and thiram fed groups, were used for tissue protein extraction and conditioned media preparation. The later was done to find any secreted proteins that could form the basis of identifying downstream biomarkers. Proteins from tissue and media were extracted using a guanidine hydrochloride
buffer and analyzed by two-dimensional gel electrophoresis. Comparative analysis of Coomassie blue stained protein spots from individual samples from both the groups using a Melanie software, revealed 7 and 3 differentially expressed proteins in tissue and conditioned media respectively. Tryptic digest of the protein spots were analyzed by automated matrix assisted laser desorption time-of-flight mass spectrometry (MALDI-TOF-MS) followed by a MASCOT data base search. Five of the tissue proteins were identified as calumenin, actin, chondroitin sulphate, matrilin, and one predicted protein of Gallus gallus. The conditioned media proteins corresponded to collagen II, triose phosphate isomerase alpha chain, and an unidentified protein. All these proteins were down regulated in TD except calumenin. Functional relevance of these proteins indicates that they may be involved in the maintenance of cartilage integrity such as their survival, maturation, hypertrophy, and mineralization. The compromise of these functions is likely to affect endochondral bone formation leading to the development of TD.

Key Words: tibial dyschondroplasia, 2D gel electrophoresis, proteomics


Turkey astrovirus type 2 (TAstV-2) is recognized as a major cause of enteritis in poult in the US and around the world; however our understanding of how it induces disease is limited. Previous studies have demonstrated TAstV-2 infection induces severe watery diarrhea and growth suppression with no significant change in intestinal morphology. More recently, other groups have reported the capsid virus of human astroviruses can induce changes to intestinal cell barrier function in vitro. To determine the patho-physiology of TAstV-2-mediated diarrhea we assayed for changes in barrier function and ion transport of control and infected poult jejunum by mounting either intact or stripped intestinal mucosa from poult at 4 days post-infection (peak of clinical signs) on Ussing chambers. Isotopic flux studies demonstrated impaired Na+ absorption with reduced short circuit current and increased conductance in astrovirus-infected jejunum. Electron microscopic examinations of these tissues revealed the terminal web region displayed frequent dense aggregations in TAstV-2 infected intestine. Rearrangement of apical F-actin in form of thick, dense aggregations, particularly in the areas of viral localization, was seen in TAstV-2-infected intestine. The actin rearrangement was limited to morphological alterations as total actin content and ratio of G: F actin in intestinal mucosa was not altered after infection with TAstV-2. Although the total protein expression for the major apical membrane Sodium Hydrogen Exchanger, NHE3, was not changed in western blot analyses of astrovirus-infected jejunum, a significant shift was observed for expression of NHE3 from detergent insoluble fractions to detergent soluble fractions of TAstV-2 infected jejunum. Alternatively, total expression of NHE2 was up regulated in infected jejunum. Taken together, astrovirus TAstV-2 induces malabsorptive diarrhea associated with actin re-arrangement and redistribution of apical membrane NHE3.

Key Words: astrovirus, diarrhea, NHE3

200 WITHDRAWN.

Immunology II

201 Synergistic effect of dietary Curcuma, Capsicum, and Lentinus on enhancing local protective immunity against Eimeria acervulina infection. H. Lillehoj*, S. Jang1, D. Kim1, C. Ionescu2, D. Bravo2, and S-H. Lee1,1Animal and Natural Resources Institute, Agricultural Research Service-U.S. Department of Agriculture, Beltsville, MD; 2Pancosma S.A., Geneva, Switzerland.

The protective effect of orally administered Curcuma longa (turmeric), Capsicum annuum and C. frutescens (hot pepper), and Lentinus edodes (shiitake mushroom) on avian coccidiosis was evaluated in young broilers. Broiler chickens were continuously fed with a standard diet or standard diet supplemented with Curcuma, Capsicum/Lentinus or Curcuma/ Capsicum/Lentinus from hatch. Body weight gain, fecal oocyst shedding, antibody titers, and pro-inflammatory cytokine gene expression were measured as parameters of protective immunity following challenge with E. acervulina. Chickens fed the Curcuma/Capsicum/Lentinus-supplemented diet showed significantly improved body weight gain compared with birds on the standard diet alone or birds given Capsicum/ Lentinus-supplemented diet following challenge with E. acervulina. Chickens fed the Curcuma/Capsicum/Lentinus-supplemented diet shed significantly reduced fecal oocysts and produced higher serum antibody titers compared to the groups fed the standard diet alone or fed Curcuma or Capsicum/Lentinus. Finally, the levels of local cytokine transcriptives of IL-1β, IL-6, IL-15, and IFN-γ were consistently higher in the Curcuma/Capsicum/Lentinus-fed group compared to the controls fed only the standard diet, Curcuma, or Capsicum/Lentinus groups. This study provides first immunological evidence that dietary supplementation of turmeric, pepper, and shiitake work synergistically to enhance local innate immunity and provide higher protective immunity against E. acervulina infection.

Key Words: broiler, coccidiosis, Curcuma, Capsicum, cytokine

202 Chicken CD25+: Chicken T regulatory cells. R. Shanmugasundaram and R. Selvaraj*, The Ohio State University, Wooster.

T regulatory cells are a subset of T cells that specialize in immune suppression. In mammals FoxP3 is the master gene regulator of Tregs. We were not able to identify a putative FoxP3 analogue in the chicken and zebra finches. This suggests that avian taxa lack FoxP3 (and hence Tregs) and/or avian Tregs are independent of mammalian FoxP3. We were not able to identify a putative FoxP3 analogue in the chicken, and zebra finches. This suggests that avian taxa lack FoxP3 (and hence Tregs) and/or avian Tregs are independent of mammalian FoxP3 signals. Chickens CD25+ cells were isolated and characterized. The distribution of CD25+ cells in chicken lymphoid organs and peripheral blood was studied. On an average, 5 to 8% of lymphocytes in different organs were CD25+. CD25+ cells were distributed in three major subpopulations, CD4+25+, CD8+25+ and CD4+8+25+. The ratio of these three subpopulations differed widely among organs. The thymus had the greatest CD4+8+25+, while the spleen had a greater CD4+25+ and blood had a greater CD8+25+ subpopulations. Both naïve and in vitro-grown
CD25+ cells from thymus, spleen and blood suppressed T responder cell proliferation, while CD25 did not suppress T responder cell population. Cytokine production profile of CD25+ cells was also quantified. The data suggest that CD25+ are the chicken analogue of T regulatory cells.

Key Words: T regulatory, avian, CD25

203 Elucidation of genes and pathways regulated by the avian miRNA, miR-10a. J. A. Hicks*, N. Trakooljul, and H. C. Liu, North Carolina State University, Raleigh.

In recent years it has been discovered that small non-coding RNA (ncRNA) can post-transcriptionally regulate gene expression. MicroRNA (miRNA) is a family of small (19-24nt) ncRNA that serves as a key regulator of a variety of biological processes, such as cell differentiation, and has been linked to disease development, particularly cancer. The initial focus on elucidating the role(s) of miRNA in eukaryotic gene regulation has been on expression profiling. This profiling has revealed that the eukaryotic genome encodes hundreds of miRNAs which display a wide range of temporal and spatial expression patterns. The next step in the study of miRNA will be to identify target genes and pathways controlled by miRNAs. We recently reported the miRNA expression profiles of miRNA in the spleen and bursa of the developing chick embryo. We found that the miRNA, miR-10a, is highly expressed in the embryonic spleen, which suggests that this miRNA is an important gene regulator during embryonic spleen development. In order to further elucidate the role(s) of miR-10a in avian spleen development, the potential genes and pathways targeted by miR-10a were identified. The miRNA target prediction algorithm miRanda was employed to identify potential miR-10a target genes. These target genes were then validated using a retroviral-based RNA interference (RNAi) strategy. Additionally, to identify miR-10a regulated pathways, a microarray strategy was employed into which a miR-10a inhibitor was introduced into spleen cells in order to knock-down miR-10a expression. Our findings suggest that miR-10a regulates hematopoiesis and megakaryocyteopoiesis as it potentially targets the genes kruppel-like factor 11 and WD repeat domain 1. Additionally miR-10a is also likely an important regulator in the immune system as it can target integrin β 1. Furthermore our microarray data suggests that miR-10a is also involved in regulating the complement system. Together these results suggest that miR-10a plays a variety of roles in the avian spleen.

Key Words: avian development, immune system, gene regulation, microRNA, microarray

204 Associations of chicken Mx polymorphism with antiviral responses in avian influenza virus infected embryo and broilers. Y. Wang1, V. Brahmakshatriya2, B. Lupiani2, S. Reddy1, R. Okimoto1, X. Li1, H. Chiang1, and H. Zhou1, 1Texas A&M University, Department of Poultry Science, College Station, 2Texas A&M University, Department of Veterinary Pathobiology, College of Veterinary Medicine, College Station, 3Cobb-Vantress, Inc, Silkam Springs, AR.

Avian influenza (AI) is a major respiratory disease of poultry that can cause catastrophic losses to the commercial poultry industry. It is imperative to develop effective control and treatment measures to prevent the spread of AI. The Mx protein has been shown to confer antiviral responses to influenza viruses in mouse. One nonsynonymous substitution (S631N) in the chicken Mx protein has been reported to be associated with resistance to avian influenza virus (AIV) in vitro in chickens. In this study we examined the associations of Mx polymorphism with the antiviral response in chicken embryo and young chicks. The embryo and young chicks were generated from the cross of Mx heterozygous parents with expected segregating ratio of 1:2:1 in the progeny; A PCR-RFLP was developed to genotype the Mx gene (NN, NS and SS) from 119 embryos and 24 chickens. Thirteen day old embryonated chicken eggs were inoculated with 10 EID50 H5N9 AIV. Hemagglutination assay was used to evaluate virus replication in chicken embryos. Hemagglutinating units (HAU) in allantoic fluid were determined at 48 hours post-inoculation for all inocfected embryos. Mean virus titers for the different phenotypes were 256 HAU for NN, 222.86 HAU for NS and 337.79 HAU for SS. For the in vivo study, 24 one-week old broilers were inoculated with 106 EID50 H5N3 AIV and virus titers in lungs were evaluated at day 4 post inoculation. The mean virus titers for three genotypes were 398.11, 501.19 and 1000 TCID50/ml for NN, NS and SS, respectively. Our results indicate that there is a tendency for birds with NN genotypes to have lower virus titer than ones with SS both in ovo and in vivo, although the association between genotypes and virus titers was not significant (P > 0.05). Our results indicate that further studies including additional Mx alleles and more animals are needed. The knowledge generated by this study provides valuable information on the effect of the Mx gene on the genetic resistance to AIV in chickens and its potential application in the poultry breeding industry.

Key Words: chicken, Mx gene, avian influenza, virus

205 High energy electron-beam irradiation: A vaccine development technology for pathogens in commercial poultry. J. L. McReynolds*, M. A. Davidson2, K. J. Genovese1, P. R. Jesudhasan2, S. E. Duke1, J. A. Byrd1, M. A. Cepada2, and S. D. Pallai2, 1USDA-ARS-SPARC-FFSRU, College Station, TX, 2Texas A&M University, Department of Poultry Science, College Station.

Our laboratories are investigating the use of High Energy (10 MeV) Electron-Beam (E-beam) Irradiation for its potential use in vaccine development. It is well known that ionizing radiation damages nucleic acids by direct and/or indirect effects thereby inactivating the organism. Though the cells are inactivated, our studies suggest that the surface antigenic properties of Salmonella enteritidis (SE) are unaltered. The present investigations (3 replicates) were performed to evaluate the efficacy of the E-beam vaccine on SE colonization during an induced molt. Laying hens were divided into 3 groups (12 hens/group): negative control, positive control, and SE-vaccinated. SE-vaccinated birds received a 1x10⁶ CFU/mL/bird injection in the breast muscle; controls were sham injected with saline. One wk prior to the beginning of the study, hens were placed on an 8-h light and 16-h dark photoperiod that continued for the 12-day induced molt. Positive control and vaccinated birds were challenged with 1x10⁶ CFU/mL/bird (15 days post vaccination) via oral gavage. SE colonization in the liver, spleen, ceca and ovaries was significantly (P<0.05) reduced in the E-beam SE vaccinated birds compared to the positive controls. E-beam technology can be customized to meet an integrators needs and can be extremely inexpensive since there is no need for R & D costs to develop the irradiation source or vaccine organisms. The results show that the immunological effects of this E-beam SE provided protection against SE colonization in laying hens during an induced molt.

Key Words: chicken, electron-beam, vaccination, Salmonella
206 Evidence of Mx independent genetic resistance to viral infection. M. D. Koci1, R. A. Ali, M. D. Quiles, E. Strain, and C. M. Ashwell, North Carolina State University, Raleigh.

The ability of individual cells to detect and respond to the presence of virus is a critical first step in the body’s ability to resist viral infection and disease. Much effort has focused on identifying proteins involved in the antiviral pathway. Several gene products have been described as part of the innate antiviral response, but our knowledge of how these proteins function or how polymorphisms in these genes affect the antiviral response is limited. In mammals, the Mx gene has been described to have antiviral properties against various several virus families. Initial studies which identified the avian Mx homologue demonstrated it lacked antiviral activity. More recent studies have demonstrated that commercial and research lines of chickens have polymorphisms in their Mx gene. One variant in particular (G2032A) has been described to have antiviral activity. Sequencing of 12 unrelated individuals from each of 9 commercial layer lines lead to the identification of additional variants in the Mx gene. To begin to understand if the sequence polymorphisms in the Mx alleles are associated with antiviral activity, we isolated chicken embryo fibroblast (CEF) cells from commercial layers. Four CEF cell lines were produced (3, 6, 7, and 8) and genotyped for Mx and MHC-I. These CEF cells were infected in vitro with an interferon sensitive virus (vesicular stomatitis virus) and assayed for resistance to virus infection. The results from these studies demonstrated two CEF lines with increased resistance (3 and 7) and two lines with decreased resistance (6 and 8). To further assess the role of Mx and MHC in viral resistance, genetic lines which produced CEF line 7 and line 8 were crossed, and resulting embryos were genotyped such that additional 11 CEF lines that provide each possible Mx and MHC combination were generated. Subsequent in vitro analysis of the crossed CEF cells demonstrated resistance to infection is not associated with Mx or MHC genotype. These results suggest that while some genotypes of Mx have been described to have antiviral activity, expression of the Ser231Asn is not sufficient to increase the innate resistance of CEF cells to viral infection.

Key Words: antiviral, innate immunity, Mx

Extension and Instruction

207 A survey of the economic, environmental, public policy and production issues facing the poultry industry in Louisiana. T. A. Lavergne*, S. M. Derouen, and G. M. Hay, Louisiana State University AgCenter, Baton Rouge.

A survey was conducted to determine the opinions of commercial producers, integrator representatives, allied industry representatives, regulatory personnel, and academic personnel concerning issues facing the poultry industry in Louisiana. Respondents were asked to rate 11 items within four categories of issues: Economic issues, Environmental issues, Public policy issues, and Production issues. The items were rated from 5 (extremely important) to 1 (not important). Of the 74 respondents, 45 were commercial growers, 12 were employed in the allied poultry industry, two were employed in the state’s regulatory agency, six were academics, and nine were employed by integrator companies. The ratings of commercial poultry producers were similar to the average of the responses of all other categories of respondents. For economic issues, the ratings of commercial producers and all others ranged from 4.1 to 4.8 and 3.54 to 4.86, respectively. Rising input costs received the highest rating for economic issues. For environmental issues, the ratings of commercial producers and all others ranged from 3.3 to 4.4 and 3.0 to 4.5, respectively. Public perception of the environmental effects of animal agriculture received the highest rating for environmental issues. For public policy issues, the ratings of commercial producers and all others ranged from 3.5 to 4.5 and 3.3 to 4.5, respectively. Consumer confidence in food and animal product safety received the highest rating for public policy issues. For production issues, the ratings of commercial producers and all others ranged from 3.5 to 4.8 and 3.0 to 4.6, respectively. Improving production efficiency received the highest rating for production issues. All respondents rated each item as moderately, substantially, or extremely important. Economic issues received the most substantially important and higher ratings. The responses indicate that economic, environmental, public policy, and production issues are important to these respondents involved in Louisiana’s poultry industry.

Key Words: poultry, economic issues, environmental issues, public policy issues, production issues

208 Multifacet, grower-driven education program. M. Miller1, J. P. Jacob2, A. J. Pescatore2, D. G. Overhults3, and R. S. Gates4, 1Kentucky Poultry Federation, Winchester; KY, 2University of Kentucky, Animal & Food Sciences, Lexington, 3University of Kentucky, Biosystems & Agricultural Engineering, Lexington, 4University of Illinois, Agricultural & Biological Engineering, Urbana.

The Kentucky Poultry Federation received a grant from the KY Ag Development Board to support the state broiler industry. The project objective is to enhance the productivity and sustainability of KY poultry growers. The project is divided into 2 parts. In the 1st part energy audits are completed for a sample of poultry houses for each of the 6 integrators in the state. The objective of these audits is to identify common areas where growers can improve energy efficiency by properly operating and maintaining existing equipment. The 2nd goal is to develop recommendations for cost effective upgrades that will help growers reduce their energy use. Information obtained from the audits is then used to develop complex-specific educational workshops for all their growers. The same information is used to develop an educational binder which is designed to serve as a reference book for the producers. The growers are kept up to date on the progress of this part of the project by means of a website and quarterly newsletter.

In the 2nd part of the project, a state-wide producer education conference is held each year and addresses current issues affecting all producers in the state. In addition, 5 of the integrators each formed an ‘Integrator Educational Advisory Committee’ with membership from the company staff as well as representatives from the growers supplying the complex. These committees set their own educational goals and agenda for what they want to accomplish within the 2-yr time frame of the project. Each committee is provided funding for educational programs based on the priorities they have identified. In some cases this involves bringing in invited speakers on specific topics, but the committees are encouraged to ‘think outside the box’ and develop creative and unique educational programs that can benefit others in the community in addition to the poultry growers.

Key Words: broilers, extension, energy
209 WITHDRAWN.

210 “ASPIRE” acquiring SAT preparation in rural education: An initiative designed to provide rural high school students with first-hand experience in the poultry industry while gaining SAT preparation necessary to gain college admission. J. B. Hoffman*, North Carolina State University, Raleigh.

The ASPIRE program is geared towards creating a partnership between the North Carolina Poultry Industry and rising high school juniors in order to provide students with summer internships in the industry while preparing them for the Scholastic Assessment Test (SAT) necessary to gain college admission. Many students residing in counties that are major broiler, turkey, and egg producers have a sincere interest in entering the poultry industry in the future. However, many of these students have not been successful in gaining admission to the Department of Poultry Science at North Carolina State University due to low SAT scores. Specifically, students living in the top poultry producing counties in North Carolina scored on average 200 points lower than the average SAT score of last year’s entering freshman class at NC State. In order to ensure the longevity of the industry, North Carolina State’s Department of Poultry Science must graduate more students who are interested in entering the industry. Achieving this goal will be dependent upon increasing SAT scores of students interested in careers in the poultry industry so that they are successful in gaining admission to NCSU. With the participation of North Carolina’s Poultry Industry, we are in the process of implementing a 6-week summer internship program for rising high school juniors. Students will intern at a poultry company’s headquarters while participating in an SAT test preparatory class sponsored by their partner poultry company. By implementing the ASPIRE program, students interested in pursuing careers in the poultry industry will be able to begin forming relationships with leaders in the industry while improving their SAT scores and likelihood of college admission.

Key Words: SAT, college, admissions, poultry, industry

211 Thermostability and feeding effects of exogenous phytase on performance variables of 3-21 day old broilers. S. A. Loop*, L. K. Worley, C. K. Gehring, K. R. Beaman, and J. S. Moritz, West Virginia University, Morgantown.

Feed ingredient price and environmental regulations have dictated an increased incorporation of the feed enzyme phytase into broiler diet formulations. Most broilers consume pelleted feed that must be steam conditioned, extruded through a die, and dried. Phytase may be denatured due to exposure to heat and moisture. Phytase manufacturers have addressed this concern by using carbohydrate/lipid coatings, selecting phytase sources that are naturally heat stable, or genetic modification. Regardless, there is potential for heat stable phytase to survive the pelleting process but lose efficacy in liberating phytate bound phosphorus in vivo. The objective of the current study was to demonstrate differences among an in vitro retention assay and in vivo feeding of nine different genetically modified, heat stable phytases. Dietary treatments consisted of positive and negative controls, as well as negative control diets including one of nine experimental phytases. All diets were pelleted at 71, 77, and 82°C. Feed samples were analyzed for phytase retention. The 77°C pellets were chosen for further evaluation due to all enzymes having high retention. The in vivo study consisted of male broilers being placed on a three day pretest, blocked by weight, and allocated to treatments in eight replicate raised wire cages. On day 21, birds were killed and right tibias were extracted for three point breaking force. Feed intake, feed conversion ratio, and live weight gain were calculated. Seven out of nine enzymes showed similar live weight gain to that of the positive control (P>0.05). However, using contrasts, five of these enzymes demonstrated decreased feed conversion ratio of eight points on average compared to the other two enzymes (P=0.0102). Bone breaking force followed feed conversion trends; however, illustrated further differences among these five enzymes (P<0.05). Evaluations of phytase must include in vivo animal testing beyond in vitro retention assays in order to fully assess efficacy.

Key Words: phytase, heat stability, pellet quality, broiler performance, breaking force

212 Effect of phytase and carbohydrase supplementation of corn-soy diets with or without the inclusion of distillers dried grains with solubles (DDGS). M. H. Schwartz*, P. R. Ferket, J. L. Grimes, and C. R. Stark, North Carolina State University, Raleigh.

Increasing the dietary inclusion of DDGS may contribute to variable growth performance of turkey because of its high nutritional variability and low energy value, but this may be remediated by dietary enzyme supplementation. Turkey toms were assigned to eight dietary treatments arranged as a factorial of 2 dietary inclusion levels of DDGS (0 and 15%) and 4 Diets: 1) positive control (PC), 2) negative control (NC), 3) NC with phytase (1000 FTU/kg feed), and 4) NC with phytase and a combination of xylanase, amylose, and protease (XAP) enzymes (Avizyme 1502, Danisco Animal Nutrition). The PC and NC diets differed by 150 kcal ME/kg, 0.15% Available P and 0.14% calcium. Turkeys were fed ad libitum 8 phases of pelleted feed that approximated requirements of digestible nutrients by age. Body weight (BW) and Feed/Gain (FCR) were determined at 23, 43, 57, 85, 98, 119, and 137 d of age. There were neither DDGS X Diet interaction effects on growth performance, nor DDGS effects on BW throughout the experiment. DDGS reduced 137d FCR (1.79 vs 1.76, P<0.05), but this effect reversed after 85d, such that 137d FCR was significantly increased by DDGS (2.47 vs 2.55, P<0.005). The effect of DDGS on FCR was associated with its effect on crumble and pellet quality of the respective feed phases. Supplementation of the NC diets with phytase -/+ XAP significantly (P<0.05) increased BW by 3% over the PC and NC diets through to 98d without effect on FCR. DDGS significantly reduced the efficiency of manufacturing low-energy starter feeds (fed from 1 to 57d), and reduced feed pellet durability of high-energy finisher feeds. Increasing DDGS to 15% had no negative effect on BW gain but negatively affected FCR and pellet quality. The addition of phytase -/+ XAP enzymes resulted in an apparent uplift of over 150 kcal ME/kg, reducing the need for dietary fat and inorganic phosphate inclusion, regardless of the dietary DDGS level.

Key Words: turkey growth performance, DDGS, phytase, carbohydrase
213 Effects of phyzyme XP and avizyme 1502 on the performance of broiler breeders and their progeny. M. Argüelles-Ramos1, J. T. Brake1, and P. W. Plumstead2. 1North Carolina State University, Department of Poultry Science, Raleigh, 2Danisco Animal Nutrition, Marlborough, United Kingdom.

Previous research has suggested that there may be negative vertical effects of multi-enzyme cocktails fed to broiler breeders on broiler progeny performance when the progeny also received the same enzyme in the feed. A study was conducted to evaluate the use of phyzyme (Phyzyme XP; PXP) with or without a combination of xylanase, amylase, and protease (XAP) enzymes (Avizyme 1502, Danisco Animal Nutrition) in broiler breeder diets on the performance of broiler breeders and their progeny when the progeny also received similar diets. A total of 1104 22-wk-old Ross 708SF females and 128 Ross 344 males were allocated to 4 treatments with 4 replicate pens. Treatments were a Positive Control (PC), Negative Control (NC), NC+PXP, and NC+PXP+XAP. The PC diet contained 2900 kcal ME/kg and all NC diets were 80 kcal ME/kg lower in diets formulated with corn, soybean meal, and 20% distillers dried grains with solubles. Phytase was added at 500 FTU /kg and replaced 0.12% available P and 0.1% Ca. Eggs and mortality were collected and recorded twice daily. Fertility and hatchability were determined weekly from 27 wk of age. Egg production, fertility, fertile hatchability, and mortality differences were not observed among the breeder treatments. Similar dietary treatments were applied to broiler progeny at 30 and 40 wk of breeder age to complete a 4 X 4 design. A total of 2304 chicks (278 males and 278 females per breeder treatment) were distributed among 96 pens at each breeder age. BW and feed consumption were measured at 0, 16, 35, and 41 d, and mortality was collected and weighed twice daily. At 42 d one male per pen was killed to evaluate carcass traits. There were no significant main effects or interactions for broiler BW, feed conversion, or carcass traits due to the breeder diets, which indicated no vertical effect of parental treatment on progeny response to the dietary enzymes evaluated in this study.

Key Words: broiler breeders, broilers, enzymes

214 The effects of feeding an enzyme complex containing carbohydrolase and phytase on the performance of broilers fed a diet containing 15% corn distiller’s dried grains with solubles. J. Brandon1, A. Batal1, V. Gady2, S. Virden3, and P. Geraert2. 1University of Georgia, Athens, 2Adisseo France SAS, Antony, France, 3Adisseo USA, Inc., Alpharetta, GA.

This experiment was conducted to investigate the benefits of a multi-enzyme complex (Rovabio® Max) containing carbohydrolases (from Penicillium funiculosum) and phytase (bacterial 6-phytase) on the performance of broilers fed corn-soybean meal based diet containing 15% corn distiller’s dried grains with solubles (cDDGS). Male Cobb 500 chicks were randomly assigned to five dietary treatments with 7 replicates of 40 birds per pen. The five dietary treatments were: 1) a positive control (PC) formulated to meet NRC (1994) nutrient recommendations; 2) negative control 1 (NC1) which was lower in AME (-65 kcal/kg), CP and amino acids (-1.5%), avP (-0.15%), and Ca (-0.12%) as compared to the PC; 3) NC1 + 0.005% Rovabio Max; 4) negative control 2 (NC2) which was lower in AME (-85 kcal/kg), CP and amino acids(-3%), avP (-0.15%), and Ca (-0.12%) as compared to the PC; 5) NC2 + 0.005% Rovabio Max. Rovabio® Max provided 1,100 visco units of endo-β-1,4-xylanase, 100 AGL units of endo-1,3(4)-β-glucanase, and 500 FTU of phytase per kg of feed. Growth performance was measured at 14, 28, and 42 days of age. The addition of Rovabio® Max to the negative control diets (treatments 3 and 5, respectively) improved (P<0.05) weight gain and feed conversion as compared to birds fed NC1 and NC2 (treatments 2 and 4, respectively). Birds fed NC2 + Rovabio® Max (Treatment 5) had better feed conversion than those fed the PC. The addition of a multi-enzyme complex of carbohydrolases and phytase to a diet containing 15% cDDGS allowed for a reduction in AME (up to -85 kcal/kg), protein and amino acids (up to -3%), dietary phosphorus (-0.15 % avP), and calcium (-0.12 % Ca) without negatively impacting performance, while improving feed conversion.

Key Words: carbohydrolase, phytase, broilers, performance, distiller’s dried grains with solubles

215 Effects of phytase supplementation during a live coccidia oocyst vaccination on broiler performance, gut morphology, and apparent ileal amino acid digestibility. C. L. Walk1, C. L. Wyatt2, M. R. Bedford2, A. J. Cowieson2, and A. P. McElroy1. 1Virginia Polytechnic Institute and State University, Blacksburg, 2AB Vista, Marlborough, Wiltshire, United Kingdom.

An experiment was conducted to evaluate the effects of phytase supplementation on broiler performance, bone ash, and gut morphology when using a live coccidia oocyst vaccine. One-day-old, Cobb 500 male broilers were obtained from a commercial hatchery and half were sprayed with a live coccidia vaccine. Chicks were weighed and placed in floors pens on clean pine shavings according to five dietary treatments (7 replicate pens/diet/treatment). Dietary treatments were 1) positive control (PC; 0.92% Ca and 0.45% npP), 2) PC + phytase (1000 FTU), 3) negative control (NC; 0.79% Ca and 0.32% npP), 4) NC + phytase (1000 FTU), and 5) NC + phytase (5000 FTU). Diets were formulated to meet or exceed Cobb nutrient requirements with the exception of Ca and P, which was reduced 0.13% in the starter, grower, and finisher. There were no diet by vaccination interactions. Phytase supplementation improved (P < 0.05) feed intake (FI), body weight gain (BWG), feed conversion (FC), and tibia ash. Coccidia vaccination reduced (P < 0.05) FI, BWG, and tibia ash and negatively (P < 0.05) affected FC. Crypt depth and villi height to crypt depth ratios (VCR) were significantly different (P < 0.05) between diets. Coccidia vaccination increased (P < 0.05) duodenal crypt depth regardless of dietary treatment. Phytase supplementation to NC increased (P < 0.05) ileal crypt depth in vaccinated broilers. Vaccination increased (P < 0.05) crypt depth and reduced VCR in intestinal sections measured. Phytase supplementation improved (P < 0.05) apparent ileal amino acid digestibility. Coccidia vaccination reduced (P < 0.05) apparent ileal amino acid digestibility for all amino acids evaluated except arginine. These data indicate vaccination using live coccidia oocysts reduced apparent ileal amino acid digestibility and altered gut integrity in broilers raised in floor pens, which may lead to associated reductions in broiler performance. Phytase supplementation improved performance and apparent ileal amino acid digestibility by removing the negative impact of phytate.

Key Words: phytase, broiler, coccidiation, vaccination, intestinal morphology

216 The effect of phytase in combinations with 1α-OHD3 added to P-deficient corn-soybean meal, and corn-peanut meal based broiler diets. A. Liem*, G. M. Pesti, A. Atencio, and H. M. Edwards Jr., University of Georgia, Athens.

Phytase and vitamin D3 derivatives, such as 1α-OHD3, improve birds’ ability to utilize phytate phosphorus. The objective of the current study was to evaluate the effects of increasing levels of phytase in combina-
tion with 1α-OHD$_3$ on broilers' performance and mineral utilization in broiler chicks. The potency of 1α-OHD$_3$ on the criteria above was also compared to the effects of phytase. Two battery studies were conducted from 1 to 16d with P-deficient corn-soybean meal and corn-peanut meal diets. In Experiment 1, the birds were randomly allocated to 6 treatments: 5 treatments with increasing phytase levels from 0 to 12,000 U/kg, and 1 treatment with of 5 μg/kg of 1α-OHD$_3$. In Experiment 2, the birds were subjected to 8 treatments: 0, 433, 1,333, and 4,000 U/kg phytase, with and without of 5 μg/kg of 1α-OHD$_3$.

Supplementation of 1α-OHD$_3$ and phytase to P-deficient corn-soybean meal and corn-peanut meal based broiler diets increased P, and phytate P utilization, as indicated by an increase in bone ash, body weight gain, plasma P, phytate P and P retention, and also reduction in incidence of P-deficiency rickets. The effect of 5 μg/kg of 1α-OHD$_3$ in Experiment 1 was comparable to 444 U/kg of phytase in increasing phytate P and total phosphorus retention, also in reducing the incidence of P-deficiency rickets. The same level was comparable to approximately 650 U/kg of phytase in increasing body weight gain. Retention numbers are often calculated by using indigestible markers such as chromic oxide and celite (for acid insoluble ash determination). In Experiment 1, both markers were utilized. While there were differences between results due to markers used, there were moderately high correlations, leading to similar general conclusions.

Key Words: 1α-OHD$_3$, phytase, phytate P utilization, chromic oxide, acid insoluble ash


A novel Serine protease (RONOZYME® ProAct) expressed in Bacillus licheniformis was granulated and coated by vegetable fat to obtain a thermostable and dust free product form. The stability of this protease, which was originally selected for improving the digestibility of amino acids in animal feed, was tested in premix and different broiler feed applications. In addition, the compatibility of the protease with other RONOZYME® feed enzymes such as Phytase, Amylase, Xylanase and Glucanase was investigated. The granulated protease was mixed with a complete premix (including minerals) and a vitamin premix and was subjected to stability testing at room temperature. The results showed excellent protease recoveries in both premixes after 1 month (99%), 3 months (93%) and 6 months (87%). Pelleting of protease supplemented broiler feed at 70-80-90°C, respectively, revealed an excellent stability of the feed enzyme product with recoveries of 99%, 99% and 94%, respectively. Subsequent storage stability testing of the pellets for 3 month at room temperature showed limited losses of <10% of the protease activity. Under very aggressive feed processing conditions (30s conditioning at 80°C and 15s expansion at 120°C) the recovery of the protease activity was higher than 90%. Compatibility testing of the protease with other enzymes was performed using liquid enzyme formulations. On top spraying of the protease in combination with other liquid enzymes such as Phytase, Xylanase, Glucanase and Amylase on pelleted feed showed no negative impact of the protease on the enzyme activities tested.

In summary, all results with this novel Serine protease demonstrated excellent per se and application stability for all feed processes investigated.

Key Words: enzyme, pellet, processing, protease, stability


In order to test the effect of several inclusion levels of Peniophora lycii (PLP) phytase on phytate P (PP) release, 96 1-d-old-Ross 308 male broilers were randomly allocated to 8 treatments with 3 replicates of 4 chicks each. The birds were housed in thermostatically controlled starter batteries with raised wired floor. Feed & water were provided ad libitum. The birds were fed a sorghum-SBM pre-starter diet from day 1 to 7 formulated to fulfill all nutrient requirements for Ross 308 males. Trial lasted from day 8 to 21, the birds were assigned to the following feeds: treatment 1 was a basal diet sorghum-SBM deficient in Av P (0.22%). Treatments 2 to 4 were added with constant increases of 0.075% inorganic P in order to get a linear broiler growth response to P addition. Treatments 5 to 8 consisted of the addition of 185, 400, 800 & 1,200 ppm of PLP to the basal diet. All diets were formulated to fulfill the Ross 308 male nutritional requirements, but Av. P (formulated as mentioned above). Variables to be analyzed were: weight gain (WG), feed intake, feed efficiency, tibia strength (TS), tibia ash (TA), tibia Ca (TC) & tibia P (TP). The results from treatments 1 to 4 were analyzed by a regression model to test for a significant linear response. Then for every level of PLP added (treatments 5 to 8) the linear regression equation was solved to find out the equivalent value of released P. It was found a linear response for WG (Y = 529.5 + 739.67X R² = 0.96 P < 0.02), TS (Y = 12,033.8 + 52,578.19X R² = 0.92 P < 0.04), TA (Y = 38.03 + 51.91X R² = 0.81 P < 0.10) & TC (Y = 13.19 + 22.88X R² = 0.86 P < 0.07). Under the experimental conditions of the present trial, the average P release values per level of PLP inclusion in the sorghum-SBM diet were; 185 ppm, 0.1%, 400 ppm 0.13%, 800 ppm 0.18% & 1,200 ppm 0.18%

Key Words: Peniophora lycii, phytase, broiler, available, phosphorus


Meat and bone meal (MBM) is the main animal by-product used in poultry diets as a source of phosphorus and protein. However, several studies find the crude protein (CP) and amino acid digestibility of MBM often to be lower than expected and highly variable. This study tested the ability of a commercially available protease to improve the protein and amino acid digestibility of a conventional commercial 45% protein MBM. The metabolism trial was performed with Cobb 500 male broilers over a 14 to 21 days period with the traditional methodology of replacing the test ingredient in a diet with 70% of the basal diet and 30% MBM. Two levels of the protease (RONOZYME® ProAct - 75000 PROT/g product) was tested: 0 and 200 ppm. After an adaptation period of four days, total excreta was collected for three days, and analyzed for 17 amino acids: aspartate (Asp), glutamine (Glu), serine (Ser), glycine (Gly), histidine (His), arginine (Arg), threonine (Thr), alanine (Ala), proline (Pro), tyrosine (Tyr), valine (Val), methionine (Met), cysteine (Cys), isoleucine (Ile), leucine (Leu), phenylalanine (Phe), lysine (Lys) and total amino acids (total AA). The apparent digestibility coefficient was determined for each amino acid and for all amino acids (AMCAA) together. The experimental design was completely randomized with
eight replicates per treatment. The data were analyzed according to SAS procedures (2001). With the use of the protease, increases in digestibility were significant (P<0.05) for Asp, Glu, Ser, His, Arg, Thr, Ala, Pro, Val, Met, Cys, Phe and Lys. The average improvement in the utilization of these amino acids was determined to be 8% (P<0.05). The average improvement achieved using the protease was 8.63% (P<0.05) when considering only the limiting amino acids, Met, Lys and Thr. This compared to an improvement of 6.32% considering total AA, which was also significant (P<0.05). We conclude that the use of 200 ppm of RONOZYME® ProAct effectively increased the average utilization of amino acids in a commercial MBM by 6.32%.

Key Words: enzyme, protease, meat and bone meal, amino acid, metabolism

220 Use of a protease to enhance the utilization of corn amino acids by broilers. J. C. C. Carvalho*1, A. G. Bertechini1, R. L. Rios1, F. R. Mesquita1, E. M. C. Lima1, and J. O. B. Sorbara2. 1Universidade Federal de Lavras, Lavras, MG, Brazil, 2DSM Nutritional Products, São Paulo, SP, Brazil.

Corn is the ingredient most widely used in poultry diets, with a marked contribution to the amino acids (proximally 10 to 20% of the requirement, depending which amino acid we are considering) and crude protein (proximally 20% of the requirement) composition to the total feed. This makes corn a critical ingredient from an economic and environmental point of view, since an increased utilization of amino acids would presumably improve economics with a reduced nitrogen excretion. In this study, we tested the ability of a commercially available protease (RONOZYME® ProAct) to improve the digestibility of amino acids in corn fed to broilers. The metabolism trial was performed with over a 14-21 day period with Cobb 500 males. Traditional methodology was applied and used 60% basal diet and 40% Corn across two levels of protease (0 and 200 ppm RONOZYME® ProAct - 75000 PROT/g product). After four adaptation days, total excreta was collected for three days, dried and analyzed for the following amino acids: aspartate (Asp), glutamine (Glu), serine (Ser), glycine (Gly), histidine (His), arginine (Arg), threonine (Thr), alanine (Ala), proline (Pro), tyrosine (Tyr), valine (Val), methionine (Met), cystine (Cys), isoleucine (Ile), leucine (Leu), phenylalanine (Phe), lysine (Lys) and total amino acids (total AA). The apparent digestibility coefficient was determined for each amino acid and for all amino acids (AMCAA). The experimental design was fully randomized with eight replicates per treatment. The data were analyzed according to SAS procedures (2001). Supplementation of the protease significantly (P<0.05) improved the digestibility for serine, glycine, threonine, proline, cystine, isoleucine and total amino acids, considering these amino acids, there was an average 6.63% increase in digestibility. The use of this protease resulted in an average 3.18% improvement of the corn amino acids metabolism during the broilers starter period.

Key Words: enzyme, protease, corn, amino acid, metabolism

221 Use of a protease to enhance the utilization of soybean meal amino acids by broilers. A. G. Bertechini*1, J. C. C. Carvalho1, F. R. Mesquita1, S. F. Castro1, D. F. Remolina1, and J. O. B. Sorbara2. 1Universidade Federal de Lavras, Lavras, MG, Brazil, 2DSM Nutritional Products, São Paulo, SP, Brazil.

Energy costs have significantly driven up the price of solvent-extracted soybean meal (SBM) for poultry feeds, and subsequently, the cost of poultry production. Studies are constantly in search of methods to utilize SBM more efficiently to reduce costs, as well as to reduce nitrogen excretion. The objective of this study was to test the ability of a protease to increase the amino acid digestibility of SBM. The metabolism trial was performed with over a 14-21 day period with Cobb 500 males. Traditional methodology was applied and used 70% basal diet and 30% SBM across two levels of protease (0 and 200 ppm RONOZYME® ProAct - 75000 PROT/g product). After four adaptation days, total excreta were collected during three days and dried for amino acid analyses: aspartate (Asp), glutamine (Glu), serine (Ser), glycine (Gly), histidine (His), arginine (Arg), threonine (Thr), alanine (Ala), proline (Pro), tyrosine (Tyr), valine (Val), methionine (Met), cystine (Cys), isoleucine (Ile), leucine (Leu), phenylalanine (Phe), lysine (Lys) and total amino acids (total AA). The apparent digestibility coefficient was measured for each individual amino acid and for all amino acids together (AMCAA). The experimental design was fully randomized with eight replicates per treatment. Significant (P<0.05) increases were found in the digestibility (%) of most amino acids when feeding 200 ppm RONOZYME® ProAct protease: Ser (4.67), Gly (12.09), His (6.34), Arg (8.74), Thr (10.23), Pro (5.77), Val (4.06), Met (6.32), Cys (10.23) and Lys (3.80) for these amino acids by using 200 ppm protease, with an average improvement (P<0.05) was 7.26 % for all amino acids. For total AA, there was an average 5.3% improvement using the protease (P<0.05). We concluded that the use of this particular protease resulted in an average 5.3% improvement in the utilization of the total AA of soybean meal.

Key Words: enzyme, protease, soybean meal, metabolism, amino acid

222 Use of a protease to enhance the utilization of full fat soybean amino acids by broilers. A. G. Bertechini*1, J. C. C. Carvalho1, F. R. Mesquita1, S. F. Castro1, D. F. Remolina1, and J. O. B. Sorbara2. 1Universidade Federal de Lavras, Lavras, MG, Brazil, 2DSM Nutritional Products, São Paulo, SP, Brazil.

Because of its protein content (35 to 42%) and lipid concentration (18 to 22%), and in spite of a lower amino acid digestibility full fat soybean (FFS) meal is often considered as an alternative for solvent-extracted soybean meal. In this study, a protease was evaluated for its ability to improve the amino acid digestibility of FFS for broilers. The metabolism trial was performed with over a 14-21 day period with Cobb 500 males. Traditional methodology was applied and used 70% basal diet and 30% FFS across two levels of protease (0 and 200 ppm RONOZYME® ProAct). After four adaptation days, total excreta was collected for three days, and dried for analyses of 17 amino acids: aspartate (Asp), glutamine (Glu), serine (Ser), glycine (Gly), histidine (His), arginine (Arg), threonine (Thr), alanine (Ala), proline (Pro), tyrosine (Tyr), valine (Val), methionine (Met), cystine (Cys), isoleucine (Ile), leucine (Leu), phenylalanine (Phe), lysine (Lys) and total amino acids (total AA). The apparent metabolism coefficient was measured for each individual amino acid and for all amino acids together (AMCAA). The experimental design was completely randomized with eight replicates per treatment. With the use of protease, significant (P<0.05) increases the digestibility all individual AA and AMCAA were found for FFS, with the exception of Tyr. Total AMCAA was improved (P<0.05) by 6.15%. Average improvement for the limiting amino acids Met, Lys and Thr was 5.76. In this experiment, this protease significantly increased the digestibility of amino acids in FFS by 6.15%, and presumably improved the nutritional value of FFS as an ingredient for poultry diets.

Key Words: enzyme, protease, full fat soy, amino acid, metabolism
223 The effect of a protease on performance of broilers fed corn-soybean meal diets containing different levels of crude protein and amino acids. M. K. Manangi1, M. E. Wehmeyer1, J. D. Garlich2, N. Odetallah1, and M. Vazquez-Anon1, 1Novus International, Inc., St. Charles, MO, 2North Carolina State University, Raleigh.

A 28 d experiment was conducted to evaluate the effect of supplementation of protease (Bacillus licheniformis PWD-1) enzyme (activity of 600,000 U/g product: CIBENZA™ DP100) preparation to broiler chicks fed isocaloric corn-SBM diets containing different levels of crude protein (cp) and amino acids (aa). A total of 720 Cobb-500 male broiler chicks were assigned to 6 treatments with 12 cages/treatment and 10 chicks/cage. The trial design was a 3 x 2 factorial with 3 levels of crude protein and aa, and with or without protease (source) supplementation. Individual dietary treatments for starter (0-12d) consisted of: T1 with 22.4% cp, 1.19% Dig Lys, 0.89% Dig TSAA, and 0.81% Dig Thr; T2 with 5% less cp and aa compared to T1; T3 with 10% less cp and aa compared to T1; T1 to T3 were without protease supplementation whereas T4 to T6 were similar to T1-T3, respectively, but supplemented with protease @0.05% of the diet. The grower (12-28d) diets were similar to starter diets except for change in cp and aa concentration. The grower T1 diet had 20.26% cp, 1.07% Dig Lys, 0.82% Dig TSAA, and 0.73% Dig Thr. No interaction (P>0.05) was observed for level and source for any of the performance parameters. Both level and source effects (P<0.01) were observed for cGain and adj F:G, whereas only source effect (P<0.01) was found for cFI. In summary, irrespective of dietary cp and aa levels the dietary protease supplementation to broiler chicks under present experimental conditions improved weight gain by 54 g (4.5%), cFI by 52 g (2.74%) and adj F:G by 2.5 points (1.6%) compared to chicks fed diets containing no protease enzyme preparation. Also, the study indicates that this dietary supplemental protease would allow reduction in nutrient (cp, aa) density of broilers diets from 5 to 10% depending on the variable (cGain or F:G).

TM.CIBENZA is a trademark of Novus International, Inc.

Key Words: protease, broiler, TSAA, Lys, Thr


Consumer interest is growing in specialty poultry products including free-range production and alternative turkey products, such as heritage. Heritage turkeys are slow-growing, naturally-mating turkeys and are typically raised with outdoor access. There is interest in sensory attributes of the meat, as well as conservation of livestock breeds/varieties. Our objective was to investigate consumer perception of specialty turkey. A consumer focus group was held to gather data and allow consumers to sample several types of turkey meat including slow-growing heritage turkeys raised with outdoor access, fast-growing turkeys raised with outdoor access, and fast-growing turkeys raised indoors (a conventional, marinated product). Consumers with an interest in natural and local food were targeted by collaborating with a local food organization and outreach through natural food stores. Roasted breast and thigh meat were offered first as an appetizer and then as part of a holiday meal (a marinated product). Consumers with an interest in natural and local food were targeted by collaborating with a local food organization and outreach through natural food stores. Roasted breast and thigh meat were offered first as an appetizer and then as part of a holiday meal (a marinated product). Consumers with an interest in natural and local food were targeted by collaborating with a local food organization and outreach through natural food stores. Roasted breast and thigh meat were offered first as an appetizer and then as part of a holiday meal (a marinated product). Consumers with an interest in natural and local food were targeted by collaborating with a local food organization and outreach through natural food stores. Roasted breast and thigh meat were offered first as an appetizer and then as part of a holiday meal (a marinated product). Consumers with an interest in natural and local food were targeted by collaborating with a local food organization and outreach through natural food stores. Roasted breast and thigh meat were offered first as an appetizer and then as part of a holiday meal (a marinated product).

Key Words: turkey, slow-growing, focus group, market, local food

225 Comparison of nutrient composition in eggs from hens housed in cage vs. range production facilities. K. E. Anderson*, North Carolina State University, Raleigh.

Public perception regarding nutritional quality of free-range vs. cage produced eggs, is based on a belief that eggs produced on free range are nutritionally superior to those produced in cages. This belief stems from a survey conducted on range eggs from 14 different pastured flocks. However, there was no information detailing the strain of hen or diets the range hens received. These analyses were then compared to the USDA nutrient data base for shell eggs. Therefore, this study compared free-range vs. caged shell egg nutrient content examining the effect of the laboratory, production environment, and hen age in a flock of 500 Hy-Line Brown layers. The birds were hatched simultaneously and received the same care, i.e. vaccination, lighting, and feeding regimens, with the only difference being the access to the range. The egg nutrient content of their eggs was analyzed for Cholesterol, Omega 3 fatty acids, Fat (Saturated), Beta Carotene, Vitamin A, and Vitamin E. The same egg pool was divided and sent to 4 different laboratories for analysis. The laboratory was found to have a significant effect on all nutrients in the analysis except for cholesterol. Total fat content in the samples varied (P<0.0001) from a high of 8.88% to a low of 6.76% in laboratory D and C, respectively. Eggs from the range production environment had higher (P<0.05) Total Fat, (P<0.05) Monounsaturated Fats, and (P<0.001) Polyunsaturated Fats than eggs produced by caged hens. Omega 3 levels were also higher (P<0.05) at 0.17% in range eggs vs. 0.14 in cage eggs. The range environment had no impact on cholesterol, 327 and 331 mg/100g in eggs from caged and range hens, respectively. Vitamin A and E levels were not affected by the husbandry to which the hens were exposed but were lowest at 62 wk of age. The age of the hens did not influence the fat levels in the egg, but, cholesterol levels were highest (P<0.0001) at 62 wk of age, 345 mg/100g. Although range production did not influence cholesterol levels in the egg, there was an increase in fat levels in eggs produced on the range.

Key Words: chicken, shell egg, nutrient composition, range production, cage production
226 Impact of cage versus free-range environments on the color of eggs and egg products. P. A. Curtis*1, L. K. Kerth1, and K. E. Anderson2, 1Auburn University, Auburn, AL, 2North Carolina State University, Raleigh.

In this test, the color of the shells, albumen, yolk, angel food cake, and fresh and stored mayonnaise was measured. The Hy-Line Brown strain was utilized to compare the free-range and cage environments within the 37th North Carolina Layer Performance and Management Test to facilitate an unbiased comparison for use in the U.S. Birds were reared in accordance with what environment they were going into and all other layer husbandry, vaccination, lighting and dietary regimens were identical. Eggs were gathered from layers at 17 to 82 weeks of age on a quarterly basis. Once collected, the color measurements of the egg shell, albumen, and yolk were made using a Hunter Miniscan (Roston, VA). Angel food cakes and mayonnaise were made from the egg components. Color measures were taken on the cakes as well as fresh and store mayonnaise. The shells from range eggs were darker (P<0.01) and had more red tones (P<0.001) than the cage eggs. The albumen of the range eggs had less green tones (P<0.0007) than the cage eggs and the albumen was darker (P<0.0001) more red (P<0.0001) and less yellow (P<0.02). Angel food cakes produced from cage eggs were lighter, more white, (P<0.0001) with more yellow undertones (P<0.0006) than angel food cakes produced from range eggs. Fresh mayonnaise produced from range eggs was darker (P<0.0001) with more red (P<0.0001) and yellow (P<0.0001) undertones than mayonnaise produced from cage eggs. However, after the mayonnaise was stored at 50°C for 7 days, the color changed and there was no longer a difference in the L value only a difference in the a* (P<0.0001) and b* (P<0.0001) values. Color of egg components and products were in most cases significantly impacted by the environment in which the eggs were produced.

Key Words: free range eggs, shell color, yolk color, mayonnaise color, angel food cake color

227 Functionality and composition of eggs from layers housed in cage or range environments. L. K. Kerth*1, P. A. Curtis1, and K. E. Anderson2, 1Auburn University, Auburn, AL, 2North Carolina State University, Raleigh.

Consumers are strongly pushing egg producers to move layers out of the traditional cages to range environments. However, little research is available on how these changes impact the functionality and composition of the egg. Therefore, this study compared the proximate analysis and functionality of eggs from range versus cage layers. The Hy-Line Brown strain was utilized to compare the range and cage environment within the 37th North Carolina Layer Performance and Management Test to facilitate an unbiased comparison for use in the U.S. Birds were reared in accordance with what environment they were going into and all other layer husbandry, vaccination, lighting and dietary regimens were identical. Eggs were gathered from layers at 17 to 82 weeks of age on a quarterly basis. Once collected, the functional properties of the egg, such as foaming and emulsification, were tested by measuring albumen pH, angel food cake volume, and fresh and stored mayonnaise emulsion strength. Proximate analysis of the egg was conducted utilizing the SmartTrac and Phoenix System by CEM (Matthews, NC). Angel food cake volume was higher (P<0.05) in cage birds than range birds. However, there was no environmental effect on albumen pH. Proximate analysis of the albumen showed that the range eggs had higher (P<0.05) percentages of solids, fat and protein, as well as a stronger emulsion (P<0.05) in both fresh and stored mayonnaise compared to cage eggs. Additionally, more oil (P<0.05) was recovered from the cage eggs but no effect was found for yolk pH, nor was there a significant impact on solids, fat or protein percentages of the yolk. Results showed that range eggs have a higher percentage of fat in the albumen when compared to those from a cage environment which negatively impacted angel food cake volume. Also, range eggs produce a stronger more stable emulsion. Therefore, it appears that crucial impacts on the functionality of the final product may occur when the environment of the layer is changed.

Key Words: cage eggs, range eggs, functionality, proximate analysis, quality

228 Room environment influence on eggshell bacterial levels of non-washed and washed eggs from caged and cage-free laying hens. R. J. Buhr*1, J. F. Hannah2, J. L. Wilson2, N. A. Cox1, L. J. Richardson1, J. A. Cason1, and M. T. Musgrove1, 1USDA-ARS Russell Research Center, Athens, GA, 2University of Georgia, Athens.

The bacteria levels of non-washed and washed eggs obtained from caged and cage-free hens housed in either wire slats or shaving-covered pens were determined. On 8 days (from 22 to 52 wk), 20 eggs were collected from each pen. Ten eggs/pen were washed with a commercial egg washing solution, while the remaining 10 eggs were not washed prior to sampling the eggshell and membranes for aerobic bacteria (APC), Escherichia coli (E. coli), and coliforms. Non-washed eggs produced in a shavings environment had slightly higher bacteria numbers (APC 4.0 and coliforms 1.1 log10cfu/mL of rinsate) than eggs produced on slats (APC 3.6 and coliforms 1.06 log10cfu/mL), which had significantly higher bacteria numbers than eggs produced in cages (APC 3.1 and coliforms 0.88 log10cfu/mL). Washing significantly reduced APC counts by 1.7 log10cfu/mL, and APC prevalence was reduced from 100, 99, and 98% (shavings, slats, and cages, respectively) to 87% for shavings and to 68% for caged and slat hens. Washing significantly reduced coliform counts by 0.5 log10cfu/mL, and prevalence was reduced from 22.5, 17.5, 12.5% (shavings, slats, and cages, respectively) to 6%. No significant differences were found in APC, E. coli, and coliform counts on eggs from the three housing types after the eggs were washed. At 53 wk hens were moved to triple-deck cages in an all cage room. From 57 to 62 wk, eggs were collected weekly and both non-washed and washed eggs were sampled for only APC. Non-washed eggs produced by hens in cages (previously housed on shavings, slats, and cages) did not differ with APC counts from 0.67 to 0.84 log10cfu/mL. Washing eggs continued to significantly reduce APC counts to below 0.2 log10cfu/mL. APC prevalence for eggs from the triple-deck caged hens after washing was 37% compared to 74% when hens were housed on shavings, slats, or cages. Housing hens in cages with manure removal belts resulted in lower APC for both non-washed and washed eggs (compared to eggs from hens housed in a room with cages, slats, and shavings) and corresponding reductions in human pathogens would further improve food safety.

Key Words: eggshell bacteria, caged hens, cage-free hens, egg washing, APC

229 Improving the safety of eggs using an in-package ozonation process. J. Jensen, A. Donner, S. Konkle, and K. M. Keener*, Purdue University, West Lafayette, IN.

There exists a need to ensure and maintain safe, high quality food from farm to fork. The goal of this research is to evaluate an in-package ozonation process on shell eggs to reduce Salmonella enteritidis. Peri-

Microcracks are very small cracks in the shell surface which are difficult to detect by human graders. Microcracks have both food safety and quality implications since the shell is recognized as the first line of defense for the egg. New technology was developed which utilizes a brief negative pressure and imaging to detect microcracks in eggs. Research has shown the system to have a 99.4% accuracy in detecting cracked and intact eggs. A study was undertaken to determine if quality differences were seen between control and negative-pressure imaged eggs during extended cold storage. Three replicates were conducted with eggs stored at 4°C for five weeks with weekly quality testing. The physical quality factors monitored were: Haugh units, albumen height, egg weight, shell strength, vitelline membrane strength and elasticity, and whole egg total solids. All measurements were conducted on individual eggs (12/treatment/replicate) each week with the exception of whole egg solids which were determined from 3 pools/treatment/replicate each week. Percent whole egg solids was the only significant ($P < 0.05$) for egg weight differences between treatments (23.65% imaged and 23.47% control). There was a significant difference ($P < 0.05$) for egg weight between replicates (60.82 g, 58.02 g and 60.58 g for replicates 1, 2, and 3, respectively). Imaging eggs in the negative pressure system for 17 hours of storage time after treatment showed reductions in L. monocytogenes of greater than 5 log$_{10}$, after reaching the consumer, consequently enhancing food safety without affecting product quality.

Key Words: eggs, ozone, bacterial reductions, PK-1 system, Salmonella enteritidis


The objectives of this study were to determine the anti-Listeria and general antimicrobial properties of nisin, rosemary, and ethylene-diamine-tetra-acetic acid (EDTA) alone and in combination on Listeria monocytogenes inoculated on ready-to-eat vacuum packaged diced turkey ham, and to ascertain the effects of the treatments on pH and objective color. Ready to eat turkey hams were cut into 0.5 cm pieces, inoculated with a L. monocytogenes cocktail containing five strains, and treated with either no treatment and no inoculum (negative control), inoculum only (positive control), 0.5% nisin, 20 mM EDTA, 1% rosemary, 0.5% nisin + 20 mM EDTA, 0.5% nisin + 1% rosemary, 0.5% nisin + 20 mM EDTA + 1% rosemary, or 20 mM EDTA + 1% rosemary. All samples were vacuum packaged, stored for 63 days at 4 ± 1°C and analyzed at one week intervals for microbiology (total aerobes, Listeria monocytogenes and lactic acid organisms), pH and objective color. Nisin, nisin with rosemary, nisin with EDTA and nisin with rosemary and EDTA treatments reduced ($P < 0.05$) L. monocytogenes counts by 4.42, 4.20, 3.73, and 4.11 log CFU/g when compared to the positive control, respectively, on Day 0. L. monocytogenes counts remained less than 3.0 log CFU/g for ham treated with nisin. The EDTA and rosemary treatments alone and in combination were ineffective in inhibiting growth of L. monocytogenes. Although none of the treatments in this study completely eliminated L. monocytogenes, the overall results indicated that ready-to-eat turkey ham can have significantly decreased L. monocytogenes when treated with nisin alone or in combination with rosemary and/or EDTA.

Key Words: nisin, rosemary, ethylene-diamine-tetra-acetic acid, Listeria monocytogenes, turkey ham

231 WITHDRAWN.

232 Nisin, rosemary and ethylene-diamine-tetra-acetic acid affect the growth of Listeria monocytogenes on ready-to-eat turkey ham stored at four degrees Celsius for sixty-three days. A. Ruiz1, S. K. Williams*1, N. Djeri1, A. Hinton2, and G. E. Rodrick1, 1University of Florida, Gainesville, 2USDA ARS Richard B. Russell Agricultural Research Center, Athens, GA.

An integrated extension and research project was conducted to measure the potential inhibitory effects of poultry processing cleaning and sanitation chemicals on aerobic and anaerobic wastewater treatment systems. University of Georgia cooperative extension specialists in Poultry Science and Bio & Ag Engineering were contacted for assistance by a poultry integrator after concern was expressed by a local municipality over potential impacts of antimicrobial chemical release into the wastewater stream on biological sewerage treatment. Poultry processing plants submitted a total of 12 commercial cleaning and sanitation solutions for analysis. The chemicals were divided into 4 sub-groups (quaternary ammonium compounds, acid cleaners, caustic cleaners, and synthetic detergents) of 3 chemicals each based on active ingredients. Each chemical was analyzed for inhibition/toxicity using 3 experiments: aerobic oxygen uptake rate (OUR), anaerobic specific oxygen uptake rate (SOUR), and bioluminescent bacteria toxicity.
Preliminary OUR and SOUR tests revealed that none of the chemicals produced significant inhibitory effects at prescribed use concentrations (i.e., 0.2 – 2.0%). However, to simulate the effects of a potential accidental spill of full-strength solution and provide a means to compare the inhibitory/toxic effect of each solution and chemical sub-group, an effective concentration range was determined for each experiment. Results showed that a commercial acetic (24%) + peroxycetic (1-5%) + octanoic (1-5%) + hydrogen peroxide (5-20%) cleaning solution had the highest inhibitory/toxic effect of the chemicals tested, followed by a caustic sodium hydroxide (15%) + sodium hypochlorite (1-5%) cleaning compound. As a sub-group the quaternary ammonium compounds were the most inhibitory/toxic, ranking 3, 4, and 5 on the list, while the synthetic detergents had the least effect ranking 9, 10, and 12.

**Key Words:** poultry processing, sanitation chemicals, wastewater treatment, oxygen uptake rate, bioluminescent bacteria

234  **Effect of SonoSteam® on reduction of pathogens on chicken carcass.** U. Nonboe*, K. Garde, and B. S. Larsen, FORCE Technology, Brondby, Denmark.

Contaminated food or water as well as insufficient cooking and kitchen hygiene are the typical causes of human *Campylobacter* and *Salmonella* infections. These infections pose an increasing health risk to humans and since poultry is the most common source, intervention programmes have been initiated to help eliminate the occurrence of *Campylobacter* and *Salmonella* on fresh poultry products. SonoSteam® is a new chemical-free technology for microbial decontamination of surfaces using a combination of ultrasound and steam. Due to short treatment time the method is applicable on heat sensitive surfaces such as e.g. freshly slaughtered poultry. The efficiency of the technology to reduce the number of pathogens on the surface of freshly slaughtered chickens has been tested in industrial pilot equipment designed for implementation in a poultry slaughterhouse. Tests at a poultry slaughterhouse revealed that *Campylobacter* in 10 g skin breast samples were significantly reduced with 1,29 log_{10} units from 2,11 to 0,82 log cfu/g (n=25) on SonoSteam® treated chickens. *Salmonella* were significantly reduced with 2,20 log_{10} units from 6,75 to 4,55 log cfu/carcass (n=10) in full carcass rinse and with 3,31 log_{10} units from 4,02 to 0,74 log cfu/25 cm² (n=10) in internal swab samples. Shelf-life tests indicated that numbers of *Pseudomonas* and Total Viable Counts (TVC) did not differ significantly between SonoSteam® treated chickens compared to non treated chickens throughout the test period (Day 0 to Day 9). Data from each day even point towards that *Pseudomonas* and TVC on the SonoSteam® treated chickens were lower than control chickens. A visual evaluation showed that SonoSteam® treatment did not considerably affect the appearance of freshly slaughtered chickens, neither from an overall point of view, nor when specifically inspecting the wings, thighs and chests. In conclusion, SonoSteam® has proven to significantly reduce pathogens on freshly slaughtered chicken carcasses without causing considerable sensory changes. In addition, tests indicated that SonoSteam has the potential prolonging the shelf-life period of fresh chicken products.

**Key Words:** chicken, decontamination, pathogens, *Campylobacter*, *Salmonella*

235  **Prevalence, serotype and antimicrobial resistance of *Salmonella* isolated from commercially processed broiler carcasses.** M. E. Berrang*, J. S. Bailey, and P. J. Fedorka-Cray, USDA-ARS-Russell Research Center, Athens, GA.

This study was undertaken to determine the prevalence, serotype and antimicrobial resistance profiles of *Salmonella* on broiler carcasses collected from commercial processing plants. Twenty US commercial processing plants representing eight integrators in thirteen states were included in the survey. In each of four replications, ten carcasses from one flock were collected at re-hang and ten more at post-chill; each carcass was sampled by whole carcass rinse. *Salmonella* were isolated from carcass rinses using standard cultural techniques, serotype was determined and the resistance to 15 antimicrobials was measured. Overall, *Salmonella* was detected on 72 % of carcasses at re-hang (ranging from 35 to 97 %) and 20 % post-chill (ranging from 2.5 to 60 %). In every instance, a significant (p < 0.05) decrease in *Salmonella* prevalence was noted between re-hang and post chill which can be attributed to processing interventions. The four most common serotypes accounting for 64 % of all *Salmonella* isolates were: Kentucky, Heidelberg, Typhimurium and Typhimurium var 5-; most isolates of Kentucky (52 %), Heidelberg (79 %) and Typhimurium (54%) were susceptible to all antimicrobial drugs tested. However, only 15 % of the Typhimurium var 5- isolates were pan-susceptible; more than half of the isolates of this serotype were resistant to 3 or more drugs. No isolate of any serotype exhibited resistance to amikacin, ceftriaxone, ciprofloxacin or the combination of trimethoprim/sulfamethoxazole. These data demonstrate that although processing lessens carcass contamination with *Salmonella*, antimicrobial resistant isolates may still be present.

**Key Words:** antimicrobial resistance, broiler, *Salmonella*, serotype, processing

236  **Evaluating different plate media for culturing and quantifying *Campylobacter* ssp. in broiler litter.** A. S. Kiess*, H. M. Parker, C. D. McDaniel, and J. C. Hamby, Mississippi State University, Mississippi State.

Poultry is a major reservoir for *Campylobacter*, the leading cause of food borne illness in the USA, but how broilers become initially colonized is still under debate. Broiler litter is a potential source, but the best technique for quantifying *Campylobacter* from litter is still unknown. Therefore, our objectives were to determine if one media is more selective for quantifying *Campylobacter* and if enrichment allowed for the detection of stressed or viable but non-culturable cells from litter samples. In this trial, 5 medium and 2 plating methods were used to enumerate *Campylobacter* from broiler litter. The media used were Campy Line (CL), Campy Cefex (CC), modified Campy Cefex (mCC), Campylobacter Agar Plates (CAP), and modified Charcoal Cefoperazone Deoxycholate (mCCDA) agars. Litter samples were obtained from a commercial broiler house. Each sample was equally divided and diluted 10-fold into peptone, for direct plating, or 4-fold into *Campylobacter* enrichment broth. Samples diluted in peptone were direct plated onto each media and incubated under microaerophilic conditions for 48 h at 42° C. Samples diluted in enrichment broth were incubated under the same conditions for 24 h, then further diluted to 10-fold prior to plating. Plates from enriched samples were incubated for an additional 24 h after plating. After incubation, all plates (direct and enriched) were counted and presumptive positive colonies were confirmed using a *Campylobacter* latex agglutination kit. Results indicate that CAP agar was able to isolate *Campylobacter* from the commercial broiler house sampled, even though the incidence of *Campylobacter* was low. There was no difference in bacterial counts between samples directly plated or enriched before plating (P=0.95). Overall bacterial counts were higher for CC, mCC, and mCCDA when compared to CAP, and CL (P<0.0001).

In conclusion, enriched samples did not improve the detection or quantification of *Campylobacter* in poultry litter. One selective media was...
able to detect *Campylobacter* however, quantification was not possible due to the low incidence within the house.

**Key Words:** poultry litter, media, enrichment broth, *Campylobacter*, Food safety

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**237 WITHDRAWN.**

**238 Effects of dietary copper, citric acid and microbial phytase supplementation on digesta pH, ileal and carcass microflora of broiler chickens fed a low available P diet.** A. Aydin¹, A. Y. Pekel*¹, G. Issa¹, G. Demirel¹, and P. Patterson², ¹Istanbul University, Faculty of Veterinary Medicine, Istanbul, Turkey, ²The Pennsylvania State University, State College.

An experiment conducted to study the effects of microbial phytase (PHY), citric acid (CA) and copper proteinate (Cu) supplementation in broilers (13 to 42 d of age) fed a low available phosphorus diet (0.25 %) on ileal and carcass microflora of broiler chicks. A factorial arrangement (2 × 2 × 2) was used to evaluate 2 levels of PHY (0 and 750 units/kg), Cu (0 and 250 ppm) and CA (0 and 3 %). Addition of 750 FTU microbial phytase significantly reduced the log10 counts for total anaerobic bacteria, *E.coli* and Coliform bacteria in the ileal digesta of chicks (0.28, 0.21, 0.68 log10, respectively). Microbial phytase supplementation did not affect the *Campylobacter*, *Enterococcus*, *Lactobacillus*, *Clostridium* or *Salmonella* counts in the ileal digesta but significantly (*P < 0.01*) increased the growth and enumeration *Staphylococcus* on the carcass of the birds. Cu supplementation has no effect on pH or microbial count of bacteria in the ileal content of the broilers. However, Cu supplementation produced significant increases in the populations of *Staphylococcus* (*P < 0.01*) and lactic acid bacteria (*P < 0.001*) on the carcass of broilers also. CA supplementation decreased the population of Coliform bacteria in the ileal content significantly (*P < 0.05*) but increased the population of *Staphylococcus* (*P < 0.05*), *Campylobacter* (*P < 0.05*) and lactic acid bacteria (*P < 0.001*) on the carcass of broilers respectively. Findings of the current study indicate that neither 3% CA addition nor Cu supplementation to broiler diets have any significant positive effects on the certain pathogenic bacteria populations in the ileum or on the carcasses, but PHY supplementation might effectively lead to some changes in ileal microbial populations by decreasing some pathogenic bacteria populations. However future research on how microbial phytase affects birds intestinal bacterial population could provide new approaches for microbial reduction in poultry.

**Key Words:** copper, citric acid, microbial phytase, microflora, broiler

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**Student Workshop: The Dos and Don’ts of Writing Pubs**

**239 The dos and do nots of writing for the trade media.** R. J. Smith*, Feedstuffs Newspaper, Minnetonka, MN.

In writing an article or news release for the trade media, it’s critically important to remember that most readers—and most editors who would be handling your material—will not be educated, experienced or trained in the scientific concept that you are addressing. So “de-jargonize” and “de-scientificize.” Other “de’s” include “de-fluff,” “de-commercialize” and “de-opinionize.” Make sure that your first two paragraphs provide “the five w’s”—telling the who, what, when, where and why of your message, and keep your article or news release as short as possible. Always provide graphics—charts, tables, photos—and always provide contact information. Finally, if you are writing an article or news release for the general media, such as a local newspaper or a national publication, everything above should be multiplied by two.

**Key Words:** trade media, five w’s, short, graphics, contact information

**240 Writing and publishing an effective journal article from start to finish.** K. J. Navara*, University of Georgia, Athens.

Journal articles represent the currency for scientific success. Without the dissemination of our findings to our scientific peers, our work may go unnoticed and important advancement within the field would not be made. This is why the publication of journal articles is crucial for both the success of an individual in academia as well as the success of the scientific field as a whole. Preparing a manuscript from start to finish, persevering through the review process, and finally getting the work accepted and published is not easy. However, there are many tips that can help you to manage the writing process efficiently, correctly target your audience, manage and respond to reviewer comments, and produce a successfully published manuscript. A full understanding of the academic publication process is the first crucial step. In a broad sense, knowledge about how your manuscript will be handled, what editors are looking for, and how to respond to reviewer comments can mean the difference between acceptance and rejection of a manuscript. The detailed aspects of the writing process, including perfecting the scientific prose of the manuscript, formatting the manuscript correctly, and preparing effective figures are also extremely important towards effectively conveying an overall message to the reviewers and eventually a specific scientific audience. Tips for getting a scientific journal article started, highlighting and focusing the intended message, and preparing a submission package that will be attractive to editors and reviewers will be discussed.

**Key Words:** scientific writing, publication, scientific prose, manuscript, format

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**241 Technical editing and manuscript preparation.** S. M. Pollock*, Federation of Animal Science Societies, Champaign, IL.

After a manuscript undergoes peer review and is accepted for publication, it is retrieved from the peer-review system for technical editing and printing in a journal. The process begins with gathering all the relevant files and processing the figures. Next, the files are marked up, edited, laid out, and sent to authors as proofs. This presentation will focus on the technical editing processes and how to use this information to prepare a manuscript for publication.

**Key Words:** technical editing, manuscript preparation

This study investigated the physiological stress of hens subjected to a conventional (feed removal) and four alternative (non-feed removal) molting programs compared to non-molted hens. Metabolic changes to blood plasma cholesterol, glucose, triglycerides, high-density lipoproteins (HDL) and low-density lipoproteins (LDL) were assessed at 79, 84 and 92 wks of age in a group of Hy-Line W-36 hens (n=216, 12 replicates/treatment) induced to molt at 80 wks of age. The treatments consisted of a conventional molt (10 d fasting followed by cracked corn for 8 d and pullet developer diet for 10 d) and alternative molting programs: soy hulls based diet (12% CP, 1455 ME kcal/kg, 1.38% Ca) offered for 14 d followed by cracked corn for 4 d and a pullet developer diet for 10 d, and the other three molt regimens consisted of feeding soy hulls during 4, 8 or 12 d followed by 10, 6 or 2 d, respectively, of a soy hulls-based diet, 4 d of cracked corn and 10 d pullet developer diet. A non-molted control group of birds were fed a laying hen diet during the experimental period. Samples of blood (5 mL) were collected from each hen through the jugular vein and immediately processed using a commercial kit. All data were subjected to ANOVA considering the effects of age, treatment and interactions. Significant treatment x age effects (P<0.001) in triglyceride and HDL concentrations were observed at 84 wks of age. Molted hens showed lower triglyceride levels than control birds regardless of molt regimen. Triglyceride levels averaged 27.58 mg/dL compared to 156.2 mg/dL showed by control hens. HDL concentration, regardless of the molt treatment, birds exhibited higher levels (88.75 mg/dL) compared to control hens (39.33 mg/dL). No differences were observed among treatments regarding the other blood plasma metabolites. Our results showed that similar physiological stress responses are occurring during molt when considering the blood metabolites, triglycerides and HDL.

Key Words: alternative molting, behavior, laying hens, soy hulls


A study evaluated behavioral changes of laying hens submitted to four non feed removal molts compared with feed removal molting methods and full-fed, control hens. The treatments consisted of a conventional molt (10 d fasting followed by cracked corn for 8 d and a pullet developer diet for 10 d) and alternative molting programs: soy hulls-based diet (12% CP, 1455 ME kcal/kg, 1.38% Ca) offered for 14 d followed by cracked corn for 4 d and a pullet developer diet for 10 d, and the other three molt regimens consisted of feeding soy hulls during 4, 8 or 12 d followed by 10, 6 or 2 d, respectively, of a soy hulls-based diet, 4 d of cracked corn and 10 d pullet developer diet. A non-molting control group of birds was fed a laying hen diet during the experimental period. Molt started when birds were 80 wks-old and video recordings were taken during molt at 80, 81, 82 and 83 wks of age. There were 48 birds/treatment and the behavioral activities were recorded considering two categories (4 birds) for 10 min, from 10 to 16h (288 hen observations total), and later scored in 10 s instantaneous behavioral states. The behavior patterns observed were resting, preening, non-aggressive pecking, walk, drink, feeder, head movement (alert) and still. Data were analyzed using logistic regression considering multinomial distribution for the response variables. Aggressive pecking was not observed in this study. Results indicated effect (P<0.0001) of treatment on bird behavior. Regardless of type of molt, birds showed some frustration through activities of resting, preening and non-aggressive pecking compared to control birds (average frequency of 57.4% vs 30.9%, respectively). Age effect was observed (P<0.001) with molted birds showing behavioral patterns that coincided with a decline in frustration activities, and an increase in alertness (still, walk, head movement) and search for food as the molt proceeded until 83 wks of age.

Key Words: alternative molting, behavior, laying hens, soy hulls


There is increasing interest in using natural products as dietary components to induce molting in commercial laying hens. This study evaluated the utilization of fungus myceliated grain as a safe and effective alternative for inducing molt, enhancing immunity, reducing Salmonella growth and returning to egg production. Laying hens were subjected to one of five treatments (trts): 1) Non-fed (NF); 2) Full-fed (FF); 3) Fungus myceliated meal (FM); 4) 90% fungus myceliated meal + 10% standard layer ration (FM-90) and 5) 90% alfalfa meal + 10% fungus myceliated meal (AF-90). Each treatment condition was replicated nine times during a 9-d molt period. Egg production for trts 1 and 3 ceased completely by d 5; whereas, hens in trts 4 and 5 ceased egg production by d 6. Body weight loss decreased significantly (P<0.05) in trts 1 (57%), 2 (8%), 3 (35%), 4 (37%) and 5 (44%). Ovary weights of hens fed all molting diets decreased significantly from the full-fed control but did not differ significantly (P>0.05) from each other. Salmonella population in the crop, ovary and ceca from hens differed significantly (P<0.05)
among treatments. Return to egg production differed between trts with higher production beginning in trt 3 and ending in trt 5. Antibody titers did differ (P<0.05) among trts. From these results, fungus myceliated meal appears to be a viable alternative to conventional feed withdrawal and other methods for the successful induction of molt and retention of postmolt performance.

Key Words: molting layers, fungus myceliated grain, Salmonella, weight loss

245P  Behavioral effects of different alternative molting strategies. R. L. Dennis*1, R. M. Marchant-Forde2, D. C. Lay3, M. E. Wilson3, A. G. Fahey4, and H. W. Cheng5. 1Purdue University, Department of Animal Science, West Lafayette, IN, 2Livestock Behavior Research Unit, USDA-ARS, West Lafayette, IN, 3West Virginia University, Division of Animal and Nutritional Sciences, Davis College, Morgantown, WV, 4University College Dublin, School of Agriculture, Food Science and Veterinary Medicine, Dublin, Ireland.

Molting is performed through reduction in light:dark ratio and dietary changes such as low energy diet or complete withdrawal of feed. However, the effects of these practices on bird welfare have not been fully examined. We examined the behavioral effects of four different molting diets. Hens were assigned to one of four molting diets for 28 days: MGA diet (standard layer diet with 4.0 mg/bird/day melengesterol acetate), feed withdrawal (FW; 9 days of feed withdrawal followed by 19 days of standard layer diet), low energy diet (LE; 94% wheat middlings), low sodium diet (LS; 0.05% sodium), or a control diet (C; standard layer diet). Behavioral observations were taken from 18 cages per treatment (2 birds/cage; cage is the experimental unit) on days 2, 11 and 29. On day 2, hens on the FW and LE diets exhibited significantly less feeding behavior compared to C birds (P<0.05), FW birds exhibited almost no pecking at the feeder during this time of feed withdrawal. On day 11, after feed was returned to FW birds, these hens spent more time eating than C birds (P<0.05). No differences were found in time spent eating on day 29 (P>0.05) following the return of layer rations. Birds on FW, LE and LS diets displayed more vigilance behaviors on day 2 than C birds (P<0.05), but on day 11 FW birds were less vigilant than C hens (P<0.05). Similarly both FW and LE birds exhibited significantly more stereotypic cage pecking than C birds on day 2 (P<0.05). For all behaviors measured there was no significant difference between MGA and C birds (P>0.05). Observant or vigilance behaviors increase during times of increased social stress, including increased risk of predation and limited food supply. Stereotypic pecking is a maladaptive behavior that may be misdirected foraging behavior, as the birds exhibiting these are eating less during this time period. Increased vigilance and stereotypic behaviors after introduction to novel diets may be interpreted as increased stress in birds receiving FW, LE and LS diets. Birds receiving MGA, however, displayed similar behavioral patterns to C birds, suggesting that MGA may be a less stressful molting strategy.

Key Words: molting layers, fungus myceliated grain, melengesterol acetate

246P  WITHDRAWN.


A longitudinal study is being conducted to evaluate the productivity, health and welfare of 3 strains of laying hens (Shaver White (SW), Lohmann Lite (LL), Lohmann Brown (LB)) housed in conventional cages, and furnished colony units, over 2 production cycles. A total of 72 conventional cages (60cm X 50cm) (n=24 per strain) each house 5 hens. Colony cages (240cm X 110cm) (n=12; 4 per strain), which house 40 hens, contain a nestbox (60cm x 55cm), 3 hardwood, semi-circular perches (240cm X 5cm) and a dustbathing facility (60cm x 20cm). Hen performance is being monitored by assessing daily egg production, location of lay (nestbox, cage, dustbath), egg quality (egg and shell weight, specific gravity, albumin height, eggshell breaking force, shell thickness) at 28, 36, 44, 52, 60, 68 and 76 wks, as well as feed consumption and conversion efficiency, and calcium balance at 28, 44 and 76 wks. Hen bone health is being evaluated through palpation for fresh and healed breaks, by x-ray analysis, and by measuring bone density and breaking strength at 36, 57 and 77 wks, and at processing (80 wks). Meat quality will also be assessed at processing. Data are analyzed using GLM for mixed effects, and effects are significant at P<0.05. Preliminary findings indicate significantly higher early egg production for LL and LB birds, than SW hens (P<0.02). LB hens also produce larger eggs (P<0.05). However, no treatment differences in egg production or quality measures have been determined. Treatment or strain differences in bone fractures, as determined through palpation and x-ray analysis, have not been detected. Subsequent findings from this study will aide in determining the extent to which movement and bone loading opportunity in furnished colony cage systems will impact bone health, egg quality and hen well-being, throughout the production cycle and at end-of-lay, as well as strain suitability to a large group, cage housing system. Consequently, these findings will provide valuable information regarding the economic and welfare implications of housing hens in alternative cage environments.

Key Words: laying hen, conventional cage, furnished cage, productivity, welfare


Perching is the natural position in which birds sleep and rest, and the presence of perches may improve the health and well-being of pullets housed on the floor, regardless of density. The objective of this study was to determine what effect the presence of perches may have on pullet performance while implementing the practice of beak trimming and varying pullet density. The study consisted of twelve treatment combinations derived from the factorial arrangement of 2 beak trimming methods (trim vs. no trim) x 2 perch treatments (perches vs. no perches) x 3 densities (8, 10 and 12 pullets/m2). The pullets were randomly allocated to the treatments in a randomized complete block design. Body weight, cumulative feed consumption, and pullet uniformity were determined weekly through 16 wk of age. Mortality was recorded daily. Heterophil to lymphocyte ratios (H:L) were measured at 2, 4, 7, 13 and 16 wk of age. Body weights were not significantly different with or without the presences of perches, or among pullets stocked at the three densities. The non-beak trimmed pullets had heavier body weights (P<0.05) as compared to those that were beak trimmed. Feed consumption was not affected by the presence of perches. Pullets that were not beak trimmed

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and housed at the lowest density (8 birds per square meter) consumed more \( (P < 0.05) \) feed than the other density treatment combinations. Mortality, pullet uniformity and heterophil to lymphocyte ratios were not affected by any of the treatments. In conclusion, perches had no significant effect on pullet growth parameters when submitted to the practice of beak trimming or placed under various stocking densities.

Key Words: pullets, beak trimming, density, stress, perches

249P Evaluation of different water flow rates of nipple waterers on broiler productivity. A. G. Gernat*1 and J. L. Grimes 2, 1Escuela Agrícola Panamericana/Zamorano, Tegucigalpa, Honduras, 2North Carolina State University, Department of Poultry Science, Raleigh.

Watering systems utilized in broiler production can impact bird performance. Many companies have increased water flow rates (WFRs) in their nipple waterer (NW) system during brooding above the manufacturers recommended level, then make adjustments in WFRs during the grow period. This has increased moisture and early caking problems in litter. The objective of this study was to determine how birds perform on different WFRs rates during brood and grow periods while observing litter condition. Seven WFR treatments were evaluated for birds reared from 1-42 d of age: 50 ml/min; 75 ml/min; 100 ml/min; 120 ml/min; 50 ml/min 1-7 d increasing to 75 ml/min 8-42 d; 75 ml/min 1-7 d increasing to 100 ml/min 8-42 d; and 100 ml/min 1-7 d increasing to 120 ml/min 8-42 d. Chickens were identified and randomly allocated in a randomized complete block design. Body weight (BW), cumulative feed consumption (FC), feed conversion (FCON) (feed: BW), litter moisture (%) and litter moisture under the NW were determined weekly to 42 d. Mortality (MO) was recorded daily. Birds tended to have heavier BW on the higher WFRs (75, 100 and 120 ml/min) in comparison to the lowest WFR (50 ml/min). No differences were observed for FC, FCON or MO. Increased water consumption \( (P < 0.01) \) was observed as birds aged to 42 d. Birds on treatments with higher WFRs (100 and 120 ml/min) and treatments which were increased to higher WFRs (75-100 ml/min and 100-120 ml/min) consumed greater amounts of water as compared to birds receiving lower WFRs (50 and 75 ml/min). A WFR of 50 ml/min resulted in the lowest litter moisture. The 100 and 120 ml/min WFRs resulted in higher percent litter moisture \( (P < 0.01) \) under the NW but decreased at the end of the growing period. In conclusion, as birds become heavier, they attempt to consume larger amounts of water benefitting from NW with greater WFRs. As WFRs increase, litter moisture under the NW will initially increase but then decrease as the birds age.

Key Words: broiler, nipples, water flow, litter, water consumption

250P Quality of poultry litter submitted to different temperatures. V. K. Silva, J. D. T. Silva, and V. M. B. Moraes*, São Paulo State University, Jaboticabal, SP, Brazil.

Fourteen hundred forty day-old male broiler chickens (Cobb-500®) were reared in three different climate chambers up to 42 d, receiving pre-diet (1 to 7 d) added or not added yeast extract (YE) and/or prebiotic (PRE). Each chamber was divided into 16 boxes with 30 kg of shavings/box and 4 replicates with 30 birds per box. All chickens received the same diet from the eighth day. The design was completely randomized in a factorial arrangement 3 x 4, with the factors temperature (high - HT 32°C, control - CT 25°C and low - LT-20°C) and diets (D1 - control diet (CD); D2- CD + YE, D3- CD + PRE and D4- CD + YE + PRE). At 42 d samples of poultry litter were collected for analysis of crude protein (CP), dry matter (DM), humidity (H), potential for volatilization of ammonia (PVA) and pH. The poultry litter was removed and weighed to determine the total quantity of residue (TQR). The diets did not influence the variables. The temperatures did not affect the CP and the TQR. MS was higher at CT (79.27), followed by LT (64.16) and HT (59.54). The highest humidity was found at HT (40.46), followed by LT (35.84) and CT (20.73). The greater PVA was observed at HT (23.87) and the less at LT (15.31); however the PVA at CT (16.58) did not differ from the others. The highest pH was found at HT (8.90) and the lowest at CT (8.71), and the pH of the LT (8.83) did not differ from the others. It is concluded that the high temperatures affected the quality of the poultry litter.

Key Words: ammonia, ambient temperature, pre-initial diet, quality of poultry litter

251P Injuries of broilers submitted to different temperatures. V. K. Silva, J. D. T. Silva, and V. M. B. Moraes*, São Paulo State University, Jaboticabal, SP, Brazil.

1440 male broiler chickens were raised in three different climate chambers up to 42 days. Each chamber was divided into 16 boxes with 30 kg of shavings/box, and 30 birds per box. The design was completely randomized, with high temperatures (HT-32°C), control (CT-25°C) and low (LT-20°C). At 42 days we evaluated the scores of injuries of the hock and foot pad of 10 birds in each replicate. The injuries were evaluated at 0 - no injuries, 1 - scattered points of inflammation, 2 - little inflammation, 3 - average inflammation, 4 - high inflammation and 5 - very severe injury, and the occurrences were expressed as a percentage. The hock injuries showed score 0 \( (P<0.01) \) and 1 \( (P<0.01) \) more often at CT \( (5.00 \text{ and } 33.44, \text{ respectively}) \) and LT \( (16.25 \text{ and } 46.25, \text{ respectively}) \) and these scores were less often at HT \( (0.31 \text{ e } 15.31, \text{ respectively}) \). Score 2 \( (P<0.05) \) was seen more times at HT \( (46.25) \) and less times at LT \( (25.31) \). There were no differences between the CT and HT or between CT and LT for this score. The scores 3 \( (P<0.05) \) and 4 \( (P<0.05) \) were more often at CT \( (20.31 \text{ and } 10.00) \) and HT \( (27.19 \text{ and } 9.37) \), and less often at LT \( (9.88 \text{ and } 1.56) \). The temperatures had no influence over the score 5 \( (P>0.05) \). For foot pad injuries more occurrences of score 0 \( (P<0.01) \) were found at LT \( (59.15) \), followed by the AT \( (32.41) \) and HT \( (4.61) \). The score 1 \( (P>0.05) \) was observed more often at CT \( (19.22) \) and LT \( (17.30) \) and less often at HT \( (9.29) \). The temperatures had no influence over the score 2 \( (P>0.05) \). The occurrence of score 3 \( (P<0.05) \) was more often at HT \( (27.00) \) than at LT \( (13.21) \). The score 4 \( (P<0.01) \) occurred more often at HT \( (26.53) \) followed by CT \( (7.73) \). Score 5 \( (P<0.01) \) was seen more times at HT \( (12.91) \) and less times at CT \( (1.43) \). It is concluded that the temperature affected the degree of injury in the hock and foot pad of broilers, since the birds showed less injuries at the cooler temperatures.

Key Words: carcass injuries, quality of poultry litter, temperature


This study evaluated the effect of passionflower in the diet on tonic immobility time and injuries against female quails in the reproductive period. A total of 24 female quails and eight male were mated at a ratio of one male for every three females, at 35 days of age, and distributed in completely randomized experimental design for a period of 120 days.

This study evaluated the effect of passionflower in the diet on tonic immobility time and injuries against male quails during the reproductive period. A total of 24 female quails and eight male were mated at a ratio of one male for every three females, at 35 days of age, and were distributed in a completely randomized experimental design for a period of 120 days. The quails were subjected to two treatments (without and with 500 mg of *Passiflora alata*/kg) with four replicates, and were housed in cages in a shed for quails. The tonic immobility time, expressed in seconds, and the injuries to the head and body, expressed as a percentage, were evaluated at the end of each production cycle of 14 days, totaling seven tests. For the statistical analysis of the results, we used the GLM procedure of SAS™ to assess tonic immobility and Chi-square for the results of injuries. The quails fed with passionflower stayed less time in tonic immobility (10.92 and 24.25, respectively; *P*<0.05) and showed fewer injuries to the head (29.17 and 95.83, respectively, *P*<0.01) and body (12.50 and 54.16, respectively, *P*<0.05) when compared to the quails that did not receive passionflower in the diet. According to the results, we can conclude that the passionflower had the anxiolytic and sedative effect, decreasing the tonic immobility time and the injuries in quails. Funding: Fapesp and CNPq

Key Words: *Coturnix coturnix japonica*, injuries, *Passiflora alata*, tonic immobility

254P The effects of social and environmental enrichments on leg strength and welfare of tom turkeys. P. A. Weber*, S. Scheideler, and L. Robeson, University of Nebraska, Lincoln.

The effects of broiler chick addition on the reduction of early mortality due to starve-outs and the effects of providing environmental enrichment on leg strength of tom turkeys were determined. This experiment was conducted in two phases. Phase one utilized 248 one-day-old turkey poult and eight three-day-old broiler chicks. Four pens of thirty two turkey poult and three 3-day-old broiler chicks were placed together with no human intervention for the treatment groups. Body weights, feed intake and behavioral measurements were collected. Phase two began immediately following phase one. The draft shields and broiler chicks were removed from pens to allow poult to have access to 114 ft ² area (3.5 ft²/bird). In four pens, an enrichment containing two adjustable ramps and a platform to perch on was placed in the center of the pen. One feeder was placed above the enrichment and another feeder was placed on the floor opposite an automatic hanging waterer. The remaining four pens remained barren except for two feeders and one automatic waterer. Body weights, feed intake, gait scores, bone quality (tibial dyschondroplasia scores, bone ash, bone tibial length and diameter), carcass yield percent, mortality and behavior measurements were made. No significant treatment differences were observed for feed intake, body weights and mortality during phase I. Behavioral results indicated that with broiler addition, poult spent equal time eating, drinking, active and resting as traditionally raised birds. It could be concluded from these results that broiler addition to a flock of poult could minimize human intervention in the setting process saving time and money for the producers. No significant differences were found in body weights, feed intake, gait scores, bone quality measurements, carcass yield percent, mortality or behavior due to the platform enrichments. Environmental complexity of this magnitude did not increase leg strength in tom turkeys.

Key Words: turkeys, welfare, enrichments

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**ABSTRACTS OF PAPERS**

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**Poster Session: Environment and Management**


Despite the degree of environmental protection and economic feasibility offered by traditional poultry houses, the practice of housing laying hens in cages has been widely criticized worldwide due to the public perception that caged housing systems provide poor welfare for laying hens. As a result of this increasing public interest in laying hen welfare, alternative management systems such as free-range environments have been resurrected. To examine differences in production performance between hens reared in caged vs. range environments, a single cycle production performance for Hy-line brown layers was monitored from 17 to 82 weeks of age. Three range replicate flocks of 75 hens and 4-72 hen replicates in cages consisting of 513 flockmates were randomly assigned to either environment. Pullets were reared to prepare them for the environment they would be entering, in growing cages or on litter, for caged and range pullets, respectively. All other rearing procedures, dietary regimens, and vaccinations were identical for cage and range-reared flocks. Cage birds had significantly better (*P*<0.05) feed conversion rates and higher (*P*<0.01) daily egg masses respectively compared to free-range hens (0.51±0.005 vs. 0.49±0.010) and (52.5±0.34 vs. 49.4±0.68). Additionally, cage birds produced significantly greater (*P*<0.001) numbers of HH (357±5.2 vs. 304±10.5) and (P<0.0001) HD eggs (81.9±0.36 vs. 77.7±0.72) compared to free-range hens. Total mortality was significantly higher in free-range hens (28.4±3.50 vs. 8.9±1.75) (*P*<0.0001) although no significant differences in egg weights or sizes were observed. Caged hens produced a greater (*P*<0.05) number of...
Grade A eggs (90.0±0.76 vs. 85.9±1.52) while free-range hens produced a greater (P<0.0001) number of Grade B eggs (5.9±0.47 vs. 11.5±0.94). Lastly, there was no overall difference in the number of checks or losses between the two groups. This indicates that the cage environment had much better overall performance than their range flockmates.

**Key Words:** chicken, free-range, caged, egg, production

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### 256P Optimizing broiler breeder pullet uniformity through maternal management

D. E. Holm1, F. E. Robinson1, R. A. Renema1, M. J. Zuidhof2, and V. E. Carney2, 1University of Alberta, Edmonton, AB, Canada, 2Alberta Agriculture and Rural Development, Edmonton, AB, Canada.

The effect of 5 rearing feed management practices on pullet BW uniformity, carcass traits and feed intake was assessed in Aviagen TP16 broiler breeders (BB). Chicks were placed in floor pens and managed according to Ross 308 guidelines to 3 wk of age when individual measurements of BW, shank length and breast width were taken. A total of 1,200 BB chicks were assigned to treatments (tmts): control, fibre (+25% oat hulls; ME=2200 kcal/kg & CP=11.4%), scatter (pelleted), skip-a-day (fed double amount on alternate d) and sorted. Standard rearing diet was used as the base for control, scatter, skip-a-day and sorted tmts (ME=2865 kcal/kg & CP=15%). Pelleted feed was scattered on the pen floor. Other tmts were fed a mash diet in pan feeders. Each tmt had 2 replicate sets of pens of 40 chicks/pen. Pullets were individually weighed every 4 wk; sorted birds were redistributed based on BW into low (below target), standard (target) and high (above target) pens. At 22 wk 450 pullets were dissected to assess fleshing, fatness and reproductive morphology.

Feed tmt significantly influenced 22 wk BW uniformity (p<0.0001). BW CV was significantly lower in sorted (6.2%), scatter (10.9%) and skip-a-day (12.8%) tmts compared to the control BB (15.4%). Improvements in BW CVs in sorted and scatter tmts (compared to control) started at 7 wk of age while skip-a-day did not improve until 19 wk of age. Fibre and control tmts did not differ in uniformity during the rearing phase. Breast width uniformity was higher in sorted (CV=5.5%) and scatter (CV=7.7%) tmts compared to the control (CV=9.8%; p<0.0001). Sorted, scatter and skip-a-day improved the uniformity of P, minor (p<0.0003), P, minor (p=0.0001) and liver (p=0.0073) weights compared to control. Sorted had the lowest CVs for all measures. Total feed consumption during the rearing phase was higher in the fibre tmt (10.45 kg) compared to the control (8.11 kg; p=0.0001), while sorted (8.19 kg), scatter (7.98 kg) and skip-a-day (8.37 kg) tmts were not different from the control. This study indicated that pullet flock uniformity can be improved by using sorted or scatter feed management practices without increased feed consumption.

**Key Words:** broiler breeders, uniformity, management

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### 258P Effects of warming end of lay broiler breeder eggs during the storage period on hatchability

T. Gamble*, J. Dowden, and D. Ingram, Louisiana State University, Baton Rouge.

This research was conducted to determine if any improvements in hatchability could be obtained by daily warming during storage of end of lay broiler breeder eggs, 6 experiments were conducted using Hubbard classic broiler breeders 51-58 wks of age. In all trials, 1,440 freshly laid eggs from 2 flocks were used. Eggs were transported for 4 hrs to the LSU farm where they were randomized and numbered, then put into a cooler operating at 15°C and 60% RH overnight. Eggs then began daily warming treatments on the following day. Trials 1-3 eggs were warmed for 0, 30, 60, 90, 120, and 150 min daily for 3d. After the 3rd day eggs were put back into the cooler overnight and were set on the 4th day of storage. Trials 4-6 eggs were also warmed for the same times daily but for 5d. After the 5th day eggs were put back into the cooler overnight and were set on the 6th day of storage. Eggs receiving the daily warming treatments were placed in a Naturereform incubator set at 37.5°C and 60% RH, removed after treatment, and placed directly into the cooler. After the storage period eggs were set in the incubator operating at the same temperature as the treatments for 18d, then transferred to the hatcher until 21d. On the 7th day all eggs were candled, infertile and early dead embryos were removed. These eggs were broken to confirm infertility. After 21d of incubation all unhatched eggs were broken and embryo mortality was determined. A randomized block design was used for statistical analysis, with level in the incubator as the block. All percentages underwent arcsine conversion before analysis. Trials 1-3 and 4-6 were combined since there was no significant trial by treatment interaction.

In all trials, percent total hatchability, percent fertile hatchability, percent pips, percent early dead, percent mid dead, percent late dead, and percent dead were measured. The treatments did not significantly

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### 257P Effect of broiler breeder diet type, feeding to peak of production, and feeder space change in production on leg health of progeny

P. E. Eusebio-Balcazar1, E. O. Oviedo-Rondon1, J. T. Brake2, M. J. Wineland3, N. A. Barbosa1, C. E. Aker1, N. A. Ardon1, H. R. Cutchin Evans3, North Carolina State University, Raleigh, 2University of Alberta, Jaboticabal, Brazil, 3Escuela Agrícola Panamericana, Tegucigalpa, Honduras.

This study examined the effects of broiler breeder nutrition and feeding practices on leg health of broiler progeny. Cobb 500 breeders were housed in 16 pens of 81 females each, and fed either corn (C) or wheat (W) based diets during rearing and production. Two feeding programs, sigmoid late fast (LF) and sigmoid late slow (LS) were used until peak of production. At 23 wk, 69 females that represented the BW distribution from each pen were placed in a two-thirds slat layer house where feeder space either remained the same (S) or was increased (M). Fourty eggs per pen were collected to obtain yolk, albumen and shell percentages, yolk/albumen ratio, haugh units, egg shape index (SI), egg surface area (ESA), and additional eggs were incubated to obtain egg moisture loss and eggshell conductance (G). Eggs produced at 32 wks of age were incubated and 16 male and 16 female chicks were assigned to 48 pens using 6 replicates per broiler interaction cell and 2 breeder pens per interaction cell in the 2x2x2 factorial design with diet type, feeding program, and feeder space as main factors. Broiler gait scores (GS) and leg problem incidence were evaluated at 42 d. Eggs coming from breeders fed C based diets had lower (P<0.05) haugh units and Y:A ratio (P<0.001) compared with the group fed W; however, only broilers from LS breeders when fed C showed higher severe valgus incidence. M breeders eggs weighed less (P<0.01), had higher (P<0.05) SI and their progeny had higher (P<0.05) GS 2 at 42 d. Breeders raised with LS feeding program laid smaller (P<0.05) eggs with lower (P<0.05) percentage shell and their progeny had higher (P<0.05) incidence of mild valgus. It was concluded that breeder feeding programs and feeder space affect egg traits that could be important during embryo development and influence leg problems and ability to walk in the broiler progeny.

**Key Words:** broiler breeder, management, nutrition, bone development, leg health
(P>0.05) improve fertile hatchability for eggs warmed for 3d or 5d. Percent pips was significantly (P> 0.06) decreased by pre-incubation warming for 5d.

Key Words: hatchability, broiler breeder, incubation, embryo mortality

259P Effect of season of hatch (January and June) on growth of Japanese quail. K. L. Arora*, Fort Valley State University, Fort Valley, GA.

During routine reproductive studies with Japanese quail (Coturnix japonica), considerable variability was observed among hatches year round with respect to post-hatching growth parameters. This is the main objective of this report. Eggs of uniform weight and size were collected from hatch–mate females from 3:00 to 5:00 PM during the months of January (JA) and June (JU). After holding at room temperature for 4h, the eggs were transferred to the incubator set at 98°-99°F and 65-68% RH. with a built-in egg turner. Eggs were transferred to hatching trays on the 15th day. Hatch chicks were removed from the incubators after they were fully dried, weighed, and transferred to well prepared brooders for the next three weeks under continuous lighting. Brooder temperature was reduced, in a graduated manner, from 98°F to 75°F by the end of the second week. At the end of brooding, birds were weighed, numbered and transferred to wire cages under 14L:10D lighting period. Two groups of 25 males and 25 females of uniform weights were weighed at weekly intervals up to 105d of age starting with 3d of age. Data was analyzed for Means, SE and ANOVA for sex and seasonal differences. Data reflects that birds, males and females, hatched in JU grew faster than those hatched in JA; the differences became very apparent after 10d of growth and continued to diverge further with age. Sexual dimorphism was evident by 16-18 days of age in both groups. Differences in growth rate, within these groups, appeared by 30-35 days; the females grew faster than males. Males, within each groups, started plateauing between 50 and 60d of age; 114g for JA and 105g for JU (P<0.05). However, the females continued to grow to the end of this project (105d); 138g for JA and 105g for JU (P<0.05). When planning experiments on reproduction, endocrinology, toxicology, nutrition and other physiological aspects with Japanese quail, seasonal differences in their growth rate should be given due consideration.

Key Words: Japanese quail, season, body weight, growth

260P Relationship between body weight and reproductive organs in Japanese quail layers. K. L. Arora*, Fort Valley State University, Fort Valley, GA.

During an on-going reproductive studies with Japanese quail (Coturnix japonica), a considerable variability in growth of ovaries and oviducts was experienced among layers. The role of layers’ weight was investigated as follows. Twenty layers which were in production for about 10 weeks were divided based upon their body weights, into two groups of 10 each. Group I: Birds weighing under 130 grams and Group II birds weighing above 145 grams. Birds were euthanized with carbon dioxide and oviducts and ovaries (including follicles) were removed and weighed to the nearest milligram (mg). Ovaries in both groups contained at least five follicles containing yellow yolk of varying sizes, which were also weighed and measured (diameter) individually using a vernier caliper. Oviducts in both groups weighed on average 5.78g and 7.13g (P<0.05) and ovaries 5.96g and 7.05g (P< 0.05) in Group I and Group II, respectively. Ovarian follicles weighed on average 2.76, 1.63, 0.54, 0.21 and 0.07g in Group I and 3.29, 1.81, 0.81, 0.42 and 0.12g, in Group II. Average size of the follicle was 16.96, 13.83, 10.38, 6.50 and 4.60mm in Group I and 18.30, 14.58, 13.27, 8.45, and 5.95mm in Group II. Three ovaries in Group II had an additional 6th follicle weighing 0.06g and measuring 4.45mm. In short, both oviducts and ovaries weighed heavier in Group II birds. The same was true for each of the growing follicle, however, the difference was significant only between the first (the largest) follicles which were next in order to ovulate (2.76g vs.3.29g; P<0.05). In addition, the eggs laid by Group II birds were also comparatively larger as compared to Group I (10.2g vs. 9.7g; P<0.05). It was concluded that the heavier birds (Group II) had bigger reproductive organs. Accordingly, weight of bird should be given a due consideration while planning an experiment.

Key Words: Coturnix japonica, Japanese quail, body weight, ovary, oviduct

261P Assessment of light intensities for chicks during brooding. D. L. Everett*1, C. D. Zumwalt1, J. L. Purswell2, and M. T. Kidd1, 1Mississippi State University, Starkville, 2USDA, Starkville, MS.

This experiment evaluated a titration of light intensity in chicks during brooding. Ross 308 chicks (straight-run) were exposed to continuous lighting during placement to 7 d of age: 25 (control), 50, 100, and 150 lux. Treatments were applied to 16 pens within two commercial broiler houses (32 total pens each containing 24 chicks; 8 replications per lux treatment). Treatments were derived by hanging one incandescent bulb over each pen (except the control) that varied in wattage to derive treatment light intensities at litter level. Lighting treatments were confirmed at placement and throughout experimentation in each pen by the use of light meter measurements at litter level. The light treatment in the control pen was achieved from incandescent lights mounted on the ceiling of the broiler house. Each pen was positioned in the commercial broiler houses to be equal distance from hanging infrared brooders. Treatments were blocked across the brood chamber to take minimum ventilation temperature differences into consideration. Built up litter was used and each pen contained one hanging pan feeder, feed lids containing supplemental feed, and one nipple drinker line. Birds were weighed at d 1 and 7, feed disappearance was measured from d 1 to 7, and dead birds were removed and recorded daily. Repeated t test comparisons indicated that BW gain, feed conversion, and mortality did not differ (P > 0.05) between treatments. Regression was applied to treatments and indicated that as lux increased mortality increased (P = 0.11) in a linear manner (1.1, 2.4, 4.2, and 2.6% for 25, 50, 100, and 150 lux, respectively). Trend lines for BW gain and feed conversion were not observed. This experiment indicates that brood chamber light intensity of 25 lux seems to be adequate for chick quality based on 7 d measurements.

Key Words: light intensity, broiler, brooding

262P Brooding light source on live performance and processing characteristics of commercial broilers. A. N. Hoover*1, C. D. Zumwalt1, J. L. Purswell2, C. D. McDaniel1, and M. T. Kidd1, 1Mississippi State University, Starkville, 2USDA, Starkville, MS.

This experiment investigated light sources during brooding in broilers reared in a two commercial houses. The houses utilized center brooding. The brood chamber was divided into two sections via mounting a black curtain in the center of the house. Each section utilized two rows
of incandescent (INC) lights. However, a center row of high pressure sodium (HPS) lights was installed on one side of the brood chamber. Brooding treatments represented 24 h of light for the first 7 d of INC lights or the INC lights with the HPS lights (2 replicates per treatment). Each replicate brood chamber contained eight pens of 24 Ross x Ross 308 straight run broilers placed equal distances from the brooders and light sources (32 total pens; 768 total broilers/experiment). However, because light was administered to each side of the brood chamber, pens represented observational units and brood chambers represented experimental units. Photometric sensors were placed in the darkest and brightest pens of each brood chamber. Intensity was recorded every 15 min. The average light intensity for the 7 d period was 20 vs 106 lux in the INC and HPS light treatments, respectively. Birds were weighed by pen at d 1, 7, and 49, and feed intake was measured from 1 to 7 and 1 to 49 d of age. Dead birds were removed and recorded daily. All birds were processed at d 49. Carcass weight was obtained on all birds and half the carcasses were selected to obtain weights of Pectoralis major and minor, and abdominal fat. Light source did not significantly (alpha = 0.05) impact BW gain, feed intake, feed conversion, or carcass yields. This experiment indicates that increasing light intensity via HPS lights to achieve a five fold increase in intensity during brooding is not warranted. However, this experiment utilized a split-house farm and was limited in terms of statistical power.

**Key Words:** broiler, light source, brooding

### 263P Induced and un-induced deep pectoral myopathy inbroilers reared on different light treatments.

R. J. Lien*, S. F. Bilgili, and J. B. Hess, *Auburn University, Auburn, AL*

The effects of light treatments on the incidence of deep pectoral myopathy (DPM) were studied in male broilers. At 49 d, replicate groups from each treatment were either un-induced or subjected to 20 bouts of wing flapping in 32 s to induce DPM. DPM incidence and the percent of breast tenders affected were assessed upon slaughter at 47 d. In trial 1, light treatments provided a 20 h dim photoperiod (1-7 d, 23L:1D and 0.5 FC; 8-40 d, 20L:4D and 0.1 FC; 41-47 d, 23L:1D and 0.1 FC) (2D treatment), a 16 h bright photoperiod (1-3 d, 23L:1D; 4-44 d 16L:8D; 45-47 d, 23L:1D; all at 2 FC) (16B treatment), or 16 h of bright light split by 2 dark periods of 4 h (1-3 d, 23L:1D; 4-44 d, 14L:4D:2L:4D; 45-47 d, 23L:1D; all at 2 FC) (16B2D treatment). In trial 2, light treatments provided a 23 h bright photoperiod (1-47 d, 23L:1D, 2 FC) (23B treatment), increasing-dim photoperiods (1-7 d, 23L:1D, 8-14 d, 12L:12D; 15-21 d, 14L:10D; 22-28 d, 17L:7D; 29-35 d, 20L:4D; 36-47 d, 23L:1D; 1 FC to 7 d and 0.25 thereafter) (ID treatment), or 18 h of bright light split by dark periods of 4 and 2 h (1-47 d, 16L:4D:2L:2D and 2 FC) (18B2D treatment) to male broilers of tray pack and breast yield strains. In trial 1, un-induced DPM incidences were 7.5% in 16B2D, 3.75% in 20D, and 2.5% in the 16B treatment. Induced incidences were 67% in 16B2D, 64% in 20D, and 44% in the 16B treatment. The percent of breast tenders affected by induction was 62% in 16B2D, 56% in 20D, and 35% in the 16B treatment. In trial 2, un-induced DPM incidences were 15% in breast yield versus 4.2% in the tray pack strain; and 7.5% in 23B and ID treatments, versus 15% in the 18B-2D treatment. Induced incidences were 86% in breast yield versus 77% in tray pack strains; and 77% in 23B versus 88% in ID, and 79% in the 18B-2D treatment. The percent of breast tenders affected by induction was 77% in breast yield versus 66% in the tray pack strain; and 71% in 23B versus 73% in ID, and 72% in the 18B-2D treatment. These results suggest light treatments may influence DPM, and that induction may have potential in the assessment of management factors and strains on its occurrence.

**Key Words:** broiler, lighting, deep pectoral myopathy, induction

### 264P Impact of providing high moisture feed for chicks post-hatch.

L. C. S. Barbosa*1, L. Araujo1, C. Araujo1, S. L. Branton2, and M. T. Kidd1, 1Mississippi State University, Department of Poultry Science, Mississippi State, 2United States Department of Agriculture, Mississippi State, MS.

Early viability of a broiler flock (i.e., good chick quality) is measured the first 7 d. One important factor in chick quality is hydration. Chick hydration can be influenced by hen age, hen performance, hatchery management, and chick transportation, in addition to broiler house management. This experiment was conducted to assess adding water to pre-starter feed in chick trays and measuring broiler performance to d 41. One thousand and eight hundred chicks (Ross 708) were obtained from a commercial hatchery and transported to the experimental facility. Upon arrival, chicks were distributed into chick trays of 50 chicks each (50% of normal density) and weighed. Chicks were provided treatments (454 g pre-starter crumbled feed) in the chick trays for 5 hr. Treatments consisted of: no feed, pre-starter feed, or pre-starter feed mixed with 10, 20, 30, or 40% potable water (6 treatments with 6 replications each). Each replicate was the chick tray (50 chicks/tray) which was subsequently placed in each pen (50 birds per pen). After 5 hr of holding in the experimental facility, chicks were placed and provided common feed from 1 to 14, 15 to 26, 26 to 35, and 36 to 41 d of age. BW was obtained before placement, and d 7, 14 and 42. Feed intake and dead birds were measured from 1 to 41 d of age. At d 41, a random sample of male and female broilers were obtained and processed for yields of carcass and breast muscles. Differences in live performance and most carcass parameters were not observed (P > 0.05). However, chicks provided feed containing 40% water post-hatch had less abdominal fat (P < 0.05) than chicks provided other pre-starter feed. Results indicate that pre-starter moisture level may affect subsequent broiler metabolism.

**Key Words:** broiler, pre-starter, feed moisture, abdominal fat

### 265P Effects of graded levels of melamine in young turkey poults.


A study was conducted to determine the toxicity of melamine (M) in young turkey poults fed dietary treatments from hatch to 21 days. One hundred and seventy-five day-old female turkey poults were purchased from a commercial hatchery and assigned to 7 dietary treatments with 5 replicate pens of five poults assigned to each treatment. The diets contained 0, 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0% M. Significant mortality was observed in turkeys fed 1.5, 2.0, 2.5 and 3% M with 27, 63, 93, and 93% mortality, respectively. Due to the high mortality in birds fed ≥ 2% M, growth performance could only be evaluated in birds fed 0, 0.5, 1, and 1.5% M. Compared with controls, feed intake was reduced (P < 0.05) in turkeys fed diets containing 1.5% M, whereas body weight gain was reduced (P < 0.05) in birds fed ≥ 1% M. Compared with controls, relative liver weights were higher (P < 0.01) in turkeys fed diets containing ≥ 1% M. Relative liver weights were not affected (P > 0.05) by dietary treatments. The consistent gross lesions observed in turkeys fed 2-3% M that died were pale and enlarged kidneys. The bile of turkeys that died in these treatment groups contained crystals that were either microscopic (< 2 microns) in size or were large white crystals visible to the naked eye. Most of the birds that died on these treatments were still eating food at the time of death with food present in the crop and/or ventriculus. Renal histopathology of birds fed 2-3% M that died were relatively uniform, and could be summarized as moderate to severe tubulointerstitial nephritis with mineralized casts within the collecting tubules.
tubules and ducts. Data indicate that compared to broilers, turkeys are more susceptible to the toxic effects of M. The gross and histopathology findings are compatible with lesions of melamine toxicity reported previously for broiler chicks. However, concentrations of M that caused toxic effects in this study are still well in excess of concentrations found in M contaminated ingredients that were reported to cause kidney failure in dogs and cats.

Key Words: turkeys, melamine, kidney lesions, crystal formation

WITHDRAWN.

266P Residual activity of _Metarhizium anisopliae_ or plant extracts on laying hens for _Menacanthus stramineus_ mite control by dipping. E. Pablo1, A. L. Sandoval1, E. Morales1, M. Fernandez2, G. Tellez*3, and M. T. Quintero4, 1Universidad Autónoma Metropolitana, México, 2Instituto Nacional de Investigación Forestales Agrícolas y Pecuarias, Morelos, Mexico, 3University of Arkansas, Fayetteville, 4Universidad Nacional Autónoma de México, Mexico.

In the present study, eighty-four Hy-Line W36 laying hens in two experiments were distributed in 7 treatments with 3 replicates of four hens each. Each treatment, hens received 3 dipping/2 minutes every 48 hours. Residual activity was done by counting mites one month after the dippings. Treated hens with no live mites were reinfested with 20 mites, and repeated during three months. In experiment one, aqueous suspensions of three plant extracts were tested as dips for control of MS mites: a) Neem (Azadirachta indica) 500 ppm; b) Ruda (Ruta graveolens) 11,700 ppm; or c) Solanacea (Ardisia solanacea) 50,000 ppm; d) Negative Control (water). After the first dipping, a significant difference (P<0.05) in the number of death mites were observed in the hens that received Neem (84.1 %) or Solanacea (98.1 %), however, after the second and third dipping, all treated groups showed a significant increase in the number of death mites compared with the control. Average after the 3 dips were: Neem (93.6 %); Ruda (85.2 %); Solanacea (98.2 %); Control (49.1 %). One month later, all 3 treated groups had 0 mites compared with 38 mites in the control group. Counts of live mites at two months after first reinfestation were: Neem (0); Ruda (1); Solanacea (43); Control (51). Counts of live mites at three months after second reinfestation were: Neem (0); Ruda (15); Solanacea (NA); Control (60). In experiment two, 3 aqueous suspensions were tested: group 1) Ruda 50,000 ppm; group 2) _M. anisopliae_ 50,000 ppm; or group 3) Coumaphos 1,000 ppm. After the first dipping, a significant difference in the number of death mites were observed in the hens that received Coumaphos (100 %), however, no significant differences were observed between treatments after the second and third dipping Counts of live mites one month later were: group 1 (2 mites); group 2 (0 mites); group 3 (38 mites). Counts of live mites at two months after first reinfestation were: group 1 (13); (16). These results confirm the effectiveness of alternative bio control methods for mites in laying hens.

Key Words: mite, hens, _Metarhizium anisopliae_, biocontrol, plant extracts


Parasitic infections can have a significant detrimental impact on free-range poultry production, but organic farming regulations do not allow the routine use of pesticides to control parasitism. Therefore, there is a need for an effective and safe method of treatment. One proposed treatment is the use of diatomaceous earth (DE). The purpose of this study, therefore, is to evaluate the effects of DE on internal parasites of free-range organic layer hens. Day old pullets of two commercial egg laying strains (Bovan brown, Lohmann brown) were reared indoors until 11 weeks of age, and then transferred to hen-houses with access to outdoor range. Birds were initially fed a certified organic grower mash, which was replaced with a certified organic layer mash at 18 weeks of age. Starting at 16 weeks of age, half the hens of each line began receiving these diets supplemented with 2 % diatomaceous earth. Body mass, and egg production and quality were monitored throughout the experiment. Parasitic load was assessed by bi-weekly fecal egg counts (FEC) performed on 40 individual hens (10 hens/diet/strain) at bi-weekly intervals between 16 and 28 weeks of age. These hens were sacrificed between 33 and 38 weeks of age, and their trachea and gastrointestinal tract examined for the presence of helminthic parasites. DE had no effect on the number of hens infected, FEC, or worm burdens. However, body mass and egg production were greater in hens consuming the DE diets. These hens also laid larger eggs with thicker shells. The results of this study suggest that there is no evidence that DE is an effective treatment to control gastrointestinal parasitic infections of free-range laying hens. However, DE as a feed ingredient may maintain body mass, increase egg production and improve egg quality in free range laying hens fed an organic diet.

Key Words: diatomaceous earth, helminthic parasites, organic layer production

269P Vaccination response in pullets from different genetic backgrounds and the impact of dietary yeast beta glucan. B. M. Rathgeber*1, K. L. Thompson1, K. L. Budgel2, and J. L. MacIsaac3, 1Agriculture & Agri-Food Canada, Kentville, NS, Canada, 2Nova Scotia Agricultural College, Truro, NS, Canada, 3Atlantic Poultry Research Institute, Truro, NS, Canada.

Poor immune response to vaccination in laying hens is a common problem in the egg industry. Dietary yeast beta-glucan (YBG) has been shown to improve or maintain growth performance in broiler chickens fed antibiotic free diets, and has been shown to improve immune response to vaccination in young piglets. A study was conducted with one commercial White Leghorn line and three heritage breeds (Barred Plymouth Rock, Brown Leghorn and Light Sussex) to determine the effect of a dietary yeast beta glucan product on immune response to common disease vaccinations in pullets, and to evaluate the role of genetics in immune response. Eggs were incubated together and day old chicks were fed standard diets with or without supplemental YBG for 20 weeks. Pullets were vaccinated for Newcastle disease (ND), infectious bursal disease (IBD), infectious bronchitis (IB) and avian encephalomyelitis (AE) according to a standard schedule. Blood samples were collected at 14 and 20 weeks to measure antibody titer levels to each of these vaccinations. Immune response to vaccination was unaffected by dietary YBG supplementation. Antibody titer levels varied (P<0.05) between heritage and commercial breeds with Light Sussex generally exhibiting greater immune response than commercial birds. Antibody titer levels also varied (P<0.05) according to bird age, with immune response of most breeds being greater at week 20 than week 14, in particular for avian encephalomyelitis (AE) and Newcastle dis-
ease (ND) vaccinations. This is the first report on the effects of dietary YBG supplementation on immune response to vaccination in pullets. In light of the published reports on improved immune response to ND vaccination in broiler chickens, further research on the ability of dietary YBG to improve immune response in layers is warranted. The superior immune response to vaccination in heritage breeds, in particular Light Sussex will provide useful information for further studies. The significantly lower titer levels in the commercial breed provide evidence that vaccination response continues to be a problem with commercial egg laying chickens.

Key Words: pullet, vaccination, beta glucan, heritage breed


Genetic selection for fast-growth can affect the ability of male turkeys to cope with stressors common to commercial production, resulting in decreased immunity to opportunistic bacterial infection. The purpose of this study was to compare the effects of ascorbic acid (AA) on the stress response in birds selected for increased 16-wk-BW (F-line) with their random-bred parent line (RBC2). Male turkeys were raised in duplicate floor pens in a randomized 2 line x 2 treatment x 2 stress challenge (SC) design. At 5 wks of age AA (1,200 ppm, Stabilized-C, Alpharma) was provided in drinking water for 24h, during which all birds were weighed. After 24h of AA treatment the SC group was subjected to a transport protocol that included disruption of the social group, catching, loading, and movement to another building, and a 12 h feed and water withdrawal. Six h after the start of transport, SC birds were also inoculated in the thoracic airsac with 1 x 10^6 cfu of Escherichia coli. At the end of SC birds were returned to their original pens and provided feed and water. The following morning 4 birds from each pen were bled and all birds were weighed and necropsied 2 d later.

BW and gain after SC was decreased in the F-line but not the RBC2 line and there were no AA effects on BW. The weight of the bursa of Fabricius relative to BW was higher in the RBC2 line (P = 0.0006), and was not affected by AA. The heterophil:lymphocyte ratio was higher in the SC F-line as compared to the SC RBC2 (P = 0.03) and was decreased by AA only in the SC F-line (P =0.01). Corticosterone (C) levels were increased by SC only in the F-line (P = 0.002) and AA decreased C levels only in the RBC2 line (P = 0.02). The challenge strain of E. coli was cleared from the AS in all treatments except the AA-treated F-line SC birds (P = 0.003). These results suggest that SC at 5 wks of age had a more deleterious effect on the fast-growing F-line than on its parent line, AA treatment had different effects in the two lines, and AA may have decreased resistance to E. coli in the SC F-line birds.

Key Words: turkeys, transport stress, genetics, ascorbic acid, immunity

271P Comparative growth performance of turkey hens fed additives in commercial and antibiotic-free diets. R. M. Hulet and T. L. Cravener, Pennsylvania State University, University Park.

Increased costs for protein and energy feed ingredients and use of antibiotic-free diets have increased the use of additives to improve gut health and feed efficiency. A study was conducted on reused litter to compare a commercial turkey hen diet (Control) supplemented with Lasalocid (90.7 gm/ton; 0 to 7 wk) and Virginiamycin (20 gm/ton; 7 to 16 wk) with a test diet (NB) supplemented with Natustat (907 g/ton; 0 to 7 wk), BioMos (907 g/ton; 7 to 16 wk), and CoccilVact (day 1) and an Antibiotic-free control diet with no additives (NEG). Eleven-hundred and fifty female Hybrid Converter poults were randomized into 8 pens (brooding) for 7 days and then spread into 24 pens at 7 days of age and placed into assigned dietary treatments. All birds and feed were weighed at 0, 7, 28, 51, 63, 84 and 111 days of age. Significant differences were found in bird weight starting at 28 days and continuing on to 111 days of age. Control hens (10.7 kg) were significantly greater in body weight than NBMs (10.4 kg) which were significantly heavier than the NEG hens (10.2 kg) at 111 days of age. While some differences existed in feed consumption, no significant difference in cumulative feed conversion was found between the dietary treatments. A significant difference in feed conversion and mortality resulted at the 7 to 28 day period that was related to a mortality challenge. Mortality was significantly higher for the NBMs (3.7%) treatment compared to the Control (0.8%) and NEG (0.26%) treatments.

In conclusion, significant growth performance differences were found between all dietary treatments and showed production advantages for Control hens grown on reused litter.

Key Words: turkey, antibiotic-free diets, growth efficiency


Increased costs for protein and energy feed ingredients have increased the use of additives to improve growth rate and feed efficiency. Some additives are used to improve energy utilization and/or phosphorus utilization while others improve nutrient utilization or influence bird health. A commercial broiler antibiotic-free diet (Control) was supplemented with Clopidol (0.0125 ‰/ton) 0 to 18 days of age and Decoquinate (27 g/ton) from 18 to 32 days while the test diet (NP) was supplemented with Natural Pak (mix of De-Ordorase, Bio-Mos, Sel-Plex, Bio-Plex, Allzyme SSP and Oregano; 1.4 kg/ton) from 1 day until marketing (42 and 52 days). Seventeen-hundred and twenty-four broilers were randomized into 48 pens at day of age and placed on randomized dietary treatments. All birds and feed were weighed at 0, 18, 32, 42, and 52 days of age.

No significant differences were found in bird weight between the Control (2.98, 3.95 kg) and NP (3.00, 3.97 kg) supplemented diets at 42 or 52 days of age, respectively. Feed intake was only significantly different between the Control and NP treatments for the starter feed (0 – 18 days). No other differences in feed conversion (18 – 52 days) were found between the Control and NP treatments. Mortality was not significantly different by period or cumulatively between the Control and NP dietary treatments. Litter analysis showed a significant decrease in values for the NP dietary treatment when compared to the Control diet for Total and Organic Nitrogen, Total phosphate, potash, calcium, magnesium, and sulfur. In conclusion, no significant growth performance differences were found between the two antibiotic-free dietary treatments; however, improved nutrient utilization/ decreased litter nutrients were found in production of heavy broilers by using the NP additive.

Key Words: broiler, antibiotic-free diets, nutrient utilization
273P Effect of inclusion of adipic acid, calcium chloride and a protease in broiler diets differing in protein concentration on performance, N retention, excreta pH and nitrogen loss from stored excreta. E. Jimenez-Moreno*1,2, R. Angel1, J. Garcia3, W. Powers4, and T. Applegate5, 1University of Maryland, College Park, 2Universidad Politecnica de Madrid, Madrid, Spain, 3Michigan State University, East Lansing, 4Purdue University, West Lafayette, IN.

Effects of inclusion of feed additives and protease supplementation in diets differing in CP on broiler performance from 10 to 20 d of age, N retention, excreta pH and potential N loss during storage were studied. A 2 × 2 × 3 arrangement of treatments (TRT) were tested: 2 CP levels (22.4% and 20.8%), 2 protease inclusions (0 and 2000 ppm), and 3 additives (none, 1% adipic acid; and 1% CaCl2). Broilers were housed in battery pens (6 chicks/pen) and TRT replicated 5 times. On d 20, all birds were sampled and ileal content taken for apparent N retention determination. Excreta were collected by pen, mixed and divided in 2 parts. To one of the parts, 4% Alum (aluminium sulphate) was added to determine its impact on pH and potential N volatilization during storage for 14 d in a poultry house kept at ambient conditions. Low CP diets reduced gain (P<0.001) and impaired (P<0.001) feed efficiency (FE). Proteases inclusion improved gain (P<0.001) and FE (P<0.001). The inclusion of CaCl2 reduced gain (P<0.001) and impaired FE (P<0.001) with respect to the control diet or adipic acid. As compared to excreta pH from the birds fed the no additive diets, pH was reduced (P<0.001) after 7 d of storage with adipic acid and further reduced with CaCl2 but these effects disappeared by 14 d of storage. Adding Alum resulted in a decrease in excreta pH at 7 and 14 days of storage. Potential N volatilization was affected by additive (P<0.05) and Alum addition (P<0.001). The inclusion of adipic acid as well as CaCl2 reduced potential N volatilization. Samples with Alum lost 24.8% of the N in the samples after 14 d of storage while those with no Alum lost 63.3% N. We concluded that low CP diets (20.8%) and inclusion of CaCl2 impairs broiler performance. The use of 1% adipic acid or CaCl2 and 4% Alum reduced excreta pH and potential N volatilization.

Key Words: adipic acid, calcium chloride, alum, excreta pH, broilers

274P Effect of diet protein, protein source, and protease inclusion on broiler performance, excreta pH and nitrogen loss from excreta during storage. E. Jimenez-Moreno*1,2, R. Angel1, J. Garcia3, W. Powers4, and T. Applegate5, 1University of Maryland, College Park, 2Universidad Politecnica de Madrid, Madrid, Spain, 3Michigan State University, East Lansing, 4Purdue University, West Lafayette, IN.

Effects of diet protein (PRT), PRT source, and protease on performance, excreta pH and potential N loss from excreta during storage were studied in broilers. A 2 × 2 × 3 arrangement of treatments (TRT) were tested: 2 PRT levels (22.4% and 20.8%), 2 protease levels (0 and 2000 ppm), and 3 PRT sources (soybean meal (SBM), 15% meat meal, MM; and 20% DDGS). All diets were corn-SBM with or without partial SBM replacement by another PRT source. Each TRT was replicated 5 times (6 broiler chicks/battery cage). Diet TRT were fed from 10 to 20 d of age. At 20 d, excreta samples were taken, mixed, and subdivided in half. Alum (aluminium sulphate) was added (4% inclusion) to 1 sample per pen to determine the effect on excreta pH and N volatilization. Excreta was kept in a poultry house at ambient conditions and pH and N content monitored for 14 d post excretion. There was a PRT level and protease effect (P < 0.001) on gain and feed efficiency (FE). Broilers fed the low PRT diet gained less than the broilers fed the control diet (579 vs. 558 g gain) and those fed diets with added protease grew more (P < 0.05) and had a better FE than those fed diets with no added protease (1.37 vs. 1.42, respectively). Both diet PRT and protease inclusion had an effect (P < 0.05) on 14 d pH. Inclusion of MM reduced pH of the excreta (P < 0.001) as compared to the SBM-or DDGS (7.28 vs. 7.89 and 7.82, respectively). Alum inclusion reduced excreta pH at 7 and 14 d of storage (P < 0.001) as compared with the same excreta with no added alum (7.39 vs. 8.82 at 7 d, and 7.02 vs. 8.31 at 14 d, respectively). Neither PRT nor protease influenced potential N volatilization but PRT source and Alum inclusion had an effect (P < 0.001). Both MM and DDGS (43.2 and 39.4% N loss, respectively) decrease the potential N volatilization over 14 d of storage vs. the SBM diet (47.9% N loss). Alum addition to excreta reduced (P<0.001) potential N volatilization by a factor of 2.2. Substitution of part of the SBM with MM or DDGS and the use of Alum reduced the potential N volatilization from stored broiler excreta.

Key Words: protein concentration, protein source, protease, excreta pH, broilers

275P Effect of dietary phytase or DDGS on nutrient contents of laying-hen manure. B. R. Behrends1 and S. A. Roberts2, 1Sparboe Farms, Litchfield, MN, 2Iowa State University, Ames.

The objective of this study was to evaluate the effect of dietary phytase or corn distillers dried grains with solubles (DDGS) on manure nutrient (P2O5, N, K2O, and Ca) contents in high-rise laying-hen houses. Thirty-four houses on 3 farms (3.2 M hens) owned by Sparboe Farms were used in this study. Manure was sampled annually from 2000 to 2008 by collecting 12 samples per house, mixing the samples, and sending one pooled sample per house to an EPA-certified laboratory for analyses. Diets were formulated to contain 4.5% Ca and 0.46% available P. During 2000, 2001, and 2002, neither phytase nor DDGS were fed. In 2003 and subsequent years, phytase was fed at 300 FTU/kg. In 2004, DDGS was fed at 8% and in 2005 and subsequent years, DDGS was fed at 12% of the diet. Data were analyzed by ANOVA with the model including treatment, farm, and the interaction farm by treatment. When the interaction was significant, means were separated by the Bonferroni test to determine if the response was consistent at all three farms. The effects of phytase or DDGS were evaluated separately to avoid confounding. House was the experimental unit and P ≤ 0.05 was considered significant. Values are reported on dry-matter basis. The P2O5 content of manure decreased 19% from 6.35% to 5.31% (P < 0.0001) when dietary phytase was introduced. There were no significant differences in manure N, Ca, or K2O content between the 300 or 0 FTU/kg phytase diets. The addition of DDGS to the diet increased (P = 0.003) the P2O5 content of the manure (5.31, 5.64, and 6.04% for the 0, 8, and 12% DDGS diets, respectively). The interaction was significant and the Bonferroni test indicated that the treatment effect was primarily due to responses at 1 farm with no significant differences in manure P2O5 content at the other 2 farms. The DDGS inclusion did not affect manure N, Ca, or K2O. In conclusion, manure P2O5 content was lower when hens were fed 300 FTU/kg phytase and tended to be higher when DDGS was fed. Neither phytase nor DDGS affected manure N, Ca, or K2O.

Key Words: layer manure, phosphate, phytase, DDGS, nutrients

276P Spatial distribution of microorganisms as it relates to poultry litter depth. K. J. Barker*, H. M. Parker, C. D. McDaniel, and A. S. Kiess, Mississippi State University, Starkville.

A common practice in the poultry industry is to reuse litter over multiple flocks. Morbidity, mortality, and condemnation, due to pathogenic bac-
bacteria, have been attributed to this practice. Due to limited information on the distribution of bacteria in litter, it is possible that pathogenic anaerobes may prefer to colonize litter at deeper depths, where oxygen is less abundant. When litter is disturbed, these organisms may be introduced to the surface of the litter where they have the potential to cause disease outbreak. Therefore, the goal of this project was to investigate the distribution of bacteria at different depths of litter. In two commercial broiler houses, 6 PVC pipes measuring 1.5 inches in diameter and 24 inches in length were drove through the litter bed to the clay floor. Each pipe was transported up-right to the lab, where they were cut into their respective sections (top, middle, and bottom) exposing the litter material to be processed. Ten grams of litter from each section was added to 90 mL of peptone, serially diluted and plated onto TSA agar plates for aerobic and anaerobic bacteria and EMB agar plates for coliforms. Plates were incubated under the appropriate atmospheric condition for 48 hours at 37 degrees C. After 48 hours, plates were counted for total aerobes, anaerobes, and coliforms. Results indicated a significant difference (P < 0.05) in bacterial counts, with the bottom section having significantly lower counts of aerobes, anaerobes, and coliforms then the top and middle sections. In conclusion, the bottom section of litter has significantly less bacteria compared to the top and middle sections, suggesting that the bottom layer of litter does not provide a favorable environment for bacteria growth.

**Key Words:** litter depth, anaerobes, aerobes, coliforms


Science-based knowledge on the fate and transport of pathogens in mixed-land use watersheds is critically needed, allowing for identifying important sources and targeting areas of a watershed for remedial efforts in minimizing transport of contaminants. *Salmonella* and *Campylobacter* are food-borne pathogens present in poultry litter and assumed to potentially contaminate water runoff after litter application to agricultural fields. To accurately determine the possible pathogen contamination of runoff water a sensitive and reliable microbiological culture method was developed. *E. coli* O157:H7 was included in the study because cattle are often also associated with agricultural fields. Runoff water samples from land applied with poultry litter were spiked with *Salmonella*, *Campylobacter* and *E. coli* O157:H7 to evaluate the efficacy of nine media for recovery and enumerative purposes: Brilliant Green with Novobiocin and Nalidixic acid (BGN+NA) agar, Brilliant Green Sulfa (BGS) agar, Campy Line Agar (CLA), CHROM (Salmonella) agar, Hektoen Enteric (HE) agar, Modified Brilliant Green Agar (MBGA), MacConkey Sorbitol (MacS) agar, Modified Lysine Iron Agar (MLIA), and Rainbow agar. Brilliant Green Sulfa (for *Salmonella*), CLA (for *Campylobacter*), and Rainbow (for *E. coli* O157:H7) agar were shown to have the greatest percent recovery of all the media tested (97%, 97%, and 100%, respectively) and gave accurate colony counts, while the other media tested were unreadable due to contaminant growth. Confirmation of positive colonies was performed by PCR. Results support the utility of these methods to detect possible pathogens in water runoff after poultry litter application.

**Key Words:** water runoff, poultry litter, *Salmonella*, *Campylobacter*, *E. coli* O157:H7


An energy efficiency assessment was conducted on 7 farms (with a total of 37 houses) growing 2.8-kg broilers with a 51-d growout. All houses were 12.8-m x 128-m and were equipped with tunnel ventilation and evaporative cooling systems. All houses had 8-9 120-cm or 130-cm tunnel ventilation fans. Houses on all but 1 of the farms had dropped ceilings. All houses originally had sidewalk curtains. Some curtains were either lightly insulated or fully insulated and covered. All houses used ½ house brooding with 24 pancake brooders (9.1 kW each) and 4 forced-air heaters (65.9 kW each). Propane was used on all farms. Annual propane use ranged from 10,603 to 22,194 L/house and electricity from 24,157 to 37,337 kWh/house. The average propane and electricity use were 14,308 L/house and 31,236 kWh/house, respectively. On a live wt basis, propane use was 31.4 to 75.2 L/1000 kg with an average of 44.7 L/1000 kg. Electricity use was 71.6 to 126.5 kWh/1000 kg with an average of 96.9 kWh/1000 kg.

Airspeeds during full tunnel ventilation were measured at broiler level in 12 houses about 23 m upstream from the tunnel fans at four equally spaced locations across the house. Mean airspeeds were 2.05 to 2.82 m/s with an average of 2.42 m/s for all houses. At each farm, a closed-house static pressure test was conducted in at least one house to evaluate house tightness. When operating 1 tunnel fan with the house closed, static pressure ranged from 14.7 Pa to 54.9 Pa, with an average pressure of 35.3 Pa. Fans for which in-situ performance data had been obtained were selected for this test, thus providing an estimate of the actual air leakage rate at the various static pressures recorded during the test. Sufficient data were available from 5 farms to estimate air leakage rate. At a static pressure of 24.9 Pa, estimated air leakage rates were 19,501 to 34,457 m³/h.

**Key Words:** broilers houses, energy efficiency
**Poster Session: Extension and Instruction**

279P  **Incorporating “problem-based learning” into an undergraduate introductory poultry science course.**  J. B. Hoffman*, North Carolina State University, Raleigh.

The standard instructional paradigm utilized in most introductory undergraduate courses consists of students learning identified content and processes through lecture, direct instruction, and guided discovery. Students then apply this new learning in well-structured situations or problem sets to see if they have “mastered” the lesson. The roles are quite clear in a standard instructional paradigm: teachers teach and students learn. However, poultry science instructors are not preparing students for “real-life” problems that they will have to solve as they enter the workforce by only utilizing this paradigm for teaching. In order to improve students’ problem-solving skills and analytical thinking, 27 students enrolled in Introductory Poultry Science (PO 201) at North Carolina State University were given a topic relating to poultry production, management, physiology, or nutrition and created their own problem-based case for their peers to solve. Students performed independent research in order to create their problem-based case studies and then presented these case studies to their classmates who investigated the problem and created problem resolutions. By incorporating problem-based learning into an introductory poultry science course instructors may put learning into context, teach students how to deal with real-life problems, promote higher order thinking, and improve students’ oral and written communication skills. This instructional methodology may meet the needs of pre-veterinary students, students interested in entering the poultry industry, and students pursuing graduate studies. Pre-veterinary students may improve their diagnostic and reference seeking skills while students interested in entering the poultry industry will learn how to trouble-shoot effectively. Lastly, students interested in pursuing graduate studies will develop critical thinking and analytical skills necessary to be successful in scientific research.

**Key Words:** problem-based learning, introductory, poultry science

280P  **Survey of poultry nutrition and disease knowledge in exhibition poultry and small flock owners of the Mid-Atlantic States.**  B. A. McCrea*, 1, T. Y. Morishita*, 2, J. D. Latshaw, 3, Delaware State University, Dover, 2 Western University of Health Sciences, Pomona, CA, 3 The Ohio State University, Columbus.

Survey responses from exhibition poultry and backyard flock owners from the Mid-Atlantic region were collected using a set of questions developed in a previous study at Ohio State University. Our objective was to determine the perception and level of knowledge in this group with regard to poultry health management and nutrition topics. Surveys were given to adult and youth poultry owners and exhibitors. Surveys were handed out at exhibition poultry shows and the Delaware Small Flock Education Series between March 2008 and February 2009. Show locations were in Kent County, Delaware and Cecil County, Maryland. The Small Flock Education Series was held three times in each of Delaware’s three counties (New Castle, Kent, and Sussex) and provided the backyard poultry flock perspective.

In general, survey participants were equally knowledgeable about poultry health management and nutrition topics. Both groups, backyard poultry and exhibition poultry owners, indicated that there remains a lack of knowledge regarding antibiotic use and vaccination in the health management section. However, both groups were very knowledgeable about medicated feeds. Participants were least knowledgeable about poultry feed composition and consumption in the nutrition section.

An understanding of these topics may be more effectively communicated to exhibitors, and the increasing population of backyard poultry owners, if it is known where poultry extension specialists should begin the education process. The information discovered in the course of this survey will be used to develop extension materials and continuing education symposiums that incorporate poultry health and nutrition topics.

**Key Words:** extension, health, nutrition, exhibition poultry, backyard flock

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**Poster Session: Genetics**

281P  **Quantitative trait loci for eggshell-related traits in the F2 families from the Oh-Shamo (Japanese Large Game) and White Leghorn.**  T. Goto*, 1, A. Ishikawa 2, S. Onitsuka 1, N. Goto 3, Y. Fujikawa 1, T. Umino 1, M. Nishibori 1, and M. Tsuzuki 1, 1 Hiroshima University, Higashi-Hiroshima, Japan, 2 Nagoya University, Nagoya, Japan.

Recently, a great number of quantitative trait loci (QTLs) has been detected in experimental animals and livestock. In the chicken also, over 1,200 QTLs have been discovered for growth, meat, egg, behavior, and disease resistance traits. However, for eggshell-related traits, a considerably small number of QTLs have been reported. In the present study, we performed QTL analysis of eggshell-related traits with the Map Manager QTX b20 software in a unique chicken resource population of the 421 F2 hens from intercrosses of an Oh-Shamo (Japanese Large Game) male and three White Leghorn females. The traits analyzed were eggshell size (the length of long and short axes of the egg: LLA and LSA), eggshell weight (EW), eggshell strength (ES), and eggshell thickness (ET), and they were measured at 300 and 400 days of hen ages. 118 microsatellite markers were genotyped. Interval mapping revealed nine significant QTLs with main effects on 300 d LLA (on chromosomes 8 and 11), 400 d LLA (chr. 8), 300 d LSA (chr. 8), 400 d LSA (chr. 8), 300 d EW (chr. 8), and 300 d ET (chr. 1 and 9), and 400 d ET (chr. 1). The identified QTLs explained 6-14 % of the total phenotypic variance. The 300 d LLA QTL on chromosome 11 and 300 d ET QTLs on chromosomes 1 and 9 appeared to be new loci based on their map locations.

**Key Words:** chicken, eggshell, quantitative trait loci, mapping, microsatellite marker

282P  **The mitochondrial genome sequence and molecular phylogeny of the budgerigar, Melopsittacus undulatus.**  X. Guan*, 1, D. Samuels 2, Z. Tu 1, and E. Smith, 1 Economically important to the pet industry and research, the Australian parrot species Melopsittacus undulatus, the budgerigar, is a bird widely used as a pet and as a model for biomedical research into auditory and oxidative stress questions. Despite this significance, there is very little published genetic information about the specie’s mitochondrial genome. The budgerigar, more commonly known as budgie, Melopsittacus undulatus, is a bird used as a pet and as a model for biomedical research into auditory and oxidative stress questions. Despite this significance, there is very little published genetic information about the specie’s mitochondrial genome. The budgerigar, more commonly known as budgie, Melopsittacus undulatus, is a bird used as a pet and as a model for biomedical research into auditory and oxidative stress questions. Despite this significance, there is very little published genetic information about the specie’s mitochondrial genome.
budgie. Here, we describe the budgie’s mitochondrial genome (mtGenome) sequence, a resource that could facilitate not only investigation into the budgie’s extraordinary ability to deal with relatively higher levels of oxidative stress, but its relationship to parrots and other birds. The potential utility of the sequence, developed using PCR, was carried out by screening the D-loop and 16S rRNA for single nucleotide polymorphisms (SNPs) and using these to evaluate the phylogenetic relationship between the budgie and other avian species. The estimated total length of the mtGenome sequence was 18,193 bp, which includes a duplicated hyper variable region, a feature unique to only a few birds, 13 protein coding genes, and 24 RNAs (22 tRNA and 2 rRNA). The duplicated non-coding regions showed 86% sequence similarity. The coding region structure implicates gene conversion in the budgie mtGenome. Further, mtGenome-based phylogenetic analysis suggests that the budgerigar is most closely related to kakapo (Strigops habroptilus). The mitochondrial sequence of the budgie described here will form a useful resource for both parrot phylogeny and the role of the mtGenome in budgie longevity.

Key Words: budgerigar, mtGenome, rearrangement, control region, phylogenetics

283P Genetic diversity of Campylobacter populations in chicken ceca. P. Singh* and Y. M. Kwon, University of Arkansas, Fayetteville.

Campylobacter species is the most common human pathogen causing gastrointestinal infections and poultry is a major source of this pathogen. In this project, we aim to study the genetic diversity of Campylobacter strains within individual chickens using cecal samples to understand the nature of intestinal colonization by Campylobacter species. Genotyping was conducted based on the DNA sequence of Short Variable Regions (SVR) in the flaA gene. Cecal samples collected from ten market age chickens were used for isolation of Campylobacter genomic DNA and SVR was amplified with flaA gene-specific primers, cloned and sequenced. Sequencing results obtained from 85 clones (~10 clones/bird) showed that on an average 24.3% of clones had mutations within individuals. When translated SVR sequences were analyzed, there was on an average 20.6% of sequences carrying altered amino acids within individuals. The mutation did not show any consistent pattern, suggesting a random nature of the mutations. Four translated sequences had nonsense mutations to produce truncated proteins. These results suggest that there are multiple genotypes colonizing in a cecum and the occurrence of truncated FlaA protein may represent a novel mechanism for evasion of adaptive immune responses.

Key Words: Campylobacter, chicken, short variable region, cecum, genetic diversity

284P Association of single nucleotide polymorphisms in candidate genes with phenotypic traits in fat or lean chicken lines. X. Liu*, 1, L. Cogburn2, M. Muchow1, E. Le Bihan-Duval3, J. Simon3, and T. E. Porter1, 1University of Maryland, Department of Animal and Avian Science, College Park, 2University of Delaware, Department of Animal and Food Science, Newark, 3Station de Recherches Avicoles-INRA, Nouzilly, France.

As a result of selection for rapid growth, excess fat accumulation in broiler chickens is a problem in the poultry industry. The current study investigated associations between single nucleotide polymorphisms (SNPs) and multiple traits in experimental fat (FL) or lean (LL) chicken lines. In previous research, cDNA microarrays were used to identify differentially expressed genes in FL and LL chickens. Based on these results, four candidate genes located in chromosomes with known quantitative trait loci (QTL) for abdominal fat were selected: superoxide dismutase (SOD3), aldo-keto reductase (AKR1B10), glycine (GPC3), and syndecan (SDC1). Within the promoter region of these genes, eight SNPs identified through sequencing of genomic DNA were unevenly distributed between the FL and LL birds. The current objective was to genotype a three-generation experimental population produced through a reciprocal intercross of the FL x LL. TaqMan genotyping assays and pyrosequencing were used to determine SNP genotypes for 463 F2, 48 F1, and 30 F0 chickens. A univariate model was used to estimate several production traits, with sire and hatch as random effects and SNP as a fixed effect. Significant associations (P<0.05) were detected between AKR1B10 SNP1 and GPC3 SNP1 and fat yield and fat weight. SDC1 SNP1 was significantly associated with fat weight (P<0.05). SOD3 SNP2 and SNP3, which were completely linked with each other, were associated with breast yield (P<0.05). A factor analysis was performed to take multiple traits into consideration. GPC3 SNP1 and SDC1 SNP1 were associated (P<0.05) with a “muscle” yield factor, which combined thigh weight, breast weight, shank diameter and shank length. A repeated measures analysis of growth rate revealed that GPC3 SNP1 interacts with body weight from 1 to 9 weeks of age (P<0.05). Finally, QTLs on chromosomes 1, 3 and 4 for body fat, initially identified using 127 microsatellite markers, were refined by incorporating these SNPs into the QTL analysis. These genetic markers could be of great value for marker-assisted selection of chickens with lower abdominal fat and improved meat yield.

Key Words: fat, QTL, MAS

285P MicroRNA expression and methylation signatures induced by Marek’s disease virus infection in chickens. F. Tian*1, H. Zhang2, and J. Song1, 1University of Maryland, College Park, 2USDA, ARS, Avian Disease and Oncology Laboratory, East Lansing, MI.

MicroRNAs are tiny, non-coding RNAs regulating gene expression at post-transcriptional level. Reported experimental evidences show that microRNAs can serve as oncogenes or tumor suppressor genes. Interestingly, methylation of microRNA genes can down regulate microRNA gene expression, similarly as it does to some protein coding genes. Since Marek’s disease virus (MDV) induces T cell lymphoma in Marek’s disease (MD) susceptible chickens, MDV infected and non-infected chickens, both from a MD resistant and a MD susceptible lines (63 and 72, respectively) of chickens, were utilized to identify microRNAs that might be involved in the host defense to the viral infection. Through microarray analysis, 24 microRNAs were identified with significantly expression differences between the infected and non-infected line 72 chickens (P<0.01; FDR<0.01) at 21 days post infection, suggesting an association between MDV infection and microRNA downregulation in susceptible chickens. These microRNAs may influence diverse pathways and biological processes through their targets. We also noticed that while the microRNA expression was down-regulated, the Dicer 1 and Drosha expressions remained steadily in the infected line 72 chickens. The methylation levels of several microRNAs were significantly higher in infected line 72 chickens than that in infected line 63 chickens. Taken together, we concluded that microRNA expression and methylation levels may serve as signatures of resistance or susceptibility for MDV induced chicken lymphoma.

Key Words: MDV, microRNA, methylation
286P WITHDRAWN.

287P Global gene expression associated with feed efficiency in male broilers. W. G. Bottje¹, B. Kong¹, J. J. Song², T. Wing¹, A. Pazeck³, R. Okimoto³, and K. Lassiter³, ¹University of Arkansas, Department of Poultry Science, Fayetteville, ²University of Arkansas, Department of Mathematical Sciences, Fayetteville, ³Cobb-Vantress, Inc., Siloam Springs, AR.

Since feed remains the highest input cost in animal production, feed efficiency (FE) remains an important genetic trait. This study was conducted to investigate global RNA expression using microarray technology. Breast muscle was obtained from male broilers with high FE (n = 6) or low FE (n = 6) out of a group of 100 birds as previously described (Poult. Sci. 81:546-555, 2002). RNA isolated from muscle samples were tested for quality by agarose gel electrophoresis. The samples were pooled into high and low FE groups and labeled with either Cy3 or Cy5 fluorescent cRNA probes (Agilent Tech., CA). The Cy3 and Cy5 cRNA probes were hybridized on a 4 x 44 K Agilent chicken oligo microarray and, after washing and incubation, were scanned (Genepix 4000B scanner, Molecular Devices, CA). Background-corrected red and green intensities for each spot were used in the subsequent analysis. Global normalization based on local polynomial regression (loess) was applied to the intensities such that only biological variations remained. A moderated t-statistic and its corresponding p-value for each gene were computed to identify differentially expressed genes and adjusted for multiple testing by false discovery rate. Genes with an adjusted p-value below 0.05 were identified as ones being differentially expressed between the low and high FE groups. Quantitative PCR performed on 12 genes was used to validate microarray results. The results revealed that there were approximately 3800 genes that were differentially expressed in the high and low FE groups. Of these, 423 genes were expressed at least 50% different between the two groups. Out of these 423 genes, 249 were higher in the Low FE group with 35 being expressed at 2 fold greater compared to the High FE group. The high FE group had 174 genes that were expressed at 50% or more and 17 of the 174 were expressed at greater than 2 fold higher compared to the Low FE group. The results of this study indicate that by using a global gene expression approach, it may be possible to identify specific genes or gene pathways that are differentially expressed in broilers selected for FE.

Key Words: broiler, feed efficiency, global gene expression

288P Association of immune-related gene expression with SNPs flanking those genes or the transcription factor, NF-Kappa-B. E. Beach, C. Ciraci, B. Abasht, J. C. M. Dekkers, and S. J. Lamont*, Iowa State University, Ames.

Genetic markers (SNPs) for gene expression may be useful additions to marker assisted selection in chicken breeding programs. Signalling by the transcription factor, NF-Kappa-B, is important in initiating and maintaining an effective immune response against pathogens. The objective of this experiment was to determine whether SNPs in the genomic regions flanking NF-Kappa-B (NFKB) and immune-related genes were associated with the level of mRNA expression of the latter group of genes. Gene expression was quantified by RT-PCR for 26 immune-related genes from spleen and cecal tissue of 60 chickens of two lines infected with Salmonella enteritisid. The RNA was isolated from tissues harvested at 6 or 7 days after inoculation of day-old chicks. A maximum of 6 segregating SNPs were identified within 5.5 megabases from the target genes (median distance 1.0 megabase). These SNPs were considered cis-acting SNPs by evaluating associations with corresponding gene expression. Six SNPs were also identified within 4 megabases of the NFKB gene (median distance 1.8 megabase), and these were evaluated as trans-acting SNPs relative to expression of each immune-related gene. Associations were identified by fitting a regression model in JMP by line and tissue, with SNP, sex, and necropsy period as fixed effects and q-PCR plate, sire, and room housed as random effects. Both cis- and trans-located SNPs were found to be significantly (P < 0.05) associated with gene expression level in both tissues and in both lines. Acknowledgements: EB is a National Needs fellow, USDA-CSREES grant no. 2007-38420-17767.

Key Words: eQTL, immune, NF-Kappa-B, SNP, transcription factor

289P Epigenetic analysis of CD4 gene in SPF chicken lines resistant or susceptible to Marek’s disease. J. Luo¹, Y. Yu¹, H. Zhang², and J. Song³,¹ University of Maryland, College Park, ²USDA-ARI ADOL, East Lansing, MI, ³China Agricultural University, Beijing, China.

Marek’s disease (MD) is a lymphoma caused by Marek’s disease virus (MDV) in domestic chickens, which results in economic loss of the poultry industry. CD4 is a surface receptor expressed on CD4+ T cells, which recognize invading pathogen during virus infection. In this study, the influence of MDV infection on epigenetic status of the CD4 gene was examined. With the aid of pyrosequencing technology, promoter methylation levels of the CD4 gene in spleens of chickens from a MD resistant line (63) and a susceptible line (72) were compared at 10 and 21 days post infection (dpi) with MDV. We found that in the promoter region of the CD4 gene the methylation levels of the line 72 chickens were drastically decreased between 10 dpi and 21 dpi (p<0.01), whereas in the line 63 chickens the methylation levels were slightly decreased (p>0.05). Moreover, the methylation levels between the non-infected and infected chickens did not differ both in line 63 and line 72 at 10 dpi (p>0.05), but significantly differ in line 72 (p<0.01) and slightly differ in line 63 (p<0.05) at 21 dpi. These results indicated that the promoter methylation status of CD4 gene was examined by using an effective immune response approach, the results of this study demonstrated that relative stability of promoter methylation status of the CD4 gene may contribute to the host resistance against MDV pathogenicity.

Key Words: Marek’s disease, epigenetics, methylation, immunology, genetics

290P Generating novel genomic libraries of the guinea fowl: Hypothalamic. J. Tyus II*, S. N. Nahashon, N. Adesope, and D. Wright, Tennessee State University, Department of Agricultural Sciences, Nashville.

Excessive fat accretion in poultry negatively impacts feed efficiency, lean tissue growth and consumer acceptability of poultry products. Annual losses incurred by poultry processors through excess fat extraction and disposal are estimated at 250-300 million USD. Saturated animal fat in the human diet has been linked to obesity, cardiovascular disease and certain cancers. Understanding hypothalamic influence of fat deposition in birds will be useful in designing feeding regimens, breeding programs and management practices for improving carcass quality and minimizing production costs. While much progress has been made in
generating genetic sequence information in chickens, turkeys and quail, there is paucity of such pertinent data in the guinea fowl (GF). Such information is essential in understanding the genome of the GF and in comparative mapping of avian species. The primary aim of this study was to construct a comprehensive complementary DNA (cDNA) library of genes expressed in GF hypothalamus (hypo). Messenger RNA was isolated from GF hypo, reverse transcribed into cDNA and cloned into the pBluescript plasmid vector using the Stratagene® cDNA Library Construction Kit. Approximately 300 clones were selectively screened, cycle-sequenced by the polymerase chain reaction and analyzed with the ABI PRISM® 3100-Avant Genetic Analyzer. Realized nucleotide sequences were subjected to sequence homology searches carried out through the NCBI databases using BLAST (http://www.ncbi.nlm.nih.gov/BLAST/). Nucleotide sequence similarity between GF and other avian species averaged 79.5%. Nucleotide sequences exhibiting high homology (i.e., ≥80%) with other avian species averaged 655.6 bases in length and ranged from 373 to 1,025 bases. Nearly 10% of the nucleotide sequences analyzed showed no significant similarity to any available sequence data. Ultimately, information obtained from this and other genomic libraries will provide an invaluable tool for comparative mapping of the avian genome and further our understanding of the mechanisms underlying appetite, satiety and nutrient utilization in poultry.

**Key Words:** guinea fowl, hypothalamus, cDNA library, genomics

**Poster Session: Immunology**

**292P WITHDRAWN.**

**293P Immunobiological effects of three phytonutrients, carvacrol, cinnamaldehyde, and capsicum oleoresin on chicken cells cultured In vitro.** D. K. Kim*1, H. S. Lillehoj3, S. H. Lee1, S. I. Jang1, C. Ionescu2, and D. Bravo 2, 1Animal Parasitic Diseases Laboratory, Animal and Natural Resources Institute, Beltsville Agricultural Research Center, United States Department of Agriculture, Agricultural Research Service, Beltsville, MD, 2Pancosma S. A., Research Department/Nutrition & Technology, Voie des Traz 6, Le Grand-Saconnex, Switzerland.

The present study was conducted to investigate the effects of three different plant-derived phytonutrients, carvacrol, cinnamaldehyde and capsicum oleoresin, on innate immune responses and tumor cell growth. To evaluate their effects, lymphocyte proliferation and the growth rate of tumor cell were assessed using a non-radioactive CCK-8 assay, and nitric oxide production was also measured using an in vitro culture treated with the three phytonutrients (carvacrol, cinnamaldehyde and capsicum oleoresin). Quantitative real-time RT-PCR was performed to measure the transcriptional expression of cytokine genes in macrophages in response to treatment with each phytonutrient. Results showed that each phytonutrient induced significant proliferation of spleen lymphocytes compared with the untreated control, and all stimulated robust nitric oxide production to the levels similar to that induced by recombiant chicken interferon-γ. All phytonutrients inhibited the growth of chicken tumor cells in a dose-dependent manner. The levels of mRNAs encoding IL-15 and IL-18 were enhanced when macrophages were treated with cinnamaldehyde. Capsicum oleoresin provoked the high expression of IL-18 and TNFSF15. The genes of IFN-α, IL-1b, IL-6 and IL-12 were not significantly influenced by the treatment of cinnamaldehyde or capsicum. These results suggest that these three phytonutrients, carvacrol, cinnamaldehyde and capsicum oleoresin, enhance host innate immune system in chicken.

**Key Words:** carvacrol, cinnamaldehyde, capsicum oleoresin, innate immunity, chicken

**294P Ethanol-induced changes in oxidative stress and immunological parameters of the chicken, Gallus gallus.** H. Deng*4, X. Guan1, K. B. Gynel1, J. Xu1, R. Dalloul1, R. M. Gogal2, R. E. Pearson3, and E. J. Smith1, 1Virginia Polytechnic Institute and State University, Department of Animal and Poultry Science, Blacksburg, 2Virginia Polytechnic Institute and State University, Department of Biomedical Science and Pathobiology, Blacksburg, 3Virginia Polytechnic Institute and State University, Department of Dairy Science, Blacksburg.

Oxidative stress is believed to be responsible for many diseases and physiological abnormalities in animals. However, the potential effect
of oxidative stress on the immune system of chicken has not been investigated. Using ethanol as an inducer of oxidative stress, the main objective of this study was to examine the possible association between oxidative stress and immunosuppression in chickens. To evaluate these relationships, 4-week-old White Leghorn chickens were randomly divided into 4 groups of 24 birds each, and provided ad libitum starter diet and drinking water containing 0, 2, 6, and 10% ethanol for 2 weeks. As oxidative stress increased, plasma IgG but not IgM decreased. Typically, heterophils are the first leukocyte to migrate from the peripheral blood to the site of infection, in this case the abdominal cavity. Birds are dependent on the recruitment of heterophils to fight off infection and foreign invaders. In the present investigation (3 replicate studies) a combination of four different field isolates of CP (type A) were administered intra-abdominally at 1 X 10^5 CFU/0.2mL/bird for CP treated birds and a 0.2mL/bird of physiologic saline was administered to the controls birds. Standard abdominal washes were performed at 0, 1, 2, 3, 4 h to evaluate total leukocyte influx into the abdominal cavity of the bird. When evaluating the total leukocytes from the CP injected and saline controls there was a significant (P ≤ 0.05) increase in leukocytes in the abdominal cavity of CP injected birds (1.2 X 10^7) at 3 h compared to saline control (2.83 X 10^6). Differentials were determined by counting monocytes, lymphocytes and heterophils. When evaluating the differential counts, there were significant (P ≤ 0.05) increases between CP and saline treated birds involving heterophil recruitment at 3 h. These results suggest there is a complex immune interaction occurring in the abdominal cavity of the birds to protect them from CP involving heterophil recruitment to the site of infection. Understanding the birds innate immune response to Clostridia will help develop future research to elucidate host/CP immune interactions.

Key Words: chickens, leukocytes, heterophils, Clostridium perfringens


Acute viral infections are one of the leading causes of illness and death in humans and animals worldwide. Identifying and understanding how host proteins are involved in protecting cells from viral infection is critical to our ability to develop novel antiviral therapies. One host protein known to be directly involved in inhibiting viral replication is known as Mx; however the mechanism by which it blocks virus replication is not well characterized. In mammals there are typically two Mx genes, with the product of one gene found in the nucleus and the other in the cytoplasm. In mice the nuclear localized Mx (MxA) has been demonstrated to inhibit influenza virus. Further analysis of MxA demonstrated that differences in mouse strain susceptibility to influenza virus were associated with specific Mx alleles. Mx genes have also been discovered in non-mammalian species. Recent reports have identified numerous Mx alleles in various lines of chickens and related these to differences in their antiviral activity. However, how the different polymorphisms in Mx affects its function is not currently known. To begin to characterize how sequence changes affect Mx biology, we examined the effect of amino acid changes on cellular localization of the Mx protein. One allele of the chicken Mx gene was cloned into the pEGFP-N1 expression system to
generate a construct which produces an Mx-enhanced green fluorescent protein (EGFP) fusion protein. This initial plasmid was then subjected to a series of site directed mutagenesis reactions to generate subsequent expression constructs encoding other Mx alleles and transfected into chicken embryo fibroblast (CEF) cells. Because localization of the Mx protein can be determined using UV-microscopy, the recombinant Mx-EGFP construct will allow us to begin to understand how various alleles of chicken Mx is related to its structure-function in cells, and how these differences may be related antiviral activity.

Key Words: Mx, antiviral

298P  Effect of dietary arginine on peripheral blood mononuclear cell populations and cytokine profiles during the acute phase response in broiler chicks. J. L. D’Amato* and B. D. Humphrey, California Polytechnic State University, San Luis Obispo.

The effect of dietary arginine (ARG) levels on peripheral blood mononuclear cell (PBMC) populations and T helper (Th) subset cytokine mRNA abundance was determined during the acute phase response (APR) in broilers. Cobb hatchlings were fed one of three diets formulated to meet or exceed NRC requirements, except for ARG. Diets contained low (1.1%), adequate (1.3%), or high (1.5%) ARG. On d19 posthatch, chicks from four replicate pens per treatment were not injected (control) or injected subcutaneously with Salmonella typhimurium lipopolysaccharide (LPS, 1 mg/kg BW). At 2 and 24 h post-injection, peripheral blood and spleen from one chick per pen were collected. PBMC were isolated by density centrifugation and CD4+ T cell, CD8+ T cell, B cell and monocyte populations were identified by flow cytometry. Spleens were frozen in liquid nitrogen prior to total RNA isolation, reverse transcription and quantification of 191-3 cytokine mRNA abundance by real-time PCR. Chicks fed 1.3% and 1.5% ARG had greater BW than chicks fed 1.1% ARG (P<0.05). From 0-2 h, LPS decreased feed intake by 40% compared to controls (P<0.05), but feed intake was similar to controls from 2-24 h post-injection (P>0.05). The percentage of CD4+ T cells, CD8+ T cells, B cells and monocytes in peripheral blood did not differ to dietary ARG (P>0.05). LPS decreased peripheral blood CD4+ T cells, CD8+ T cells, B cells and monocytes by 46, 52, 38, and 82%, respectively, at 2 h post-injection (P<0.05). The APR reduces food intake and T cell, B cell and monocyte populations in peripheral blood by 2 h post-infection, irrespective of dietary ARG levels.

Key Words: arginine, cytokine, leukocyte, lipopolysaccharide, monocyte

299P  In vitro effects of plant and mushroom extracts on immunological function of lymphocytes, macrophages, and tumor cells. S-H. Lee*, 1, H. Lillehoj1, Y. Hong1, 2, D. Bravo2, and L. Mazuranok2, 1Animal and Natural Resources Institute, Agricultural Research Service-U.S. Department of Agriculture, Beltsville, MD, 2Pancosma S.A., Geneva, Switzerland, 3Chung-Ang University, Anseong, Korea.

The present study was conducted to examine the ability of various plants extracts (turmeric, milk thistle) and mushrooms extracts (Shiitake, Reishi) to stimulate innate immunity and kill tumor cells. Innate immunity was measured by lymphocyte proliferation and nitric oxide production. Ability of extracts to inhibit tumor cell growth was assessed using a non-radioactive CCK-8 assay. In vitro culture of chicken spleen lymphocytes with extracts of turmeric (Curcuma longa), milk thistle (Silybum marianum), shiitake (Lentinus edodes) and reishi (Ganoderma lucidum) mushrooms, induced significantly higher cell proliferation compared with the untreated control cells. Stimulation of macrophages with extracts of milk thistle, shiitake and reishi mushrooms, but not turmeric, stimulated robust nitric oxide production to levels similar to that induced by recombinant chicken interferon-γ. All extracts uniformly inhibited the growth of chicken tumor cells in vitro. Finally, the levels of mRNAs encoding IL-1β, IL-6, IL-18, and TNFSF15 were enhanced when macrophages were treated with the extracts of turmeric or shiitake mushroom compared with the untreated control. These results show that the extracts examined (turmeric, milk thistle, shiitake and reishi) enhanced innate immunity in chickens.

Key Words: plant, mushroom, lymphocytes, macrophages, tumor cells

300P  Gene expression profiling difference between resistant and susceptible broilers responding to Campylobacter jejuni infection. X. Li1, C. Swaggerty2, M. Kogut2, H. Chiang1, Y. Wang1, K. Genoves2, H. He2, I. Pevzner3, and H. Zhou*1, 1Texas A&M University, College Station, 2United States Department of Agriculture, Agricultural Research Service, College Station, TX, 3Cobb-Vantress, Inc, Siloam Springs, AR.

Campylobacter jejuni (C. jejuni) is one of the most common pathogens causing human gastroenteritis worldwide. Chickens, as a natural reservoir of C. jejuni, are a good animal model to study the molecular mechanism of a host’s response to C. jejuni infection. Previous studies showed there was a significant difference in C. jejuni colonization between two distinct parental lines (A and B) and that there was considerable variation within line. To elucidate the molecular mechanisms of genetic resistance to C. jejuni colonization, the Agilent chicken 44K microarray was used to profile gene expression. Day-old chickens from lines A and B were challenged orally with C. jejuni. Cecal content and the cecal tonsil were collected for colonization quantification and total RNA isolation 7 days post-challenge, respectively. Twenty samples with the highest (S) or lowest bacterial number (R) in cecal content within each line were randomly pooled into four biological replicates. The pair comparisons between the two groups (R and S) within each line (A and B) were analyzed. The signal intensity of each gene was normalized using LOWESS method. A mixed model was used to identify differentially expressed genes by SAS (P < 0.01). There were 564 and 6105 genes differentially expressed between groups in the comparison of AS/AR and BS/BR, respectively, and 1565 and 2488 genes between the two lines (AS, BS, AR/BR, respectively). However, there were 18 and 62 immune-related genes differentially expressed in AS/AR and BS/BR, respectively, while only two immune-related genes were shared between AS/AR and BS/BR. The results showed that a significantly different response to C. jejuni infection occurred not only between different genetic lines but also between resistant and susceptible chickens within line, and the individual contribution should be considered when evaluating genetic resistance.

Key Words: broiler, C. jejuni, microarray, gene expression
301P  Innate immune response to Campylobacter jejuni infection in the broiler bursa. J. Hilley1, X. Li2, C. Swaggerty2, H. Chiang2, Y. Wang1, K. Genovese2, H. He2, V. DiRita1, I. Pevzner1, and H. Zhou*1, 1Texas A&M University, College Station, 2United States Department of Agriculture, Agricultural Research Service, College Station, TX, 3University of Michigan, Ann Arbor, 4Cobb-Vantress, Inc., Siloam Springs, AR.

Campylobacter jejuni (C. jejuni) is one of the most common causes of food-borne illness worldwide. Chickens are a major reservoir for C. jejuni. To identify the differentially expressed genes between chickens infected with wild-type (wt) C. jejuni and non-infected chickens, a broiler line susceptible to C. jejuni infection was challenged with wt C. jejuni or PBS at the day of hatch. Total RNA was isolated from bursa harvested at 1 and 4 hours post-inoculation. Eight biological replicates were used in infected and non-infected groups at each time point. The signal intensity of each gene was normalized using LOWESS method. A mixed model was used to identify differentially expressed genes by SAS program (P < 0.01). There were 1016 and 275 genes significantly differentially expressed between infected and non-infected chickens at 1 and 4 hours post-challenge, respectively. The finding of more differentially expressed genes at 1 hour than 4 hours post-challenge between infected and non-infected chickens was compared to previous results observed in a line more resistant to C. jejuni. There were 2591 and 2936 genes significantly changed between 1 and 4 hours post-challenge in infected and non-infected chickens, respectively. The results show there was a strong early host response to wt C. jejuni in this susceptible chicken line. To further characterize the molecular mechanisms of the host innate immune response to C. jejuni infection in broilers, gene expression profiling at additional time-points post-challenge is underway in our laboratory.

Key Words: broiler, C. jejuni, innate immune response, microarray, bursa

302P  Downregulation of liver expressed antimicrobial peptide (LEAP-2) mRNA following coccidiosis challenge. S. Casterlow1, X. Li2, C. Swaggerty2, H. Chiang2, Y. Wang1, K. Genovese2, H. He2, V. DiRita1, I. Pevzner1, and H. Zhou*1, 1Texas A&M University, College Station, 2United States Department of Agriculture, Agricultural Research Service, College Station, TX, 3University of Michigan, Ann Arbor, 4Cobb-Vantress, Inc., Siloam Springs, AR.

C. jejuni is a major disease of poultry caused by the intestinal protozoa Eimeria, which results in reduced feed efficiency and body weight gain. The objective of this study was to compare gene expression in Aviagen line A and line B birds that show differential susceptibility to Eimeria infection. Line B chicks showed higher lesion scores and higher mortality compared to line A chicks when orally challenged with C. jejuni or PBS at the day of hatch. Total RNA was isolated from bursa harvested at 1 and 4 hours post-inoculation. Eight biological replicates were used in infected and non-infected groups at each time point. The signal intensity of each gene was normalized using LOWESS method. A mixed model was used to identify differentially expressed genes by SAS program (P < 0.01). There were 1016 and 275 genes significantly differentially expressed between infected and non-infected chickens at 1 and 4 hours post-challenge, respectively. The finding of more differentially expressed genes at 1 hour than 4 hours post-challenge between infected and non-infected chickens was compared to previous results observed in a line more resistant to C. jejuni. There were 2591 and 2936 genes significantly changed between 1 and 4 hours post-challenge in infected and non-infected chickens, respectively. The results show there was a strong early host response to wt C. jejuni in this susceptible chicken line. To further characterize the molecular mechanisms of the host innate immune response to C. jejuni infection in broilers, gene expression profiling at additional time-points post-challenge is underway in our laboratory.

Key Words: chicken, LEAP-2, coccidiosis, Eimeria maxima, microarray

303P  Development of a CXCL8 (IL-8)-bioassay to determine its role in turkey poult viral enteritis. R. A. Ali* and M. D. Koci, North Carolina State University, Raleigh.

Turkey astrovirus type-2 (TAstV-2) was originally identified and associated with poult enteritis and mortality syndrome (PEMS), but has since been recognized to cause severe enteritis in turkey poult throughout the Americas and Europe. In spite of its broad distribution and impact on turkey production we know little about TAstV-2 pathogenesis or the host immune response to it. Studies done in our laboratory have demonstrated TAstV-2 infection induces severe watery diarrhea and growth suppression. Analysis of infected intestines demonstrated no histological change or signs of inflammation despite increased gene expression of the pro-inflammatory chemokine CXCL8 (interleukin-8, IL-8). CXCL8 is recognized as a potent chemotaxant signal for heterophils and is often recognized as one of the first innate immune molecules secreted by infected tissues to elicit cells of the innate immune system to initiate the host response. However, following TAstV-2-induced CXCL8 expression, there is no influx of immune cells to the site of TAstV-2 replication. In addition to its chemotaxis properties, it has been suggested that CXCL8 have angiogenic properties and may play a role in inducing proliferation of intestinal epithelia cells. To better understand the role of CXCL8 following TAstV-2 infection, our laboratory developed a CXCL8 bioassay using the mouse pre-B cell line L1.2 expressing a recombinant chicken CXCR1 and recombinant turkey CXCL8 as a positive control. This new assay will be an important tool in our ability to determine the various functions CXCL8 expression in the intestine and specifically its role in the innate immune response to virally induced poult enteritis.

Key Words: TAstV-2, PEMS, IL-8, CXCL8, CXCR1

304P  Mass spectrometric identification and measurement of avian beta defensins 2. N. C. Rath*1, L. Kannan1,2, R. Liyanaige3, and J. O. Lay, Jr.3, 1USDA/ARS, Fayetteville, AR, 2University of Arkansas, Department Poultry Science, Fayetteville, 3University of Arkansas, Statewide Mass Spectrometry Lab., Fayetteville.

Beta defensins are small, cationic peptides that bind to microbial membranes and disrupt their integrity thereby exerting the antimicrobial effects. These peptides play important role in innate immunity defending against microbial pathogens. Using matrix assisted laser desorption ionization-time of flight mass spectrometry (MALDI-TOF MS), we found the chicken heterophils teemed with avian beta defensin 2 (AvBD2) isoform. The heterophils play a crucial role in innate immunity defending against microbial pathogens. Because heterophils undergo activation through their membrane bound ‘Toll-like receptors (TLR)’ that recognize ‘pathogen associated molecules,’ we wanted to find whether TLR ligands stimulate AvBD2 production. We cultured chicken heterophils with different TLR ligands representing both bacterial and
viral motifs that included lipopolysaccharides, peptidoglycans, flagellin, lipoxygenase, Cpg-ODN, and poly I: C for 6 hours, and extracted the conditioned media for measurement of AvBD2. To measure the changes in AvBD2 production, aliquots of each extract containing AvBD2 (m/z 3916) was reduced and alkylated, resulting in the carbamidomethylated 6 cysteine residues and a mass shift to m/z 4264. Considering that the chemical modification and treatments likely affect spectral intensities, correction factors (CF) for each treatment group were calculated using the intensity ratios of AvBD2 in 1:1 mixture of nonreduced (nr) and reduced (r) aliquots of each sample by MALDI-TOF MS. The reduced extracts from individual treatments (Tr) were then mixed with non reduced control aliquots (Cr) at 1:1 ratio (with respect to protein content) and then subjected to MALDI-TOF MS as above. The Tr/Cnr ratio was multiplied by an appropriate correction factor and compared with similarly calculated control (Cr/Cnr*CF). The results showed that most pathogen mimetics (except CpG-ODN) were potent inducers of AvBD2. In conclusion, these results show that MALDI-TOF MS is able to identify mature AvBD peptides and is also able to to take advantage of their chemistry to modify and measure changes in their production in response to different stimulants.

Key Words: heterophil, beta defensin, mass spectrometry

305P Identification of potential target genes of the novel chicken-specific miRNA, miR-NC-57. A. Whisnant*, J. Hicks, and H. C. Liu, North Carolina State University, Raleigh.

MicroRNA (miRNA), a class of small (~19-24nt) regulatory RNA, function in post-transcriptional regulation of gene expression. It has been suggested that up to 30% of genes are regulated by miRNA. MiRNA function by knocking down the expression of target genes by binding to complementary sites in the targeted miRNA. These target sites often lie within the 3' untranslated region. MiRNA expression profiles have revealed that hundreds of dynamically expressed miRNA are encoded in the eukaryotic genome. Many miRNAs are conserved across species and it is likely that these conserved miRNAs function similarly. However, it also appears that each genome also encodes a unique set of miRNAs that possess species-specific function(s). We recently used the deep sequencing approach to profile miRNA expressed in the developing chick embryo. This profile identified a group novel and likely chicken-specific miRNA, of which the miRNA miR-NC-57 is a member. To further understand the involvement of miR-NC-57 in chick development, the present study was undertaken to identify its potential target genes. Potential miR-NC-57 target genes were identified using the miRNA target prediction algorithm miranda. These potential target genes were then validated using a retroviral-based RNA interference (RNAi) strategy. mir-NC-57 was found to potentially target two members (B-cell translocation gene 2 and B-cell translocation gene 4) of the BTG/Tob family. This family consists of structurally related proteins that are involved in regulating cell proliferation by inducing G1 phase arrest during the cell cycle. This suggests that miR-NC-57 may function to allow increased cell proliferation during chick embryonic development by targeting anti-proliferative genes.

Key Words: microRNA, embryonic development, gene regulation, RCAS, immune system

Poster Session: Metabolism and Nutrition

306P Effect of Saccharomyces cerevisiae fermentation product on immune function of broilers challenged with Eimeria tenella. J. Gao1, H. J. Zhang1, S. G. Wu1, S. H. Yu2, I. Yoon2, D. Moore3, Y. P. Gao2, H. J. Yan1, and G. H. Qi*1,2, 1Feed Research Institute, Chinese Academy of Agricultural Sciences & Key Laboratory of Feed Biotechnology, Ministry of Agriculture, Beijing, China, 2College of Animal Science and Technology, Northwest A & F University, Yangling, Shaanxi, China, 3Diamond V Mills Inc., Cedar Rapids, IA.

The purpose of this study was to compare various levels of a Saccharomyces cerevisiae fermentation product with and without a coccidian challenge. Three hundred and sixty day-old male Arbor Acres broilers were randomly allotted to 6 groups with 2 X 3 factorial arrangement. Three supplemental levels (0.25 and 0.50%) of Saccharomyces cerevisiae fermentation product (Diamond V XP™) were fed to control and Eimeria tenella infected broilers. Each treatment consisted of 6 replicates of 10 birds each. Growth performance and immune response criteria were measured after coccidian infection. Broiler ADG and feed conversion were lowered (P < 0.01) by coccidian infection. The ADG was improved by XP supplementation (P < 0.05) during d 21 to 42 for both coccidia infected and non-infected birds. Supplementation of XP increased CD3+, CD4+, and CD8+ T lymphocyte content (P < 0.05) and ratio of CD4+/CD8+ in blood (P = 0.06) and spleen (P = 0.04) as well as ileum intraepithelial lymphocytes count, cecal tonsil slgA content, serum lysozyme content (P < 0.01), serum IgM content and albumin to globulin ratio (P = 0.02). The above immune indexes exhibited a dose response to the XP supplemental level, especially for the coccidian infected birds. When XP supplementation increased in the diet of coccidia-infected broilers, CD3+, CD4+ in blood and spleen, ileum intraepithelial lymphocytes count, cecal tonsil slgA content, serum lysozyme content increased linearly (P < 0.01), and CD8+ quadratically (P < 0.01). These results suggest that dietary XP supplementation could improve immune function and growth performance in coccidia-infected broilers.

Key Words: Saccharomyces cerevisiae fermentation product, broiler, immune function, coccidiosis

307P Effects of Saccharomyces cerevisiae fermentation product on immune function of broilers challenged with endotoxin lipopolysaccharide. J. Gao1, H. J. Zhang1, S. G. Wu1, S. H. Yu2, I. Yoon2, D. Moore3, Y. P. Gao2, H. J. Yan1, and G. H. Qi*1,2, 1Feed Research Institute, Chinese Academy of Agricultural Sciences & Key Laboratory, Ministry of Agriculture, Beijing, China, 2College of Animal Science and Technol-
The purpose of this experiment was to evaluate various levels of a *Saccharomyces cerevisiae* fermentation product during a lipopolysaccharide (LPS) challenge. Three hundred and sixty-day-old male Arbor Acres broilers were randomly allotted into six groups to investigate the effects of different dosages (0, 0.25, and 0.50%) of *Saccharomyces cerevisiae* fermentation product (Diamond V XPTM) on the immune response of broilers in the serum and intestine stimulated by endotoxin LPS injection. Each group consisted of 6 cages of 10 birds each. Growth performance, serum immunoglobulin, ceruloplasmin and lysozyme, myeloperoxidase activity, intraepithelial lymphocyte count (IEL), IgA+ plasmacyte count and sIgA content in intestine and cecal tonsil were measured. Half of the broilers from each dietary treatment were intraperitoneally injected with 0.25 mg/kg LPS (*E. coli* O55:BS) on d 23, 25 and 27 and the same dose of sephadex on d 24 and 26 of age. The other half were injected the same dose of saline as the control. Broilers were fed a corn-soybean meal diet for 28 days. Injection of LPS lowered growth performance (P = 0.02) while supplementation of XP in diets tended to increase (P = 0.08) ADG. Dietary XP increased sIgA content, IgA+ plasmacyte count and IEL count in the duodenum and cecal tonsil (P < 0.01) as well as serum IgM and lysozyme content (P < 0.05), but lowered the ceruloplasmin content on d 6 after first LPS injection (P < 0.01). Dietary XP did not affect the intestinal myeloperoxidase activity in duodenum. These results suggested that dietary XP could modulate immune function during an LPS challenge and improve intestinal health.

**Key Words:** *Saccharomyces cerevisiae* fermentation product, broiler, lipopolysaccharide, immune function


L. Zhang1,2, H. Y. Yue1, H. J. Zhang1, L. Xu1, S. G. Wu1, H. J. Yan1, Y. S. Gong2, and G. H. Qi1,2, 1Feed Research Institute, Chinese Academy of Agricultural Sciences & Key Laboratory of Feed Biotechnology, Ministry of Agriculture, Beijing, China, 2College of Animal Science and Technology, Northwest A & F University, Yangling, Shaanxi, China.

The effect of transport stress on blood metabolism, glycolytic potential (GP) and meat quality in broilers was studied. Arbor Acres chicks (n = 360, day-old, male) were randomly allotted to five treatments: unstressed control; 45 min (Short-term) transport with 45 min (Short-term) recovery; 45 min transport with 3 h (Long-term) recovery; 3 h transport with 45 min recovery, and 3 h transport with 3 h recovery. Each treatment consisted of 6 replicates with 12 birds. On d 46, all birds (except control) were transported abided by a designed protocol. One bird of each replicate was selected for blood and skeletal muscles sampling after electrically stunned. Plasma was obtained by centrifugation. The right pectoralis major and thigh muscle were sampled for assay of meat quality. Rectangular-shaped left tibialis anterior muscle and pectoralis major muscle were sampled for analysis of meat quality. Glycogen and lactate were measured in the thigh muscle. The results suggested that transport induce release of plasma CORT and glycopenia, which affected the contractive status of muscle fibers by changing their area and density, and enhanced glycolysis and even lipolysis. A long-term recovery after transport was beneficial in lowering plasma CORT levels and reducing muscle glycolysis, which might improve broiler meat quality.

**Key Words:** transport stress, broiler, blood metabolism, GP, muscle type

### 309P Effects of dietary inclusion of a *Saccharomyces cerevisiae* fermentation product on performance and gut characteristics of male turkeys to market weight.

J. D. Firman*1 and D. Moore2, 1University of Missouri, Columbia, 2Diamond V Mills, Cedar Rapids, IA.

An experiment was conducted to test the effects of different levels of a *Saccharomyces cerevisiae* fermentation product on the performance and gut characteristics of male turkeys to 18 weeks of age. Turkeys were housed in a 32 pen facility (800 birds) with 8 replicates and 4 levels (0, 0.0625%, 0.125%, 0.25%) of XPC™ (Diamond V Mills). Experimental parameters measured included: body weight, feed intake, feed conversion, mortality and gut parameters (villi height, crypt depth, gut section histopathology). Processing yield was measured at the conclusion of the trial. All other diets and husbandry practices were based on industry standards. Feed efficiency was significantly improved in the 15-18 week period at all treatment levels (2.64 vs 2.76 feed:gain at 18 weeks). No other differences in performance parameters measured were observed. Pectoralis major yield was higher in all treatment groups, (19.9% vs. 20.7%) when compared to controls. No statistical differences were seen in gut samples in terms of gut scores, villi height, or crypt depth. The data reported here indicates that supplementing the diet with XPC may have a positive effect on the feed efficiency and breast meat yield of tom turkeys, but that further studies will be needed to define this effect.

**Key Words:** *Saccharomyces cerevisiae*, turkey, breast yield, feed efficiency, production

### 310P Effect of the composition of yeast strain isolated from Colombian tropical fruits on selected microbial parameters of gastrointestinal tract metabolism of broilers.


In this study, the effects of probiotic and prebiotic of yeasts were associated with the chemical composition of its cell wall and how they affected selected parameters of gastrointestinal tract (GIT) metabolism such as the concentration of short-chain fatty acids (SCFA) and ammonia in broiler chickens. The chemical composition of six isolated yeasts from Colombian tropical fruits and two commercial yeasts were characterized in terms of biomass production, total protein, total carbohydrates, hexose concentration (mannose, glucose and galactose), b-glucans, quitin and total selenium. The caecum content from 756 Hydro male broilers supplemented with yeast at 0.5% of the diet in a commercial approach, were collected at 8, 15 and 25-d of age and analyzed for total *E. coli* using classical plating techniques. SCFA were determined by a gas chromatographic method, and ammonia by UV spectrophotometry. Yeast biomass production ranges from 2.33 to 4.44 mg/mL and its average composition was 61.7% total carbohydrate, 16.3% protein, 0.07% selenium, 2.2% quitin, 2.9% b-glucan, 10.6%
mannose, 15.7% galactose, 43.4% glucose. In general, yeast composition affected differentially the selected microbial parameters of GIT metabolism according to the age of the bird. Protein was correlated negatively (P < 0.05) with the concentration of both acetate and butyrate at 15-d (P < 0.05). Total carbohydrate showed a negative correlation with acetate at 8-d (P < 0.05) and ammonia at 15-d (P < 0.05) and E. coli hemolysin at 25-d (P < 0.001). Glucose correlated positively with ammonia (P < 0.01) and negatively with acetate (P < 0.05) and butyrate (P < 0.05) at 15-d. Galactose showed positive correlation with butyrate (P < 0.05) at 8-d. b-glucans correlated positively with both pH (P < 0.05) and propionate (P < 0.05) at 8-d. Total selenium was affected negatively by E. coli hemolysin (P < 0.05) and positively by isobutyrate at 15-d (P < 0.05). Quito did not correlate with any parameters of GIT metabolism of broilers.

Key Words: yeast, tropical fruits, broiler

311P Progeny responses from breeder hens fed a Saccharomyces cerevisiae fermentation product. L. Araujo*,1, C. Araujo1, D. Moore2, R. Upton3, L. C. G. S. Barbosa1, and M. T. Kidd1, 1Mississippi State University, Department of Poultry Science, Mississippi State, 2Diamond V, Cedar Rapids, IA.

Two experiments were conducted to evaluate growth and carcase parameters of progeny from breeder breeders fed diets containing a Saccharomyces cerevisiae fermentation product. Chicks were obtained from Cobb 500 hens fed either a control diet or a control diet plus Diamond V XPC™ (1.5 lbs/ton) A total of 300 eggs (150 eggs per treatment) were obtained and set when breeders were 30 and 38 wk of age. At d 1, chicks were separated, weighed, and wing-banded by breeder treatment. Straight-run chicks were placed into 16 pens (12 birds/pen) of a floor pen facility. Each pen contained 1 nipple drinker line, 1 tube feeder, and used soft-wood shavings as litter. Broilers received 24 h of light. Few studies, however, have examined the effects DFM have on the broiler chick crop as well as to further describe changes associated to the control treatment. Future studies should be conducted to elucidate effects of Saccharomyces cerevisiae fermentation products on breeder diets and its effects on progeny.

Key Words: progeny, broiler, breast yield

312P WITHDRAWN.

313P WITHDRAWN.

314P Effect of Bacillus subtilis C-3102 spores (CALSPORIN®) in the diet of caged ISA Brown laying hens on productive performance and external and internal egg quality characteristics. T. Jinez1, E. Posadas1, E. Sánchez2, I. Sánchez1, E. Avila1, F. Gómez2, and D. M. Hooge3, 1Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, Santiago Zapotitlán, Tláhuac, Mexico, 2Hocho Mexico SA de CV, Cuauhtémoc, Mexico City, Mexico, 3Hooge Consulting Service, Eagle Mountain, UT.

A 14-wk feeding trial was conducted with 360 ISA Brown laying hens from 75 to 89 wk of age to evaluate effects of dietary Bacillus subtilis C-3102 (Bs C-3102; CALSPORIN®, Calpis Co. Ltd, Tokyo, Japan) on live performance and egg quality traits. There were 5 replicate groups of 24 hens (120 hens) each per treatment. Treatments were: 1) negative control basal diet (nCON), 2) basal diet + Bs C-3102 (3x10⁶ cfu/g feed), and 3) basal diet + bacitracin-md (BMD®, Alpharma, Inc., Ft. Lee, NJ) at 50 ppm. At the middle (7 wk) and end (14 wk) of the trial, 3 eggs were collected from each replicate pen for evaluation. Egg cracks and checks (microfissures) were determined by candling. Shell thickness was measured by micrometer. Yolk pigmentation was scored using a Roche (DSM) color fan. Redness of each egg shell was measured with a Minolta reflectance colorimeter. Statistical analysis was by 1-Way ANOVA with mean separation by LSD procedure. After 4 wk, Lactobacilli counts in fresh excreta samples were substantially higher in the Bs C-3102 group but much lower in the BMD® group compared to nCON. No significant differences between treatments were found for feed consumption in g/hen/d (P = 0.882), feed/egg in kg/kg (P = 0.922), egg production (P = 0.597), egg mass in g/hen/d (P = 0.808), Haugh units (P = 0.524), or yolk color score (P = 0.531). Shell thicknesses for nCON, Bs C-3102, and BMD® treatments were 0.347, 0.366, and 0.364 mm (P = 0.531) and cracks and checks % were 12.7, 7.7, and 14.5% (P = 0.374), respectively. Egg weights by treatment were 63.60, 64.66, and 64.80 g (P = 0.036), respectively, with nCON significantly lower. Egg shell redness scores tended to be improved with Bs C-3102 (2.11) or BMD® (2.06) supplemented diets compared to nCON (1.26) diet (P = 0.065). Supplementing ISA Brown laying hen diets with either Bs C-3102 spores or BMD® significantly improved egg weight and tended to improve egg shell redness scores in a 14-wk feeding trial from 75-89 wk of age.

Key Words: bacitracin, calsporin, egg weight, ISA Brown, laying hen


Direct fed microbials (DFM) have been reported to promote health by helping to stabilize the gastrointestinal (GI) micro-environment. Our previous studies have demonstrated that the DFM, Primalac®, can enhance the development of the lower GI physiology of broiler chicks. Few studies, however, have examined the effects DFM have on the pre-gastric regions of the digestive tract. The objectives of the current study were to investigate the effects of DFM on the ultrastructure of the broiler chick crop as well as to further describe changes associated with DFM in small intestinal structure and ultrastructure. Day-old male broilers were allocated to two diet groups: control starter diet (CSD), or DFM diet (CSD plus Primalac®, 0.3% w/w; PRIM). At day 7, 14 and 21, the crop and ileum was sampled from 6 birds per group and the effects of PRIM were assessed by scanning electron microscopy (SEM). Meanwhile, ileum was also sampled for histomorphometric analysis. Intestinal lengths were measured on days 1, 7, 10, 14, 16 and 21. Crops from animals fed PRIM were observed to have more adherent bacteria than animals fed CSD. Crop wall erosion was decreased in broilers fed PRIM and crops from PRIM treated birds had increased and more-continuous microfolds of squamous epithelial cells. PRIM increased...
SI length at day 10 (P<0.05), enhanced ileal villi surface and length as well as increased microvilli structure and numbers. These data suggest PRIM enhances crop wall integrity and increases ileal villi length and surface, and improves microvilli structure.

**Key Words:** DFM, digestive tract, crop, villi, ileum

### 316P Use of probiotics as growth promoters in broiler diets.

C. Gutiérrez¹, A. Zuñiga¹, A. G. Lorenzoni*², G. Tellez³, and J. L. Vicente¹.

¹Universidad de La Salle Bajio, León, Guanajuato, Mexico; ²University of Arkansas, Fayetteville; ³Sigrah-Zellet Mexico, Queretaro, Mexico.

Objective: to compare the effect of two diets (with or without probiotics) on broiler productivity (body weight – BW, feed conversion, and intestinal villi development). Two hundred one d-old Ross males were used in each of three independent trials. Two treatments (treated / control) and two repetitions per treatment (n=50 birds / repetition) were used in each trial. A commercial Lactobacillus based probiotic (Floramax®) was administrated at days 1, 12, 23, 34, and 45. At day one, the birds were weighed, tagged, and placed on fresh litter (rice hulls). Birds received feed and water ad libitum. The probiotic was dosed into the drinking water at 0.33 g / L. Birds were weighed weekly, five birds were euthanized each week by cervical dislocation, duodenums were collected and fixed with formaldehyde (10%). The fixed samples were used for the preparation of slides for microscopic villi length measurement. BW, feed conversion and villi length were compared between treatments using the student’s t test. Differences were declared when P < 0.05. At placement, BW in trial 1 and 3 was not different between groups. At day 48, BW was higher in the treated than in the control group in trial 1 (1.893 ± 29a and 1.797 ± 27b, treated and untreated groups, respectively) but not in trial 3 (2.424 ± 35 and 2.383 ± 34, treated and untreated groups, respectively). In trial 2 control birds were heavier than treated birds at placement, at day 7 there was not difference between groups, and at day 48 the treated birds were heavier than control birds (2.684 ± 39a and 2.570 ± 34b, respectively). In trials 1 and 2 the duodenal villi were longer in the treated compared to the control group in a total of 2 and 3 out of four evaluation periods, respectively. In trial 3 there was no difference in villi length between groups. There was no difference between groups in feed conversion (1.774 and 1.742; average trials 1, 2, and 3 for the treated and the control groups, respectively). Conclusion: the increased BW in the treated group could be partially explained by improved intestinal integrity measured as villi length.

**Key Words:** probiotics, body weight, broiler

### 318P Effects of plant-derived essential oils on broiler performance during a coccidial vaccine challenge.

N. Reisinger¹, T. Steiner², S. Nitsch², G. Schatzmayr¹, and T. J. Applegate*³

¹Biomin Research Center, Tulln, Austria; ²Biomin Holding GmbH, Herzogenburg, Austria; ³Purdue University, West Lafayette, IN.

Because of pending and current regulations, the poultry industry is searching for alternatives to growth promoting antibiotics including plant-derived supplements which may prevent or lessen the severity of coccidiosis. Therefore, a 2 x 2 experiment (8 pens / treatment, 26 birds / pen) was conducted with 2 doses of a coccidial vaccine (1X or 5X; Paracox® administered at 1d of age) with or without supplementation (125 g/1000 kg) with a phytogenic feed additive containing essential oils from oregano, anise and citrus peel (Biomin®P.E.P. 125 poultry). Within each pen, 13 birds received the coccidial vaccine while the remainder was naturally infected through recycling of oocysts in the litter. The BW, feed intake, and feed conversion (FCR) were determined at d 14 and 27. The higher (5X) Paracox® dosage decreased broiler BW up to 27% (P<0.08), but the Paracox® dosage did not effect FCR and mortality (P > 0.05). The birds that were not vaccinated had lower BW CV with the 1X dosage (vaccine dosage x vaccinated/unvaccinated interaction; P = 0.068). Between d 14 and 27, birds with the 1X Paracox® dosage that were fed the phytogenic additive had a 5.6% increased BW gain (P < 0.05). Supplementation with the phytogenic additive did not affect feed intake or FCR (P > 0.05). In conclusion, the dosage of coccidial vaccine has an impact in BW and BW CV, whereas the effects of dietary supplementation with the phytogenic feed additive on bird performance during a coccidial vaccine challenge were minor.

**Key Words:** broiler, coccidial vaccine, plant-derived supplement

### 317P Effect of oregano essential oils on lactic acid bacteria populations in the intestinal tract of broiler chickens.

V. Phandanounvong², F. Rodriguez¹, L. Betancour², M. Hume³, C. Ariza-Nieto¹, D. Nisbet¹, and G. Afanador-Tellez³.

¹CORPOICA, Bogota, Colombia; ²Universidad de la Salle, Bogota, Colombia; ³USDA, ARS, FFSRU, College Station, TX.

Oregano extracts have been shown previously to have positive effects on broiler intestinal villus characteristics, body weight gain, and mortality, and negative effects on enteropathogen proliferation. The present study evaluated the effects of oregano essential oil (EO) extracts from different varieties of cultivated oregano, on lactic acid bacteria (LAB) populations, specifically Lactobacillus and Bifidobacterium, in the intestinal tract of broiler chickens. Twenty-five 1-day-old Hybro male broiler chickens in each of six experimental groups were assigned to the basal diet, and the basal diet supplemented with either 500 ppm of chlorotetracycline, 50 ppm of EO from Origanum vulgare H. ground in Greece, and 200 ppm each of EO from 3 varieties ground in Sabana of Bogotá-Colombia, O. vulgare H., O. vulgare L., and O. majoranum. Intestinal contents were collected from the duodenum, jejunum, ileum, caeca and colon of chickens at 3, 7, 14 and 21 days of age. Populations of LAB, were quantified by Real-Time PCR. The distribution of LAB throughout the intestine was analyzed at each collection date. The effect of the supplemented AEO was evaluated in chickens during the growth period (21 to 35 days-old). Total populations of monitored LAB were significantly different at 3 and 7 days of age (P<0.05), LAB particularly showed that the Lactobacillus, were established in the intestine at this time, while bifidobacteria were detected later. In addition, LAB differed significantly by intestinal segments (P<0.05), LAB were mostly detected in proximal intestine but the total Lactobacillus concentrations decreased in a proximal-distal direction. Bifidobacterium were mainly present in the duodenum. Supplemented OEO from different varieties of oregano showed no significant effects (P>0.05) in terms of the LAB populations, specifically Lactobacillus and Bifidobacterium. In summary, OEO showed beneficial effects on intestinal LAB populations and OEO extracts did not affect LAB populations; this may explain part of the positive effects of EO on the performance of broiler chickens.

**Key Words:** oregano essential oils, broiler chickens, real-time PCR, lactic acid bacteria

In many countries, pressure is put to find alternatives to antibiotic-growth promoters (AGP). Even if the mechanisms of action of AGP are not clear yet, it is admitted that their main effect is on digestive microflora. Previous studies mainly looked at identifying bacterial species that are affected by AGP. To investigate more globally the effects of AGP on digestive microflora, we set up an in vitro study to look at changes of fermentation products formed by ileal microflora, when using AGP. Ileal digestive contents from broilers were incubated in vitro in anaerobic conditions, with or without AGP (bacitracin (Bn), tylosin or carbadox). After 24h incubation, none of the AGP had reduced significantly the production of total fermentation products. However, the distribution of the products formed was changed. Despite different modes of action, all AGP completely inhibited butyrate production (p < 0.001) and decreased propionate production (-20% to -100%; p < 0.05). Depending on the AGP used, either acetate or lactate production was increased. This suggests that AGP would not decrease the overall activity of microflora but would specifically inhibit butyrate and propionate production. A second study was set up to further investigate these in vitro observations. Fermentation products of ileal microflora from broilers grown either with or without Bn supplementation were compared. At 14 days, 20 birds from each group were euthanized and their ileal contents were used for in vitro incubation. The production of total volatile fatty acids and the production of lactate, acetate and propionate were not different between the 2 groups. Butyrate production was significantly decreased (-76%; p < 0.05) for samples from the Bn-treated group, when compared with the control group. This study shows that butyrate production at ileal level is particularly affected by the use of AGP. This observation could be used as a marker to screen for alternative compounds to AGP. Butyrate being a useful microbial metabolite, especially at caecal level, the next step of our investigation will be to look at AGP effect on fermentation by caecal microflora.

Key Words: chicken, AGP, ileum, microflora

320P WITHDRAWN.

321P Effects of feeding NuPro® for different time intervals on antibody titers and gut microbiology of commercial broilers. M. C. Shivakumar¹, H. V. L. N. Swamy², H. N. Narasimhamurthy¹, and A. E. Sefton*,¹,¹KVAFS University, Bangalore, Karnataka, India,²Alltech Canada, Guelph, ON, Canada.

The objectives of the study were to determine the effects of feeding NuPro® (Yeast Derived Protein, Alltech Inc.) for different time intervals on antibody titers and gut microbiology of commercial broilers. The trial lasted from 0 to 42 days, tested 880 birds on deep litter, conducting 4 treatments, 10 replications per treatment and 22 birds per replication. Four diets used in the trial are: a control (corn-soybean meal), and 2% treatments, 10 replications per treatment and 22 birds per replication. Lasted from 0 to 42 days, tested 880 birds on deep litter, conducting 4 treatments, 10 replications per treatment and 22 birds per replication. On d 42, intestinal content was evaluated for Infectious Bursal disease (IBD) on d 7 and antibody titers were measured on a weekly interval. Data were analyzed as a randomized complete block design and means were compared using Tukey’s multiple comparison test (P<0.05). Antibody titers were observed in birds fed all the three NuPro diets as compared to Control birds on d 42. Birds fed NuPro for 14 and 42 d had higher Lactobacilli count than those fed Control diet (P<0.05) on d 42. Feeding NuPro significantly reduced E. coli count in all the three NuPro diets as compared to Control diet on d 42. This may be due to the proportionate increase in Lactobacilli count in the same birds and thus may explain the role of NuPro in competitive exclusion of pathogens. Further research is needed to understand the reasons behind the differential role of NuPro in Lactobacilli multiplication but E. coli inhibition as well its effect on cell mediated immunity.

Key Words: broilers, gut health, immunity, NuPro, yeast derived protein

322P Effect of glucomannan mycotoxin adsorbent on the performance and organ weights of broiler chickens fed Fusarium mycotoxin-contaminated diets. M. B. Daley¹, S. Leeson¹, H. J. Boermans¹, and A. E. Sefton*,¹,¹University of Guelph, Guelph, ON, Canada,²Alltech Canada, Guelph, ON, Canada.

An experiment was conducted to investigate the effects of a polymeric glucomannan mycotoxin adsorbent (GMA, Mycosorb®, Alltech Inc) on the performance and organ weights of broiler chickens fed diets naturally contaminated with Fusarium mycotoxins. One hundred twenty eight 1-d-old male broiler chickens were fed corn and soybean meal-based diets for 24 d. Two rooms were used with each room containing 8 pens. Two pens in each room were assigned to one of the 4 treatments and there were 8 chicks within each pen making up 32 chicks per treatment. Four treatments were: Control diet made of high grade corn, Control diet with 0.2% GMA, Diet with mycotoxin contaminated corn (16 ppm DON, 1.3 ppm 15-acetyl DON, 1.5 ppm zearalenone) and Contaminated diet with 0.2% GMA. Data were analyzed as a randomized complete block design and means were compared using Tukey’s multiple comparison test (P<0.05). Feeding of contaminated grains significantly decreased body weight gain and feed intake but increased FCR as compared to Control diet. Inclusion of GMA in the mycotoxin diet significantly improved these parameters. GMA group had the highest body weight and feed intake, and best feed conversion and there was a significant mycotoxin X GMA interaction for these parameters. Birds fed mycotoxin diet had a significant increase in relative weight of the liver and bursa of Fabricius, but had no significant effect on the relative weight of pancreas, spleen and gizzard. There was a significant mycotoxin X GMA antagonistic interaction for relative weight of spleen even though there were no significant single dietary effects. It was concluded that broiler performance and some of the organ weights were adversely affected by feed borne Fusarium mycotoxins, and GMA prevented the adverse effects on the performance.

Key Words: broiler chicken, deoxynivalenol, Fusarium mycotoxin, organ weights, performance

323P Effects of glucomannan mycotoxin adsorbent on blood parameters and intestinal morphometrics of broiler chickens fed Fusarium mycotoxin-contaminated diets. M. B. Daley¹, S. Leeson¹, H. J. Boermans¹, and A. E. Sefton*,¹,¹University of Guelph, Guelph, ON, Canada,²Alltech Canada, Guelph, ON, Canada.

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Key Words: broiler chicken, Fusarium mycotoxin, hematology, intestinal morphometrics, plasma biochemistry

324P Effect of fat emulsifier on growth performance and fat metabolism in broilers. C. M. Yanga,b, A. G. Chen,c, X. J. Chen,d, J. S. Liu, and Q. H. Hong1. 1Zhejiang University, Hangzhou, China, 2Hangzhou Normal University, China.

A total of 600 hubbard broilers at the age of 1d were used to investigate the effects of emulsifier on growth performance, fat digestibility and fat metabolism. The chicks were allocated to 4 treatments, each of which had 4 pens of 25 birds per pen. The dietary treatments were basal diet only (control group), basal diet + 250 mg/kg mixture of monoglyceride and sucrose ester (MSE), basal diet + 500 mg/kg MSE and basal diet + 500mg/kg lecithin. Six randomly selected birds from each treatment were slaughtered for the serum and intestinal contents. Compared to the control, supplementation with 250 mg/kg MSE increased average daily gain (ADG) by 6.69% during the whole period (P<0.05). Supplementation with 500 mg/kg lecithin increased the ADG by 4.68% compared with the control diet. However, there are no significant effects in feed efficiency (F/G) and survival rate between control and emulsifier treatment. Supplementation with 250 mg/kg MSE significantly increased the fat digestibility. Chicks fed with 250 mg/kg MSE or 500 mg/kg lecithin had lower serum triglycine (TG3) and higher serum volatility fatty acid (VFA) than those in control. No significant difference was found in serum total cholesterol (TC), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) between the control and emulsifier diet. Lipase of intestinal contents was not affected by emulsifier treatment.

This work was supported by the Science and Technology Research Program of Zhejiang Province (project no.2007C22046).

Key Words: broiler, fat, emulsifier, metabolism, growth performance

325P In vitro characterization of various clay minerals to bind aflatoxin B1. S. Fruhauf1, D. Schatzmayer2, E. Vekiru1, and G. Schatzmayer2, 1Christian Doppler Laboratory for Mycotoxin Research, Tulln, Austria, 2BIOMIN Research Center, Tulln, Austria.

Aflatoxin B1 (AFB1) causes a variety of effects in poultry resulting in decreased performance. Aflatoxins are the only class of mycotoxins which can be efficiently counteracted by adsorbents. A great variety of binding agents is available and therefore in vitro screening procedures are needed to characterize and select suitable adsorbents. The aim of the study was to investigate clay based binding materials concerning their ability, specificity and capacity to adsorb AFB1. 7 bentonites (R, C2, MB, B7, M32, M34) and one zeolite (Z08) were tested in this study. The material R is scientifically well described and served as a reference. All materials were regarded as good aflatoxin binders based on results from standard in vitro assays using 0.1% of the binding agent in a buffer solution spiked with 200 µg/l of AFB1. In this study adsorption tests under intensified conditions (0.02% adsorbent, 4 mg/l AFB1) and in gastric juice were carried out. Additionally, isothermal analysis was performed in order to determine the binding agents’ affinity and capacity to bind AFB1. At pH7 all bentonites except M32 were able to bind more than 90% of the aflatoxin. The zeolite only bound 22% of AFB1. At pH5 all bentonites except C2 were able to adsorb more than 90% of the AFB1. C2 bound 64% of AFB1 and Z08 9%, respectively. In the gastric juice MB and B7 adsorbed more than 80% of the toxin, R, C2, M32, M34 and M5 bound between 50 and 70% of the toxin whereas Z08 reduced the AFB1 concentration only by 6.4%. Isothermal analysis was carried out to determine the maximal binding capacity (Qmax, mol/kg) of each test substance. The Qmax values of MB (0.442 mol/kg), B7 (0.405 mol/kg), M32 (0.442 mol/kg), M34 (0.370 mol/kg) and M5 (0.394 mol/kg) were higher than that for the reference (0.364 mol/kg). C2 (0.263mol/kg) and Z08 (<0.1 mol/kg) were below the reference. Based on the results obtained in this study, the clay materials could be categorized in good (R, MB, B7, M32, M34), average (C2) and poor (Z08) adsorbents. However, feeding experiments with AFB1 challenged birds have to be carried out to confirm in vitro results with in vivo performance.

Key Words: aflatoxin, adsorption, mycotoxin, detoxification, adsorbents

326P Investigation of replacing vitamin E with EconomasE® in broiler diet. J. L. Pierce*,1, T. Ao1, R. F. Power1, K. A. Dawson1, A. J. Pescatore1, A. H. Cantor1, M. J. Ford1, and Y. L. Xiong2, 1Alltech® University of Kentucky Nutritional Research Alliance, Lexington, 2University of Kentucky, Lexington.

EconomasE® is a proprietary blend of ingredients that maximizes antioxidant status of the animal and reduces the requirement of vitamin E (VE). A study was conducted to investigate the effects of supplementing EconomasE® in broiler diet on the performance, oxidative stability, meat quality and storage stability of broiler chicks. Dietary treatments included: 1) corn-soy control diet supplemented 0.3 ppm Se as selenite, but no VE; 2) corn-soy control diet supplemented 0.3 ppm Se as selenite, plus 50 IU/kg VE; 3) corn-soy control diet supplemented 0.3 ppm Se as selenite, plus 100 IU/kg VE; 4) corn-soy control diet, plus 200 g/Ton EconomasE®. A total of 640 chicks was raised for six weeks. Eight replicate cages of 20 chicks were randomly assigned to each of four dietary treatments. Chicks were housed in floor pens with new litter in an environmentally controlled room and were given ad libitum access to feed and water. No significant difference among all the treatments
was observed in terms of weight gain and feed intake. The breast meat from chicks fed Economase® showed better color stability and less amount of drip loss compared with that from chicks fed other treatment diets. The total antioxidant capacity of serum from chicks fed Economase® was the same as that from chicks fed additional 50 or 100 IU/kg VE and was higher (P<0.01) than that from chicks fed control diet. The breast muscle from chicks fed Economase® had higher (P<0.01) Se content than other treatment groups. No dietary effect on breast muscle VE content was detected. The results from this trial showed that supplementing Economase® in broiler diet had the same or better effects on performance, meat quality and total antioxidant capacity of chicks compared with dietary supplementation of 0.3 ppm Se as selenite plus 50 or 100 IU/kg VE.

Key Words: broiler chick, selenium, vitamin E

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Folic acid (FA) is the most commonly used supplemental dietary source of folate. FA is not a natural folate metabolite, and its conversion to the biologically active 5-methyltetrahydrofolate (5-MTHF) form is regulated by the activity of key enzymes in the folate cycle. In order to gain further insight on the factors regulating the conversion of FA to 5-MTHF, a study was conducted to examine the impact of dietary folate supply (FA vs. 5-MTHF) on mRNA expression and activity of key folate enzymes. A total of 24 laying hens (24 weeks) of each strain (Shaver White and Shaver Brown) were randomly assigned to receive 1 of 3 (n=8) dietary treatments: 1) basal diet with no supplemental folate and 2) basal diet + 10 mg/kg FA and 3) basal diet + 11.30 mg/kg 5-MTHF, for 21 days. The hepatic activity and mRNA abundance (as determined by real-time PCR) of folate-dependent enzymes were measured as response parameters. The level of hepatic activity of dihydrofolate reductase (DHFR), serine hydroxymethyltransferase (SHMT), methylenetetrahydrofolate reductase (MTHFR) and methionine synthase (MS) were influenced by the level and form of folate supplemented in the diet. Hepatic DHFR and SHMT activities were higher (17.9 vs. 15.6 mmol/hr/g) (P<0.05) in FA-fed hens, while MS activity was lower (632.9 vs. 728.4 mmol/ hr/g) (P<0.05) in 5-MTHF-fed birds, as compared to hens receiving the control diet. Gene expression analysis of genes encoding the 4 folate-dependent enzymes tended to follow similar trends; however the results were not significant. Overall, the data provide evidence that the form of folate supplementation modulates the activity of key enzymes involved in the conversion of FA to 5-MTHF. Furthermore, mechanisms beyond transcriptional regulation may be involved in this modulation.

Key Words: folic acid, 5-methyltetrahydrofolate, enzyme, mRNA abundance, laying hen


The proton-coupled folate transporter (PCFT) is a recently discovered folate carrier (SLC46A1) in humans and other mammals. PCFT mediates folate transport across epithelia and into systemic tissues by a proton-coupled and pH-dependent mechanism. However, there are no reports of the importance of PCFT in avian systems. In the current study, cDNA was cloned, and tissue distribution and mRNA expression of PCFT were examined in Shaver White laying hens (n = 8 per diet) that received wheat-based diets containing either: 1) no supplemental folate; 2) folic acid (10 mg/kg) or 3) 5-methyltetrahydrofolate (5-MTHF; 11.30 mg/kg) for 21 d. Intestinal PCFT mRNA levels were analyzed by real-time PCR. Results revealed that the cloned PCFT cDNA containing the entire coding region from duodenum was highly homologous (99%) to the reference gene available in GenBank. PCFT mRNA was detected in the liver, intestine and other tissues tested. No significant differences (P > 0.05) due to diet were found in the PCFT mRNA levels in duodenum and cecum. However, PCFT mRNA in jejunum was decreased (P < 0.05) in hens fed the 5-MTHF diet in comparison with the basal diet. Collectively, this study demonstrates that the PCFT cDNA containing the full-length coding region was cloned from Shaver White laying hens. The wide tissue distribution of PCFT transcripts is suggestive of an important role of PCFT in folate transport in chickens. Furthermore, folate supplementation downregulates jejunal PCFT mRNA expression. Such findings provide fundamental information necessary for the further characterization of the role of PCFT in folate delivery to intestinal and other tissues in avian systems.

Key Words: proton-coupled folate transporter (PCFT), folate supplementation, cloning and tissue distribution, mRNA expression, laying hens


Studies in our lab demonstrated that supplementing 12 ppm Zn as Bioplex Zn® (a chelated Zn proteinate) in corn-soybean meal diet is equivalent to supplementing 40 ppm Zn as zinc sulfate in terms of growth performance and tissue mineral status of chicks. This study was to compare the effects of supplementing different levels of Zn in corn-soybean meal diet provided as zinc sulfate or Bioplex Zn® on the performance and tibia Zn content of chicks during 42d period. Chicks were reared in floor pens in an environmentally controlled room and were given ad libitum access to food and water. Dietary treatments included: 1) corn-soy control diet without addition of Zn; 2) control + 40 ppm Zn as zinc sulfate; 3) control + 80 ppm Zn as zinc sulfate; 4) control + 12 ppm Zn as Bioplex Zn®; 5) control + 24 ppm Zn as Bioplex Zn®. A total of 800 chicks was randomly assigned to each of five dietary treatments with eight replicate pens of 20 chicks. In first two week period, dietary
supplementation of 24 ppm Zn as Bioplex Zn® significantly increased (P<0.01) weight gain of chicks compared with other treatment groups. The gain to feed ratio of chicks fed diet containing 24 ppm Zn as Bioplex Zn® was higher (P=0.057) than chicks fed other treatment diets except those fed diet including 12 ppm Zn as Bioplex Zn®. In entire six week growing period, no difference was found among all treatment groups in terms of growth performance. The chicks fed corn-soy control diet had significantly lower (P<0.01) tibia Zn content than those fed other treatment diets. The chicks fed diet with a supplementation of 80 ppm Zn as zinc sulfate had significantly higher (P<0.01) tibia Zn content than those fed other treatment diets except those fed diet including 40 ppm Zn as zinc sulfate. These results indicate that supplementing 24 ppm Zn as Bioplex Zn® in corn-soy diet may have better growth promoting effects for broiler chicks during starter period than supplementing 80 ppm Zn as zinc sulfate.

Key Words: broiler chick, zinc, Zn proteinate, organic zinc, zinc sulfate


The determination of the identity of zinc glycine complexes (BTZn) in water was the first step to set an analysis method to trace BTZn in diluted media (feed, stomach juice, plasma, ...). The identification was performed by mass spectroscopy with an electrospray QqTOF mass spectrometer (ESI-QqTOF-MS) either in full scan TOF mode or in tandem mass spectrometry (MS/MS) mode. BTZn was dissolved in a 50% methanol and 10 mM ammonium acetate (AAC) buffer at pH 7. Once the chemical structures determined at pH 7, the pH of the BTZn solution was varied from 7 to 2 by step of 1 to determine the stability of the complexes towards acid conditions. The stability of BTZn on a chromatographic column was investigated by size exclusion chromatography with an inductively coupled plasma mass spectrometer detector (SEC-ICP-MS). AAC was chosen as buffer, and the mobile phase was optimized in term of ionic strength (10 to 200 mM AAC) and pH (6, 7.4 and 8). The BT solutions were injected on a SEC column with the selected mobile phase and the ICP-MS data were recorded. The metal remaining on the column was eluted by EDTA, which was removed before the next injection. The chemical structure of BTZn in water was [Zn(Gly)(SO₄)(H₂O)]ₙ with n=1, x=1 and n=2, x=0. The complexes were detected on the whole pH range. An acid pH induced a partial degradation of the complexes, as free glycine seemed to be more abundant while the acidity of the solution was increased. BTZn was stable on a SEC column with a high ionic strength (200 mM AAC) and a neutral pH, and 90% of the complex were recovered during the elution phase. Zinc sulphate did not elute from the column in any of the conditions tested. The identification of BTZn in aqueous solution and its stability on a SEC column rendered possible the development of analytical traceability methods. Moreover SEC could be selected as a purification method.

Key Words: zinc, organic trace mineral, mass spectrometry, size exclusion chromatography

335P Effect of source and level of zinc combined with manganese, copper, and selenium on performance and immune response of turkeys. L. Li1, J. L. Pierce2, R. A. Dalหลวง1, C. L. Novak2, and A. P. McElroy*,1, 1Virginia Polytechnic Institute and State University, Blacksburg, 2Alltech, Nicholasville, KY, 3Land O'Lakes Purina Feed, LLC, Kansas City, MO.

An experiment compared the effect of using commercially available organic or inorganic Zn in combination with other trace minerals on performance, immune response, and intestinal morphology of commercial turkeys from 0 to 6 wks of age. A total of 2,376 day old Hybrid Converter turkey hens were used in a 4 by 2 design with coccidia vaccinated (VAC) and non-vaccinated (Non-VAC) and 4 dietary treatments varying in Zn concentration in organic or inorganic form with other trace minerals. Dietary treatments (9 replicate pens each) consisted of: 1) standard inorganic (SI), inorganic Zn at 150 ppm with inorganic source of Mn (165 ppm), Cu (10 ppm), and Se (0.2 ppm); 2) reduced inorganic (RI), inorganic Zn, Mn, and Cu at 10% of SI, and inorganic Se at 0.2ppm; 3) organic 1 (O1), organic Zn at 15 ppm with organic source of Mn (16.5 ppm), Cu (1 ppm), and Se (0.2 ppm); 4) organic 2 (O2), organic Zn at 30 ppm with the same level and source of other trace minerals as O1. Body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were calculated at d7, 14, 21, 28, 35, and 42. Cumulative FI was influenced by VAC (P=0.003), and cumulative BWG was increased (P=0.03) in pouls fed RI compared with O2. VAC decreased (P<0.05) cumulative BWG and BW at d 7, 21, 28, 35, and 42. BW was decreased in pouls fed O2 compared with RI at d 28, 35, and 42. VAC increased (P=0.01) spleen weight at d 7 and thymus weight at d 42. Birds fed O2 had increased (P<0.05) thymus weight compared with SI at d 7. Interaction between diet and vaccination was observed for CD4+ T-cell numbers at d 28 (P=0.03) and d 42 (P=0.01). The ratio of CD4+ to CD8+ T-cells was increased (P=0.05) in VAC pouls at d 42. Jejunal villus height in VAC was increased. These results suggest using low levels of organic or inorganic trace minerals was adequate to maintain turkey performance and immune response.

Key Words: trace minerals, turkeys, coccidia, performance, immunity

336P Effect of HMTBa chelated organic trace minerals - zinc, manganese, copper and selenium yeast on broiler performance and immunity. A. S. Ranade*,1, D. Joardar2, R. B. Agivale1, and D. N. Desai1, 1Bombay Veterinary College, Parel, Mumbai, India, 2Novus International, Inc., St. Louis, MO.

Experiment was conducted on 600 broiler chicks of Cobb 400 for six weeks. The chicks were divided into two equal groups. Each group was further divided into 12 replicates of 25 birds. The first group received diet with trace mineral mixture containing Inorganic salts (ITM group). Another group received the diet with mineral mixture containing Zn-, Mn-, and Cu-(HMTBa) (MINTREX®, Novus International Inc.) and Selenium Yeast, Iron and Iodine were supplemented using Inorganic salts (OTM group). Corn-soy diets were prepared as per the Indian Standards (IS). OTM Group received the trace minerals under study in Organic form @ 25% of their levels used in Inorganic form provided in the diet of ITM group. The source of Met used was MHA® feed supplement (Novus International Inc.). The objective was to evaluate usefulness of OTM at 25% of IS over ITM at 100% IS on performance of broilers in terms of growth and immunity. Data pertaining to growth parameters were recorded. Blood collection was done on 0th, 21st and 42nd day for ND and IBD titers and estimation of Zn, Mn and Cu by Atomic Absorption Spectrophotometer on 21st and 42nd day. Liver and

A 3x2x2 factorial experiment was conducted to determine the effects of rearing program, dietary NPP intake, and breeder feeding regimen on production performance, chick quality, and bone remodeling. 1600 Cobb 500 broiler breeder pullets were reared on three different growth curves: 20% under, Cobb standard, and 20% over. At 21 weeks of age, 624 hens were fed one of two breeder diets differing only in the amount of dietary NPP: 0.15% or 0.40%. The effect of quantitative NPP intake was determined by two regimens. A normal feeding regimen was one appropriate for the particular growth curve; an alternate regimen considered the three growth curves as a flock. Egg production and quality, mortality, hatchability, progeny weight, breeder and progeny tibia quality were determined through 45 weeks. At 24, 26 and 29 weeks of age, blood plasma was sampled from each treatment group every four hours over a twenty-four hour period. Plasma samples were analyzed for total alkaline phosphatase, tartrate-resistant acid phosphatase, and PTHrp. Eggs per hen housed were diminished in hens fed the low dietary NPP and by low pullet target weight. Hens fed low dietary NPP also had lower egg weights but better shell quality. Mortality was significantly higher in hens fed low dietary NPP and by low pullet target weight. Breeder tibia relative strength and ash was also significantly lower in hens fed low dietary NPP %. Hatch of fertile was not impacted by NPP intake or by rearing program, but was affected by breeder feeding regimen (P=0.0031). Progeny bone quality was not significantly affected by any treatment, nor was 7-week body weight. However, an initial benefit in 1 day progeny weight was seen in hens fed 0.4% NPP. Circulating breeder blood PTHrp was higher at 24 weeks of age than at 29 weeks of age. Levels were also higher in the 20% under and standard hens. Dietary NPP did not exert an overall effect on PTHrp levels. In summary, 0.15% dietary NPP negatively impacted breeder skeletal quality, egg production and mortality. Finally, body composition appears to be a main contributor in bone remodeling mechanisms.

Key Words: NPP, broiler breeder


A 65-week study was conducted to determine the effects of L-carnitine supplementation on the fat characteristics of broiler breeder hens and subsequent progeny quality. 1600 Cobb 500 broiler breeder pullets were reared according to Cobb guidelines. Beginning at 4 weeks of age, pullets were placed on either a standard feed or a carnitine supplemented feed at 50 ppm. Supplementation was carried over into the breeder phase. Liver, egg, and carcass fat were sampled at 28, 40 and 65 weeks and immediately frozen. Fatty acid profiles were determined for egg contents and carcass fat by GC/MS. Hens were artificially inseminated at 42 weeks of age and progeny weight was monitored through 21 days of age. Carnitine supplementation decreased the amount of 16:1, as well as several PUFAs (18:3n3, 20:2, 22:5) in the egg while increasing the amount of 18, 18:1, and 20:1. The fatty acid profile in the egg was also impacted by age. Older hens had increased amounts of 18:1c9 and 22:5, while other notable fatty acids decreased over time. Hatch of fertile was not impacted by carnitine supplementation, nor was 1-day
progeny weight. In summary, L-carnitine supplementation alters the fatty acid profile of the breeder egg but confers no additional advantage to subsequent progeny weight.

**Key Words:** carnitine, breeders, fatty acid metabolism

**340P**  Effect of sodium and electrolytic balance levels in pre-starter ration on tibia characteristics for broilers. J. H. Stringhini*, M. S. Thon, M. A. Andrade, N. S. N. Leandro, and J. S. Santos, Universidade Federal de Goiás, Goiania, GO, Brazil.

Sodium affects water and other components absorption in intestinal mucosa, specially in younger ages. An experiment was carried out to evaluate, from one to 21 days of age, tibia characteristics, blood biochemical parameters, carcass moisture for broilers fed different levels of sodium (Na⁺) and electrolytic balance (BE) expressed as Mongin number Na⁺ + K⁺ - Cl⁻ in pre-starter ration based on corn-soybean. A total of 330 Cobb 500 chicks were allotted in a randomized block design in a factorial arrangement 3 x 2 (BE 200; 240 e 310 mEq/kg x Na⁺ 0.2 and 0.4%) with 6 treatments and 5 replicates of 11 birds each. Carcass moisture, excreta moisture from 4 to 7 days of age, bone relative weight at 7 days of age, bone density and tibia ash, tibia growth plate, blood biochemical parameters and incidence of tibial dyschondroplasia (DT), Na⁺, K⁺ and Cl⁻ blood levels at seven days of age were investigated. Excreta moisture were significantly affected by sodium levels. BE of 200 and 236 mEq/kg of ration promoted higher weight gain in first week. Levels of 0.4% of sodium in diet resulted in higher water intake resulting in higher excreta moisture. Higher incidence of DT was observed in chicks fed diets with 0.2% Na⁺ and BE of 310mEq/kg, because BE presented a linear effect (Y=0.013+0.00105x, R² = 1.00) Tibia density increase quadratically for BE (Y=12.46-0.084x+0.000154x²). Blood electrolyte levels of K and Na were affected linearly by the nutritional treatments, as expressed by the equations for Na (Y=156,60-0,155x R² = 0.90) and K (Y=100.97+0.0136x R² = 0.86). The use of 200 a 236mEq/kg in first week of age and 0.4% sodium contributed to reduce incidence of leg problems in broilers during pre-starter and starter rations.

**Key Words:** bone, electrolytes, growing, post-hatch feeding

**341P**  Digestible lysine levels in broiler pre-starter rations. J. H. Stringhini*, M. S. Thon, N. S. M. Leandro, M. B. Cafe, and B. M. Santos, Universidade Federal de Goiás, Goiania, GO, Brazil.

An experiment was carried out to evaluate performance, development of digestive organs of young broiler chicks (one to twenty one days of age) fed diets with different levels of digestible lysine in pre-starter diet (1 to 7 days old). A total of 480 day old Cobb 500 male chicks allotted in brooded batteries in a randomized block design with four levels of digestible lysine levels. No significant effect was observed for broiler performance from 1 to 21 days of age, as observed in Table above. It is possible to recommend a digestible lysine level for male broilers of 1.05% in pre-starter diet (1 to 7 days old).

**Key Words:** pea protein isolate, wheat distiller’s dried grains with solubles, standardized ileal digestibility, amino acid, broiler

**342P**  Coefficients of standardized ileal amino acid digestibility in pea protein isolate and wheat distiller’s dried grains with solubles fed to broiler chickens. N. Nandha*, R. Payne2, G. Crow3, W. Guenter1, and C. M. Nyachoti1,1 University of Manitoba, Winnipeg, MB, Canada; 2 Evonik Industries, Kennesaw, GA.

Digestibility coefficients are the best predictors of dietary amino acid (AA) utilization for optimum production in poultry. Further, the coefficients of standardized ileal digestibility (CSID) obtained by correcting the coefficients of apparent ileal digestibility (CAID) for basal endogenous losses (BEL) are considered to be more accurate in practical formulation of poultry diets. Thus, two trials were conducted using 4 pea protein isolate (PPI) (Exp. 1) and 5 wheat distiller’s dried grains with solubles (WDDGS) (Exp. 2) samples locally produced, to determine the CSID of AA. Day old birds (300) were fed a chick starter diet for the first 14 d and test diets for the next 7 d of life. The test diets contained PPI or WDDGS as the sole source of protein (20 or 21%) with chromic oxide (0.3%) as an indigestible marker. Five (Exp. 1) or six replicates (Exp. 2) of 6 birds each were fed test diets in a completely randomised design. The digestibility coefficients in PPI were determined by the direct method, whereas the difference method was used for WDDGS. Ileal digesta was sampled on d 21. CSID were estimated using BEL values determined previously in our laboratory. The calculated CSID values (mean ± SEM) in PPI and WDDGS for the most limiting AA in poultry were 0.93 ± 0.01 and 0.82 ± 0.01 for methionine, 0.87 ± 0.01 and 0.76 ± 0.01 for methionine + cystine and 0.96 ± 0.01 and 0.55 ± 0.02 for lysine. Both lysine and sulphur AA were more digestible in PPI than WDDGS. Of all the essential AA analyzed, lysine was the most and least digestible in PPI and WDDGS, respectively. The standardized digestibility coefficients determined in this study will not only enable poultry nutritionists in formulating more cost effective diets, but also, encourage them to use alternative sources of protein in broiler diet formulation.

**Key Words:** amino acid, performance, ration

**343P**  Effect of dietary threonine on the performance and immune function of broilers fed diets containing two levels of protein. F. Zaefarian*, M. Zaghari1, M. Shivazad1, M. R. Abdollahi2, and V. Ravindran2, 1 University of Tehran, Karaj, Iran; 2 Massey University, Palmerston North, New Zealand.

The objective of this study was to examine the effects of the dietary Thr and protein on the performance and immune function of broiler starters (1 to 21 d). The experimental design was an 8 x 2 factorial arrangement of treatments evaluating eight levels of Thr (4, 5, 6, 7, 8, 9, 10 and 11 g/kg) and 2 levels of protein (160 and 190 g/kg). Prior to diet mixing, corn and soybean meal were analysed for protein and amino acid contents. Day-old male broiler (Ross 308) chicks were weighed and allotted to 64 cages (6 birds per cage). Each treatment was then randomly assigned
to 4 replicate cages. Increasing the dietary Thr level from 4 to 7 g/kg increased feed intake in both high and low protein diets. However, feed intake was lower (P < 0.05) in birds given the high protein diets compared with those fed the low protein diets. Weight gain and feed efficiency were improved up to 7 g/kg Thr at both protein levels. Total haemagglutinin titre against sheep red blood cell at 5 and 10 days after injection was influenced (P < 0.05) by Thr level. Highest antibody titres were obtained with 8 and 9 or 9 g/kg Thr at 5 and 10 days after injection, respectively. Interaction of protein and Thr was significant (P < 0.05) for the antibody titre. Birds fed low Thr diets showed lower (P < 0.05) toe web thickness at 24 or 48h after phytohaemagglutinin injection. Birds fed 8, 9 and 10 g/kg Thr level had higher toe web thickness. These results showed that the performance and immune function of broiler starters were influenced by dietary Thr levels. Optimum performance was achieved at 7 g/kg Thr, but higher Thr level was needed for optimum immune system function.

**Key Words:** threonine, protein, performance, immune function, broilers

**344P** Effect of arginine supplementation in the broiler breeder diet on progeny’s performance and bone parameters. A. E. Murakami*1, J. I. M. Fernandes2, L. M. G. Souza1, J. C. Faveri1, and E. N. Martins1, 1Universidade Estadual de Maringá, Maringá, PR, Brazil, 2Universidade Federal do Parana, Palotina, PR, Brazil.

In order to verify the influence of different levels of arginine supplementation in broiler breeder hens diets on progeny performance and bone parameters, 1,050 one day old, male Ross chicks (BW = 41.22 g) were used. The chicks were housed in accordance with the treatment received by the breeders in a completely randomized design with five levels of digestible arg (0.943; 1.093; 1.243; 1.393 and 1.543%), in six replicates of 35 birds. The birds had received the same diet without supplementation of arginine. In the initial period (1 to 21 days of age), there was a quadratic effect (P<0.05) of hen nutrition, where the best feed conversion was obtained with 1.359% of digestible arg. However, there was an increasing linear effect (P<0.05) of the supplemental levels of arg received by the hens on the percentage of broiler progeny carcass traits. The bone parameters of broilers had a quadratic effect (P<0.05) of maternal digestible arg level on tibia diameter to the seven days of age, where 1.196% of digestible arg resulted in the lowest diameter, and was gradually increased from this in with higher supplement levels. Feeding 1.359% and 1.543% of digestible arg to the broiler breeder hen provided the best feed conversion and percentage of carcass, respectively, in broiler offspring.

**Key Words:** carcass yield, digestible arginine, tibia, broiler breeder, broiler

**345P** Effects of feeding programs including valine, isoleucine, and glycine supplementation on broiler carcass quality. C. C. Goulart1, F. G. P. Costa*1, E. T. Nogueira2, M. Kutschenko2, J. H. V. Silva1, C. F. S. Oliveira1, and V. P. Rodrigues1, 1Federal University of Paraiba, Areia, PB, Brazil, 2Ajinomoto Animal Nutrition, São Paulo, SP, Brazil.

The experiment was carried out at the Center of Agrarian Sciences, UFPA, Areia, PB, Brazil. It aimed at evaluating the effects dietary crude protein levels (CP) and essential amino acids: non-essential amino acids (EAA:NEAA) ratios on 40-day-old broiler carcasses. A total of 480, 22-day-old male Cobb broilers were distributed in a completely randomized experimental design into five treatments with six replicates of 20 birds each. Treatment 1 consisted of a control diet based on corn and soybean meal supplemented with DL-Methionine, L-Lysine HCl, and L-Threonine, formulated to supply the digestible amino acid requirements of each rearing phase. Treatment 2 also included L-Valine (VAL), and crude protein (CP) was reduced until isoleucine requirements were met, but the diet was deficient in glycine+serine. Treatment 3 was similar to T2, but Glycine (GLY) was added. In treatment 4, in addition to the amino acids already used in treatments 2 and 3, L-Isoleucine (ILE) was supplemented, and CP was reduced to supply arginine requirements. As in T2 glycine+serine requirements were not met, GLY was added in treatment 5. Statistical analyses were carried out using SAS, and means were compared by Tukey’s and Dunnett’s tests at 5% probability. At 42 days, two birds per replicate were selected, fasted for 12 h, sacrificed by neck dislocation, and then submitted to bleeding, defeathering, evisceration, and cut-up. Products were weighed on a digital scale. The evaluated parameters (carcass, breast, legs, thighs, and wings weights and yields, and heart, gizzard, and liver absolute and relative weights) were not influenced by the treatments. It was concluded that the use of feeding programs with reduced-protein diets supplemented with VAL and ILE do not affect carcass traits.

**Key Words:** amino acid, broiler production, carcass yield, ideal protein, supplementation

**346P** Effects of crude protein levels and essential amino acids: Non-essential amino acids ratio on broiler carcasses. F. G. P. Costa*1, C. C. Goulart1, E. T. Nogueira2, M. Kutschenko2, J. H. V. Silva1, and G. B. V. Lobato1, 1Universidade Federal do Paraiba, Areia, PB, Brazil, 2Ajinomoto Animal Nutrition, São Paulo, SP, Brazil.

The experiment was carried out at the Center of Agrarian Sciences, UFPA, Areia, PB, Brazil. It aimed at evaluating the effects dietary crude protein levels (CP) and essential amino acids: non-essential amino acids (EAA:NEAA) ratios on 40-day-old broiler carcasses. A total of 480, 22-day-old male Cobb broilers were distributed in a completely randomized experimental design into four treatments with six replicates of 20 birds each. The diet was formulated to supply digestible amino acid (AA) requirements, contained 16.5% CP, and was supplemented with lysine, methionine, threonine, arginine, valine, isoleucine, glycine, and tryptophan. EAA supplement in total AA (TAA) was checked after formulation. Total EAA contents were summed, and its ratio to dietary CP levels was calculated, and this value was considered as TAA. The following AAs were considered essential: lysine, methionine+cystine, threonine, arginine, valine, tryptophan, isoleucine, leucine, phenylalanine, and histidine. In the other treatments, glutamic acid was supplemented to achieve 17.5, 18.5, and 19.5% CP. Starch, oil, and inert material was used to make feeds iso-energetic. EAA:NEAA ratios were 49:51, 46:54, 44:56, and 41:59, respectively. Data were submitted to polynomial regression analysis and Dunnett’s test at 5% probability. The 19.5% CP diet was used as control. At 40 days, two birds per replicate were selected, fasted for 12 h, sacrificed by neck dislocation, and then submitted to bleeding, defeathering, evisceration, and cut-up. Products were weighed on a digital scale. The evaluated parameters (carcass, breast, leg+thighs weights and yields, and heart, gizzard, liver, and abdominal fat absolute and relative weights) were not influenced by the treatments. It is suggested that dietary CP can be reduced up to 16.5% with an EAA:NEAA ratio of 49:51 for 22- to 40-day-old broilers.

**Key Words:** carcass yield, glutamic acid, ideal protein, protein reduction, supplementation
Effects of valine, tryptophan, and potassium supplementation to reduced-protein diets on the performance of layers in their second production cycle. C. F. S. Oliveira¹, F. G. P. Costa*¹, E. T. Nogueira², M. Kutschenko², C. C. Goulart¹, and A. G. V. O. Lima¹.

The experiment was carried out at CCA, UFPB, Areia, PB, Brazil. It aimed at evaluating the effects of valine, tryptophan, and potassium supplementation to reduced-protein diets on the performance of heavy layers in their second production cycle. A total of 336 57-week-old Bovans Goldline heavy layers were distributed in a completely randomized experimental design into seven treatments of six replicates of eight birds each. Treatment 1 (T1) consisted of a control diet based on corn and soybean meal supplemented with L-lysine, DL-methionine, and L-threonine and formulated to supply bird’s nutritional requirements, with all amino acids reaching or slightly exceeding the recommendations. Treatment 2 (T2) consisted of a feed with 3% CP reduction supplemented with the industrials amino acids lysine, methionine, and threonine to achieve the same levels of the control diet; however, this diet was deficient in tryptophan, valine, and potassium. The remaining treatments consisted of supplementing the T2 diet with valine (T3), tryptophan (T4), valine and tryptophan (T5), and potassium carbonate plus the amino acids added in the previous treatments (T6) to supply amino acid and potassium requirements. An additional diet, similar to T6 but with the same potassium levels as the control diet; however, this diet was deficient in tryptophan, valine, and potassium. It was concluded that CP can be reduced up to 13.5% in the diet of heavy layers in the second production cycle if valine and tryptophan are supplemented.

Key Words: amino acid, egg weight, supplementation

Valine, isoleucine, and glycine in reduced-protein pre-starter broiler feeds. F. G. P. Costa*¹, C. C. Goulart¹, E. T. Nogueira², M. Kutschenko², H. S. Rostagno³, P. E. N. Givisz1, and V. P. Rodrigues¹.

The experiment was carried out at the Center of Agrarian Sciences, UFPB, Areia, PB, Brazil. It aimed at evaluating the effects of valine, isoleucine, and glycine supplementation in reduced-protein diets on the performance of 1- to 7-day-old broilers. A total of 600 one-day-old male Cobb broilers were distributed in a completely randomized experimental design into five treatments with six replicates of 20 birds each. Treatment 1 consisted of a control diet based on corn and soybean meal supplemented with DL-Methionine, L-Lysine HCl, and L-Threonine, formulated to supply digestible amino acid requirements. Treatment 2 also included L-Valine (VAL), and crude protein (CP) was reduced until isoleucine requirements were met, but the diet was deficient in glycine+serine. Treatment 3 was similar to T2, but Glycine (GLY) was added. In treatment 4, in addition to the amino acids already added in treatments 2 and 3, L-Isoleucine (ILE) was supplemented, and CP was reduced to supply arginine requirements. As in T2 glycine+serine requirements were not met, GLY was added in treatment 5. Statistical analyses were carried out using SAS, and means were compared by Tukey’s test at 5% probability. The lowest feed intake (FI) was obtained in the birds fed the control diet, containing 23.9% de CP (T1), whereas the birds fed the diet with 22.0% CP supplemented with VAL, ILE, and GLY (T5) presented the highest FI. However, the highest weight gain (WG) and feed conversion ratio values were obtained when solely VAL was added to the 22.6% CP diet (T2). Protein reduction to 21.7% with VAL and ILE supplementation (T4) promoted the worst results as compared to the diets with higher CP levels. GLY supplementation (T5) increased WG relative to T4, but did not reach the same WG obtained with T2. It was concluded that feeds formulated with the addition of VAL only promoted the best performance.

Key Words: amino acid, broiler production, ideal protein, performance, supplementation

Feeding programs with valine, isoleucine, and glycine supplementation for 1- to 42-day-old broilers. C. C. Goulart¹, F. G. P. Costa*¹, E. T. Nogueira², M. Kutschenko², C. B. V Rabello³, and C. F. S. Oliveira¹.

The experiment was carried out at the Center of Agrarian Sciences, UFPB, Areia, PB, Brazil. It aimed at evaluating the performance of
Effects of digestible isoleucine:lysine ratios on broiler performance and breast yield. A. M. A. Campos¹, E. T. Nogueira², L. F. T. Albino¹, and H. S. Rostagno*¹, ¹Universidade Federal de Viçosa, Viçosa, MG, Brazil, ²Ajinomoto Biolatina/Ajinomoto Animal Nutrition, Sao Paulo, SP, Brazil.

The formulation of diets using the ideal protein concept, with no deficiencies or excesses of amino acids, is essential to maximize performance and reduce N excretion in broilers. However, there are few studies on digestible isoleucine:lysine ratio (Ile:Lys). Two experiments were carried out to evaluate digestible Ile:Lys ratios for male Cobb 500 broilers in two periods: 7 to 21 (starter) and 28 to 40 (finisher) days of age. The experiments were conducted separately in a completely randomized experimental design with five digestible Ile:Lys ratios: 57 (0.616% Dig Ile), 61, 65, 69, and 73% in the starter period, and 58 (0.568% Dig Ile), 62.5, 67, 71.5, and 76% in the finisher period, with eight replicates of 25 birds per experimental unit (EU) in the starter and 20 birds per EU in the finisher period. Diets were formulated to meet or exceed the nutritional requirements in both periods, except for digestible Lys (1.08% and 0.98% for the starter and finisher periods, respectively). The following digestible Val:Lys ratios were used in the starter period 69 (0.745% dig Val), 72, 75, 78, and 81%, and in the finisher period were 72 (0.706% dig Val), 74.5, 77, 79.5, and 82%. In the starter period, the birds weight gain, feed conversion ratio, and breast fillet yield presented a quadratic response (P<0.05) to Val:Lys ratios, as described by the equations Y = -2.592.8 + 89.58 Val - 0.59 Val² (R² = 0.97), Y = -5.17 + 0.093 Val - 0.00058 Val² (R² = 0.92) and Y = -55.59 + 1.861 Val - 0.012 Val² (R² = 0.81), respectively. The recommended dietary digestible Val:Lys ratio for the finisher phase is 78% or 0.84% digestible Val. In the finisher phase, there was a quadratic effect (P<0.05) on feed conversion ratio (Y = 11.8 - 0.2522 Val + 0.00159 Val²; R² = 0.94) and breast fillet yield (Y = -1862.2 + 59.47 Val - 0.3772 Val²; R² = 0.89). These results indicate that a Val:Lys ratio of 79% or 0.77% digestible Val is sufficient to maximize broiler performance during the finisher phase.

Key Words: valine, lysine, performance, breast yield, broiler

Digestible valine:lysine ratios for broilers during the starter and finisher periods. A. M. A. Campos¹, E. T. Nogueira², L. F. T. Albino¹, and H. S. Rostagno*¹, ¹Universidade Federal de Viçosa, Viçosa, MG, Brazil, ²Ajinomoto Biolatina/Ajinomoto Animal Nutrition, Sao Paulo, SP, Brazil.

Valine (Val) is the fourth limiting amino acids for broilers. However, little information has been reported on digestible Val:Lys ratios for starter and finisher broilers. Two experiments were carried out to evaluate digestible Val:Lys ratios for male Cobb 500 broilers in two periods: 7 to 21 (starter) and 28 to 40 (finisher) days of age. A total of 1000 starter and 800 finisher broilers were distributed in a completely randomized experimental design with five digestible Val:Lys ratios and eight replicates of 25 and 20 birds per experimental unit (EU) in the starter and the finisher period, respectively. Diets were formulated to meet or exceed the nutritional requirements in both periods, except for digestible Lys (1.08% and 0.98% for the starter and finisher periods, respectively). The following digestible Val:Lys ratios were used in the starter period 69 (0.745% dig Val), 72, 75, 78, and 81%, and in the finisher period were 72 (0.706% dig Val), 74.5, 77, 79.5, and 82%. In the starter period, the birds weight gain, feed conversion ratio, and breast fillet yield presented a quadratic response (P<0.05) to Val:Lys ratios, as described by the equations Y = -2.592.8 + 89.58 Val - 0.59 Val² (R² = 0.97), Y = -5.17 + 0.093 Val - 0.00058 Val² (R² = 0.92) and Y = -55.59 + 1.861 Val - 0.012 Val² (R² = 0.81), respectively. The recommended dietary digestible Val:Lys ratio for the finisher phase is 78% or 0.84% digestible Val. In the finisher phase, there was a quadratic effect (P<0.05) on feed conversion ratio (Y = 11.8 - 0.2522 Val + 0.00159 Val²; R² = 0.94) and breast fillet yield (Y = -1862.2 + 59.47 Val - 0.3772 Val²; R² = 0.89). These results indicate that a Val:Lys ratio of 79% or 0.77% digestible Val is sufficient to maximize broiler performance during the finisher phase.

Key Words: amino acid, broiler production, ideal protein, performance, supplementation

Digestible threonine:lysine ratios for brown egg laying hens. G. R. Lefls¹, E. T. Nogueira², L. F. T. Albino¹, and H. S. Rostagno*¹, ¹Universidade Federal de Viçosa, Viçosa, MG, Brazil, ²Ajinomoto Biolatina/Ajinomoto Animal Nutrition, Sao Paulo, SP, Brazil.

When formulating minimum cost layer diets it is essential to supply threonine (Thr) requirements to allow birds to express their maximum genetic potential. Throneine deficiency may decrease the efficiency of the utilization of methionine + cystine and lysine (Lys), which are the first and second limiting amino acids in layer diets. An experiment was carried out to evaluate digestible Thr:Lys ratios for brown egg laying hens. A total of 270, 42 to 54 wk old Dekalb Brown layers were evaluated during three periods of 28 days each. A completely randomized experimental design with five treatments and 9 replicates of 6 birds per experimental unit was applied. The following digestible Thr:Lys ratios were tested: 66 (0.436% dig Thr), 70, 74, 78, and 82%. Diets were formulated to meet or exceed the birds nutritional requirements, except for Thr and Lys. In order to prevent excess Lys, digestible Lys level (0.660%) was calculated to supply 93% of the Brazilian Tables recommendation. Laying hens fed diets containing different Thr:Lys ratios presented quadratic response (P<0.05) for the following parameters: egg production (%/bird/day Y = -408.11 + 12.9072 Thr - 0.0846 Thr²; R² = 0.90); egg mass (g egg/bird/day Y = -191.19 + 6.3178Thr - 0.0415 Thr²; R² = 0.93); feed conversion per dozen eggs (kg/ dozen eggs Y = 9.878 - 0.2225 Thr + 0.00146 Thr²; R² = 0.92) and feed conversion per egg mass (g/g egg Y = 11.509 - 0.2501Thr + 0.00164 Thr²; R² =...
Based on the evaluated parameters, the digestible Thr:Lys ratio recommended for 42 to 54 wk old brown egg laying hens is 76% or 0.502% digestible Thr.

Key Words: threonine, lysine, requirements, performance, brown egg layers

### 354P Digestible valine:lysine ratios for brown egg laying hens.
G. R. Lelis¹, E. T. Nogueira², L. F. T. Albino¹, and H. S. Rostagno*¹
¹Universidade Federal de Viçosa, Viçosa, MG, Brazil, ²Ajinomoto Bio-latina/Ajinomoto Animal Nutrition, Sao Paulo, SP, Brazil.

Valine (Val) is considered a potentially limiting amino acid for laying hens, after methionine, lysine (Lys), tryptophan, and threonine. Adequate Val levels must be considered when diets are formulated using the ideal protein concept, (i.e., containing the correct balance of amino acids, with no deficiencies or excesses), thereby reducing nitrogen excretion. A study was carried out to evaluate digestible Val:Lys ratios for brown egg laying hens. At total of 270 42 to 54 wk old Dekalb Brown layers were evaluated during three periods of 28 days each. A completely randomized experimental design with five treatments and 9 replicates of 6 birds per experimental unit was applied. The digestible Val:Lys ratios were: 84 (0.555% dig Val), 88, 92, 96, and 100%. Diets were formulated to meet the nutrient requirements except for Val and Lys. In order to prevent Lys excess, digestible Lys level (0.660%) was calculated to supply 93% of the Brazilian Tables recommendation. During the period of 42 to 54 weeks, there was a quadratic response to the dietary Val:Lys ratios as to egg production (P<0.03) (%/bird/day Y = - 566.22 + 13.5524 Val - 0.0708 Val²; R² = 0.87); egg mass (P<0.07) (g egg/bird/day Y = - 313.13 + 7.4715 Val - 0.03863 Val²; R² = 0.91); feed conversion per dozen eggs (P<0.04) (kg/dozen eggs Y = 8.03 - 0.14096 Val + 0.00074 Val²; R² = 0.95) and feed conversion per egg mass (P<0.08) (g/g egg Y = 10.54 - 0.1766 Val + 0.00091 Val²; R² = 0.93). Based on the evaluated parameters, the digestible Val:Lys ratio recommended for 42 to 54 wk old brown egg laying hens is 96% or 0.63% digestible Val.

Key Words: valine, lysine, requirements, performance, brown egg layers

### 355P Understanding the limitations of dietary isoleucine and valine in broiler chick diets.
A. Corzo*, R. E. Loar II, and M. T. Kidd, Mississippi State University, Mississippi State.

Considering the variety of ingredients used by broiler integrators in the US, the most likely candidates to set the crude protein level and become fourth limiting in practical formulas are Ile and/or Val. A study was conducted to observe the response and needs of Ile and Val in practical broiler chick diets. Broiler chicks were fed a diet adequate in all nutrients that served as positive control (PC). A second diet served as negative control (NC), and was formulated to resemble all nutrient concentrations of the PC except for Ile and Val which were assigned no minimum values in the formula. Other treatments fed were: NC plus 0.15% Ile; NC plus 0.15% Val; NC plus 0.075% Ile and 0.075% Val; NC plus 0.15% Ile and 0.15% Val.

At the end of the study (21 d of age), BW gain and feed conversion values suggested that Val, may be needed prior to Ile due to equal responses to the PC when Val was individually fed. Plasma concentrations for total protein and albumin also indicate that Val was more limiting than Ile. However, overall responses appear to indicate that Val may reach a point where it may no longer be efficiently utilized unless dietary levels of Ile are made available, perhaps suggesting that these two amino acids may be co-limiting in a diet where corn, soybean meal, and poultry by-product meal are the major ingredients.

Key Words: isoleucine, valine, broiler

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### 356P WITHDRAWN.

### 357P Calcium silicate and calcium levels of hens in the second laying cycle.
A. C. Caiel, J. C. C. Carvalho, F. A. Gomes, E. J. Fassani, and A. G. Bertechini*, Universidade Federal de Lavras, Lavras, MG, Brazil.

The nutritional requirements of laying hens for silicon (Si) are absent in the NRC (1994). Silicon sources have soluble calcium that may contribute to hen nutrition. The present study evaluated the effects of different dietary levels of calcium silicate and calcium levels (Ca) on performance and egg quality of laying hens in the second laying cycle. Four hundred and eighty Hy-Line W-36 hens were used in a completely randomized design in a 2 x 4 factorial for Ca (3.0 and 3.8%) and calcium silicate level (0, 0.75, 1.50 and 2.25 %) using 5 replicates of 12 birds/treatment from 98 to 107 wks-old in 3 experimental periods of 21 days each. A corn-soybean meal based diet (2730 kcal/kg EM, 15.3% CP) was supplemented with minerals and vitamins. The calcium silicate contents were 25% and 11% of calcium and silicon, respectively. Results showed significant interactions (P<0.05) between Ca and silicate levels for egg production and egg quality. Increased egg production was found when 3.0% Ca and 1.08% silicate were added to the diet. It was observed that the increase on Ca levels was followed by a decrease in feed consumption, but this effect was reduced as increasing levels of silicate were added to the diet. Results showed that improved feed efficiency (g/g) was obtained when combinations of Ca and silicate were 3.0% and 0.96% and 3.8% and 2.25% for Ca and Ca silicate, respectively (quadratic response, P<0.05). Reduced cracked eggs (P<0.05) were observed when 3.0% Ca and 0.78% silicate were added to the diet; it was also observed a linear decrease (P<0.05) on cracked eggs when 3.8% Ca was supplemented as dietary silicate levels increased. Dietary Ca and silicate had no influence (P>0.05) on egg shell thickness and specific gravity but Haugh unit was improved when silicate levels were increased for both Ca levels studied. Supplementation of silicate regardless of dietary Ca level improved egg production and internal egg quality in aged hens.

Key Words: eggshell thickness, internal egg quality, laying hens, calcium silicate

### 358P Activity of phytases in different conditions of storage, pH, temperature and thermic processes.
L. P. Naves, A. D. Corrêa, J. C. C. Carvalho, J. A. G. Brito, and A. G. Bertechini*, Universidade Federal de Lavras, Lavras, MG, Brazil.

The objective of the present study was to evaluate phytase activity from different sources (Aspergillus oryzae, Aspergillus niger and Saccharomyces cerevisiae) considering storage time, pH and temperature in vitro, and heat exposure on phytase activity stored during 60 d (room temperature). In the first assay the phytase were evaluated as ‘per se’ and in the vitamin-mineral premix in its catalytic activity during 0, 30, 60, 90, 120, 150 and 180 d of storage in a completely randomized design with four replicates in a factorial scheme (3x2x7). The enzyme activity was also determined through pH and temperature data. In the
second assay the phytase activity was evaluated in four times of heat exposure (control, 4, 8 and 12 minutes at 80-85 °C) and five storage times (0, 15, 30, 45, 60 d) at room temperature. Sodium phytate were used to monitore phytase activity. Results showed a linear decrease (P<0.05) on enzyme activity due to storage time in both, ‘per se’ and in the premix. The A. oryzae phytase exhibited the highest activity at pH 4.0, while the others showed optimum pH between 4.5 and 5.0. The A. oryzae phytase showed highest activity at 40 °C while the A. niger phytase presented the highest activity at 45 °C. The S. cerevisiae phytase presented the highest thermal resistance, between 50 and 60 °C. The distinct sources of phytase showed different activities considering the storage condition, pH, temperature and heat exposure.

**Key Words:** phytase activity, phytase sources, phytase storage

359P  Effects of three commercially available phytase enzymes on broiler growth performance and bone ash when fed diets deficient in available phosphorus.  J. R. Coppedge¹, L. A. Oden¹, J. Klein¹, S. Pohl¹, M. Farnell¹, B. Ratliff², B. Brown², S. Frankenbach², and J. T. Lee¹, ¹Texas A&M University, AgriLife Research, College Station, ²Enzyvia, LLC., Sheridan, IN.

Phosphorus is an important nutrient in broiler diets due to the effects observed on growth performance and bone mineralization. Recent increases in costs of dietary inorganic phosphorus sources have lead to increased use of phytase enzymes worldwide. A 35-day experiment, having a 14 day starter and 21 day grower period, was conducted to investigate the effect of three commercially available phytase enzymes (A, B, and C) on growth performance and bone mineralization in phosphorus deficient corn/soy based diets. The experimental design consisted of a total of ten treatment groups with six replicates per treatment and 50 chicks/rep. Treatments one through four were a phosphorus titration containing incremental levels of added inorganic phosphorus (0.22, 0.27, 0.32, and 0.37% aP and 0.17, 0.22, 0.27 and 0.32% aP in the starter and grower diets, respectfully). The other six treatment groups included each enzyme supplemented at the inclusion rate recommended to release 0.10% of phosphorus from phytate and an additional inclusion rate thought to release between 0.13 and 0.15% phosphorus from the diet. Right tibias were collected from six males/rep on day 35 for bone ash determination. Data from the phosphorus titration revealed a linear relationship between inorganic phosphorus consumption with observed body weight and bone ash. Following regression analysis, bone ash data indicated a phosphorus releasing capability with these inclusion levels for enzyme as follows: A - 0.14 to 0.19%, B - 0.10 to 0.15 %, and C - 0.04 to 0.14%. These data confirmed the ability of each phytase enzyme to release dietary phosphorus from phytate based on observed body weights and bone ash analysis, however the responses varied according to enzyme and supplemented level.

**Key Words:** enzymes, nutrients reduction, performance, digestibility

360P  Effect of dietary supplementation of phytase and a combination of xylanase, amylase and protease on nutrient digestibility and performance of broiler chickens.  M. A. Bonato², N. K. Sakomura³, L. Romero¹, A. Cowieson², M. Hruby³, and M. Cunha³, ¹Universidade Estadual Paulista, Jaboticabal, São Paulo, Brazil, ²Danisco Animal Nutrition, Marlborough, Wiltshire, United Kingdom, ³Danisco Animal Nutrition, Woodbury, MN.

A study was conducted to evaluate the efficacy of Avizyme® 1500 and Phyzyme® XP combination in corn-soybean diets on nutrient digestibility and performance of broiler chickens. A total of 1440 Cobb 500* male broiler chicks were randomly assigned to four treatments with 8 replicates of 45 chicks each. The trial used a 2 x 2 factorial design, with two diets (Positive Control, PC; and Negative Control, NC), with or without supplementation of the enzyme combination. The enzymes were: Avizyme® 1500 (endoxylanase, α-amylase, protease)-1000g/ton, and Phyzyme® XP 5000G (E.coli-origin, 6-phytase)-100g/ton (Danisco Animal Nutrition). PC diets were formulated based on corn and soybean according to nutritional requirements, and NC had reduced ME (starter-130 kcal/kg; finisher: -145 kcal/kg), Ca (-0.15%), and P (-0.14%). Ileal digestibility of nutrients was determined at 21 and 42 d. Ten birds from each pen were slaughtered and the contents of 20 cm of the ileum were collected. Enzyme supplementation of the PC diets did not affect nutrient digestibility, however, enzyme supplementation of the NC diets improved ileal digestibility of dry matter, protein and energy compared to NC (66.4 vs 60.6%, 77.0 vs 71.7% and 3,308 vs 3,035 kcal/kg, respectively; P<0.05). Chickens fed the NC diets showed lower feed intake, body weight and feed conversion than those fed PC (4238 vs 4635 g, 2358 vs 2720 g, 1.797 vs 1.704, respectively; P<0.05). The addition of the enzyme combination to NC diets increased feed intake (4507 g) and body weight (2581 g) and reduced feed conversion (1.746) compared to birds fed the NC diets (P<0.01). In conclusion, the combination of xylanase, amylase, protease and phytase was able to restore performance and increase ileal digestibility of energy and protein of broilers fed diets reduced in ME by 130 to 145 kcal/kg and Ca and P by 0.15% and 0.14%, respectively.

**Key Words:** amino acids requirements, nitrogen balance technique

361P  Lysine requirement for maintenance of poultry.  J. C. Siqueira¹, N. K. Sakomura¹, M. A. Bonato¹, E. Oviedo-Rondon², and H. S. Rostagno³, ¹Universidade Estadual Paulista, Jaboticabal, SP, Brazil, ²North Carolina State University, Raleigh, ³Universidade Federal de Viçosa, Viçosa, MG, Brazil.

Three metabolic assays were carried out to determine lysine maintenance requirements by nitrogen balance technique (NB). Leghorn roosters (30) were used (1.98±0.18kg) in assay 1, 60 ISA Label (4.33±0.15) in assay 2, and 60 Cobb 500 roosters (5.11±0.44kg) in assay 3. Birds were fed five dietary levels of lysine intake. The diets were based on corn, starch and crystalline amino acids formulated to contain all the essential amino acids according to 50% of recommendation. The dietary treatments were obtained by dilution technique and enable digestible lysine intakes ranging from 10.3 to 93.2 mg/kg0.75 /day. Initially the birds were submitted to adaptation to diets for 120 hours, followed by total excreta collection during 96 hours. Based on nitrogen content of the diets and excreta was determined the NB. Lysine requirement for maintenance was estimated by simple linear regression of NB (mg/kg0.75 /day) as a function of lysine intake (LysI) (mg/kg0.75 /day), defined by lysine intake to keep NB at zero. The linear regressions were: NB= -122.16(±12.1) + 2.71(±0.2)LysI (r²=0.74) (P<0.0001) for ISA; NB= -120.95(±18.7) + 2.72(±0.3)LysI (r²=0.67) (P<0.0001) for Leghorn; NB= -120.95(±18.7) + 2.72(±0.3)LysI (r²=0.60) (P<0.0001) for Cobb, resulting in 44.9, 44.4 and 47.0mg/kg0.75 /day, respectively. As the linear regressions were not statistically different, according to parallelism test, a equation is described as: NB= -122.16(±12.1) + 2.71(±0.2)LysI (r²=0.67) (P<0.0001). The maintenance lysine requirement was 45mg/kg0.75 /day or 32mg/kg/day, independent of lineage.

**Key Words:** broiler, phytase, bone ash, performance, phosphorus
362P  **Supplementation of β-mannanase to starter and grower diets for broilers.** C Kong*, 1 J. H. Lee, 2 and O. Adeola 1, 1 Purdue University, West Lafayette, IN, 2CTCBOI Inc., Seoul, Korea.

This study was conducted to investigate the efficacy of the CTCZYM® β-mannanase product, in broiler chickens fed corn and soybean meal-based diets. One hundred and ninety two male broiler chickens were assigned into 4 diets arranged in a 2×2 factorial of energy level (corn-soybean meal-based diet that met NRC nutrient requirements (AE) or low energy (LE) diet containing 100 kcal of ME/kg less than the AE diet) and enzyme level (0 or 400 IU of β-mannanase/kg of diet). The LE diet contained 2.5% soy hulls and 2.5% corn distillers dried grains with solubles at the expense of corn and soybean meal. There were 8 birds per pen and 6 replicate pens per diet in a randomized complete block design. The study was conducted over a 42-d period and bird weights and feed consumption were measured on a pen basis at days 1, 21, and 43 post-hatch. The body weight (BW) of birds at day 1 post-hatch (46 g per chicken) was identical for the all diets. At the end of the starter period of the study (d 21 post-hatch), there was an interaction between energy level and enzyme level for BW gains (P = 0.1063) of chickens whereas no interaction was observed for the feed intake and feed efficiency. The BW gains of chickens fed the LE diet containing β-mannanase were greater (P < 0.05) than those of chickens fed the diet without β-mannanase, but β-mannanase supplementation did not affect the BW gains of birds fed the AE diet. During the grower period (days 21 to 43 post-hatch) and for the overall period (days 1 to 43 post-hatch), BW gain of chickens was not different among the treatments. There were no dietary treatment effects on feed intake and feed efficiency of birds during the starter, the grower, and for the overall periods. These results show that supplementing a low energy diet containing 2.5% soy hulls and 2.5% corn distillers dried grains with solubles with 400 IU of β-mannanase/kg improved BW gain of chickens in the starter period.

**Key Words:** broiler chickens, growth performance, enzyme, β-mannanase, DDGS

363P  **Effect of origin of soybean meal and enzyme supplementation of the diet on growth performance of turkey poult from 1 to 28 days of age.** M. Frikha1, M. P. Serrano1, M. Habboub2, R. Lázaro1, and G. G. Mateos*1, 1 Universidad Politécnica de Madrid, Madrid, Spain, 2Société de Nutrition Animale, Bellaterra, Spain.

A total of 960 one-day-old Hybrid poulets were used to study the influence of the origin of the soybean meal (SBM) and the supplementation with an enzyme mixture (ES) on performance from 1 to 28 d of age. There were 4 diets arranged factorially with two sources of SBM (ARG, Argentinian; USA) and two levels of ES (0 vs. 50 mg/kg of diet). The CP, trypsin inhibitor units (TIU), and KOH solubility for the ARG and USA SBM were 47%, 5.9 mg/g, and 81.2%, and 48.3%, 3.4 mg/g, and 86.8% respectively. The ARG meal was obtained from a local trader and the USA meal (SOYMAX trademark) from Owensboro Grain Co (Owensboro, KY). The calculated digestible lysine and AMEn content of these two SBM sources were 2.54 and 2.68%, and 2.310 and 2.390 kcal/kg, respectively. The enzyme complex used (Rovabio, Adisseo, StAntony, France) contained 14,000 IU of β glucanase/kg diet, 20,000 IU of xylanase/kg diet, and included some additional amounts of other enzymes. The experimental diets were based on SBM and corn, and had similar AMEn, CP content, and essential amino acids profile (2,700 kcal AMEn/kg, 26% CP, and 1.4% digestible lysine) on calculated bases. Diets were fed as crumbles. Origin of SBM did not affect performance from 1 to 14 d of age but cumulatively, poulets fed USA SBM had higher BWG (36.98 vs. 35.28 g/d, P≤0.01), ADFI (52.82 vs. 51.37 g, P≤0.05), and better FCR (1.43 vs. 1.46, P≤0.05) than poulets fed ARG SBM. Growth performance was not affected by ES. We concluded that SBM of USA origin had more AMEn and digestible lysine than SBM of ARG origin and that its inclusion in the diet resulted in better performance of poult from 1 to 28 d of age. The supplementation with enzymes did not affect performance of poult fed a corn-SBM diet at early ages.

**Key Words:** soybean meal origin, turkey poult, growth performance, enzyme supplementation

364P  **Effect of soybean meal origin on performance of broilers from 1 to 37 days of age.** M. Frikha1, M. P. Serrano1, A. Mrabet2, S. Makni3, and G. G. Mateos*1, 1Universidad Politécnica de Madrid, Madrid, Spain, 2Société Medimix, Sfax, Tunisia, 3Société Chahia, Sfax, Tunisia.

Two trials were conducted to study the influence of origin of soybean meal (SBM) on performance of broilers from 1 to 37 d of age. The CP, trypsin inhibitor units (TIU), and KOH solubility were 47% and 48.3%, 5.9 mg/g and 3.4 mg/g, and 81.2% and 86.8% for the Argentinian (ARG) and USA SBM, respectively. The calculated digestible lysine and AMEn content were 2.54% and 2,310 kcal/kg for ARG SBM and 2.68%, and 2,390 kcal/kg for the USA SBM. For each of the 2 periods, starter (1 to 21 d) and finisher (22 to 37 d), the diets had similar calculated AMEn and digestible lysine content. In trial 1, 5,200 straight-run, one-day-old Hubbard chicks were used. There were 4 treatments arranged factorially with two diets based on ARG or USA SBM and two birds strain (F15 and JV). Each treatment was replicated 10 times (a floor pen with 130 chicks). Origin of SBM did not affect performance at any age. Broilers from the F15 strain ate more feed (P≤0.01) and grew faster (P≤0.001) than JV broilers. In trial 2, 1,500 straight-run, one-day-old JV chicks were used. There were 6 treatments arranged factorially with 3 SBM sources (ARG, USA, and local) and two levels (0 vs. 250 mg/kg of diet) of plant oil extract rich in terpenes (AEN 1400, Phytosynthèse, Clairemont ferrand, France). The local SBM contained 47.3% CP and had similar calculated nutritive value than ARG SBM. Each treatment was replicated 5 times. Cumulatively, birds fed USA and ARG SBM grew faster (P≤0.001), and had better FCR (P≤0.01) than birds fed local SBM. The inclusion of prebiotic improved BW gain and FCR in birds fed the local SBM but not in those fed the others SBM. The percentage of prime parts (breast, thighs, and wings) was lowest for birds fed the local SBM (P≤0.05). We concluded that USA SBM had more AMEn and digestible lysine for broilers than ARG and local SBM. Also, the prebiotic used might improve performance in broilers fed low quality SBM.

**Key Words:** soybean meal origin, broiler, strain, performance, prebiotics

365P  **Effect of the soybean meal origin on growth performance of broilers.** D. Solà-Oriol1, P. S. Agostini 1, J. F. Pérez 1, and G. G. Mateos*2, 1Universitat Autònoma de Barcelona, Bellaterra, Spain, 2Universidad Politécnica de Madrid, Spain.

The hypothesis of the present experiment was that the botanical origin and the technology applied to the soy beans affect the nutritional quality of the soybean meal (SBM) produced. A total of 240 straight-run broilers (Ross 308), one-day old were used to study the influence of origin of soybean meal (SBM) on productive performance of broilers from 1 to 35 d of age. There were 2 feeding periods: 1 to 21 d (3,000 kcal AMEn/kg,
21% CP, and 1.25% total lys) and 21 to 35 d of age (3.140 kcal AMEn/kg, 19.7% CP, and 1.14% total lys and 4 experimental diets based on cereals and with the SBM under study as the main source of protein. The SBM tested were obtained from Argentina (ARG, 44.3% CP), Brazil (BRA, 48.9% CP), or USA (either from Owensboro Grain, KY; USA-1, 49.3% CP or Carolina Soya, NC; USA-2, 49.1% CP). All diets within each period were formulated to contain similar CP content. Each treatment was replicated 12 times and the experimental unit was a cage with 5 chucks each. Thus, the SBM contained in the diets differed according to the type of meal used. From 7 to 35 d of age FCR was lowest for USA-2 and highest for ARG meal with USA-1 and BRA meals being intermediate (1.490, 1.557, 1.529, and 1.529, respectively; P<0.01). Also, from 7 to 21 d of age broilers fed ARG meal showed higher feed intake (84.2 vs. 79.4, 80.3, and 80.3; P<0.001) but were less efficient (1.313 vs. 1.254, 1.271, and 1.285; P<0.01) than broilers fed USA-1, USA-2 or BRA meals. The differences observed in broiler performance among the different soybean meals might be due to the differences in NDF, trypsin inhibitor, CP, and saccharose content. In fact, ARG SBM had more NDF and less CP and lower trypsin inhibitor activity than USA-2 meal. It is concluded that feed mills should analyze incoming batches of SBM for major nutrients prior to feed formulation.

Key Words: soybean meal, origin, broiler, performance

366P Influence of length storage on parameters used to measure the quality of soybean meal. S. Sueiro1, M. P. Serrano2, M. González1, M. Hermida1, and G. G. Mateos*2, 1Laboratorio de Mouriscade, Pontevedra, Spain, 2Universidad Politécnica de Madrid, Madrid, Spain.

An experiment was conducted to determine the influence of length of storage on the values used by the industry to estimate protein quality of soybean meal (SBM): KOH solubility (KOHsol.), protein dispersibility index (PDI), urease activity (UA), and trypsin inhibitor activity (TIA). The KOHsol. and PDI have been found useful in estimating the degree of toasting and damage in SBM. Meals with KOHsol. values between 80 and 88%, PDI values between 20% and 35%, and UA values between 0.02 and 0.20 mg/g are considered of acceptable quality. For TIA a value of less than 2.5 mg/g (≤ 4-5 mg TI/g) is considered best. However, protein solubility changes with the methodology used and thus, the variability among- and inter-laboratory is high. Length and environmental conditions during storage might influence protein solubility and thus KOHsol. and PDI values. Seven samples (500 g) of Argentine SBM were collected during June 2007. Samples were analyzed at arrival of the vessels to port (Pontevedra, Spain) and after 24, 48, and 80 wk of storage (12 ± 2ºC and 70 ± 3% humidity). Also, meals were analyzed in 8 wk old turkeys. A turkey feeding trial was conducted with commercial Large White toms during 6 to 19 wks of age. The study examined incorporation of CG and HP in diets with and without DDGS. Two levels were used for each co-product addition. The diets were fed in mash form and adjusted for age. Diets were formulated on a digestible amino acid basis and used supplements of lys, met, and thr. Supplemental fat was adjusted to keep the diets isocaloric. A corn/SBM/poultry byproduct


Recent work has shown that chemical composition and nutritive value of soybean meals (SBM) might differ with changes in agricultural practices and processing conditions in origin. Near infrared spectroscopy (NIRS) and colour measurements are versatile and inexpensive analytical techniques with ability to identify and classify food products and to detect improper processing conditions. The objective of this work was to assess the potential of NIRS and colour as rapid tools to discriminate SBM by origin (Brazil, BRA; Argentina, ARG; United States, USA). A total of 165 SBM samples of known origin were scanned using a monochromator instrument (Foss NIRSystems 5000) over the range 1100-2500 nm. Colour (CIELAB system) was also recorded in these samples using a Minolta colorimeter (model CR-300). The three sets of SBM samples were randomly split into a training set (ARG, n= 45; BRA, n=40; USA, n=50) used to develop linear discriminant models (option PLS2-DA, WinISI v.1.50) and a validation set (ARG, n= 10; BRA, n=10; USA, n= 10). The best classification model, selected by the lowest standard error of cross validation (SECV), yielded a SECV value of 0.263 with 94% of the samples classified correctly (93% for ARG; 88% for BRA, and 100% for USA, respectively). In the validation step, 90% of the samples were classified correctly (90% for ARG; 80% for BRA, and 100% for USA, respectively). Colour parameters of SBM samples differed (P<0.001) among origins, with the BRA meals being redder than the ARG and USA meals (6.09 vs. 5.34 and 5.33, respectively). The yellowness and luminosity were higher for the USA meals than for the South American meals (6.09 vs. 5.34 and 5.33, respectively). The results indicate that NIRS can be used as a reliable and accurate method to differentiate the SBM samples by origin, and that colour measurements can help to confirm these results. Both technologies can be readily applied for the quality control of SBM by the feed mill industry.

Key Words: soybean meal, origin, color, near-infrared spectroscopy

368P WITHDRAWN

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Changes in ethanol production have led to different types of corn co-products. Two products commercially available are a high protein distillers grains (HP) and corn germ (CG). The objectives of the study were to characterize these different products and examine differing inclusion levels of HP and CG in market turkey diets. Samples of DDGS, CG, and HP were analyzed chemically. True amino acid digestibility was determined in cockerels and true metabolizable energy was determined in 8 wk old turkeys. A turkey feeding trial was conducted with commercial Large White toms during 6 to 19 wks of age. The study examined incorporation of CG and HP in diets with and without DDGS. Two levels were used for each co-product addition. The diets were fed in mash form and adjusted for age. Diets were formulated on a digestible amino acid basis and used supplements of lys, met, and thr. Supplemental fat was adjusted to keep the diets isocaloric. A corn/SBM/poultry byproduct
meal based diet series (Treatments (T) 1-5, 11) was used along with a 20% DDGS diet series (T 6-10). Levels of 15 and 30% CG, and, 7 and 14% HP were used and were decreased by 50% when incorporated into the 20% DDGS diets. T11 contained 30% CG and 14% HP. The experimental design was a randomized block design with 8 replicate pens per treatment. For CG, HP, and DDGS the respective percent contents of CP and lys were 12.2 (%), 40.5 (1.22), and 26.8 (%); digestible lys was 76, 76, and 75%; and, TMean was 2835, 2710, and 2730 kcal/kg (as-fed). Addition of 15% and 30% CG to diets without DDGS improved body weight and feed conversion, respectively, when compared to T1 (P<.05). Turkeys fed T11 had reduced BW and gain compared to T1. Inclusion of 14% HP had no effect on 19 wk BW or cumulative F/G, however, gain and F/G was poorer in the final feeding period of 17-19 wks of age. Inclusion of 20% DDGS tended to reduce gain and feed intake in the 17-19 wk period and suggests that a lower level of DDGS should be fed during that time period. Addition of up to 14% HP appears possible in diets without DDGS but should be confirmed in future studies especially for feeding this high level near market age.

Key Words: turkey, corn, distillers grains

371P Effects of feeding distillers dried grains with solubles (DDGS) to commercial laying hens: II. Live production. R. E. Loar II*, S. N. Homen*1, C. D. McDaniel1, C. D. Coufal1, S. R. Rogers2, K. Karges3, and A. Corzo1, 1Mississippi State University, Mississippi State, 2Cal-Maine Foods, Jackson, MS, 3Poet Nutrition, Sioux Falls, SD.

The objective of this experiment was to evaluate the effects of including DDGS in the diets of commercial leghorns on the live production of second cycle Bovan White layers. The birds were fed one of five dietary levels of DDGS: 0, 8, 16, 24 or 32%. Diets were formulated to be similar in all relevant nutrients. Treatments were fed for a period of 15 weeks. Interaction between week and DDGS inclusion was tested for all variables monitored. Data was analyzed as a randomized complete block design using Fisher’s protected LSD test to separate treatment means. Data collected included egg production, feed consumption, feed conversion, mortality, egg weight, cracked eggs, soft shell eggs, and specific gravity. Data indicated that the 16% DDGS treatment had a significantly higher (P<0.0001) egg production than all other treatments, except the 32% DDGS treatment. Feed conversion was significantly lower (P<0.01) for the 16 and 32% DDGS diets compared to either the 8 or 24% DDGS diets, with the 0% DDGS diet intermediate. Egg mass was observed to be higher (P<0.05) for the 16% DDGS treatment compared to the 8 and 24% DDGS treatments, with the 0% and 32% being intermediate. No differences (P>0.05) between treatments were observed for soft shell eggs, cracked eggs, feed consumption, egg weight or mortality. Hens fed with 0% DDGS had a significantly lower (P<0.10) specific gravity than either the 24 or 32% treatments. Overall data shows that there were no negative effects that resulted from feeding up to 32% DDGS in the diet of second cycle commercial leghorns.

Key Words: distillers dried grains with solubles, Leghorns, egg production

372P High dietary inclusion of dried distillers grains with solubles in laying hen rations in combination with Allzyme® SSF enzyme. M. K. Masadeh*, A. A. Aljamal, and S. E. Scheideler, University of Nebraska, Lincoln.

A study was conducted to test the effects of feeding high levels of Dried Distillers Grains with Solubles (DDGS) in combination with Allzyme® SSF enzyme on Phase one of egg production from 23 to 43 weeks of age. Two hundred forty Hy-Line W-36 laying hens were used in this study. Hens were fed diets containing five levels of DDGS (0, 10, 20, 30 or 40%) and two levels of Allzyme® SSF (0, 0.02%) having activities of Phytase, Protease, Pentosanase, Pectinase, Cellulase, Beta-Glucanase, and Amylase, in a 5X2 factorial design. The diets containing 0% enzyme were formulated to provide 2875 K Kcal/kg ME, 16.75% protein, 0.88% lysine and 0.44% methionine whereas the diets containing 0.02% enzyme were formulated to provide 2800 Kcal/kg ME, and the same level of protein and amino acids. The Allzyme® SSF enzyme treatments were substituted with 75 Kcal/kg ME, 0.1% calcium and 0.1% phosphorus for the enzyme value. Six replicate cages (4 hens/cage) were assigned per dietary treatment in a randomized complete block design. DDGS by enzyme interactions were not significantly different (P>0.05) for feed intake, hen weight and egg parameters. Average feed intake was similar (P>0.05) between dietary treatments with an average of 102 g/hen/d. Average hen weights were similar (P>0.1) between dietary treatments. Average egg production was not affected by dietary treatments (P>0.05). However, hens fed 40% DDGS had lower egg production (P<0.1) compared to 0, or 10% DDGS. Egg wt. was not significantly (P>0.05) affected by DDGS treatments. There was no difference (P>0.1) in egg Haugh unit, and specific gravity between treatments. Yolk color increased with increasing DDGS level with the highest Roche color fan score (p<0.05) of 7.8 for hens fed 40% DDGS. In summary, feeding up to 30% DDGS with or without enzyme treatment during Phase 1 of production had no negative effects on feed intake, egg production, egg weight, haugh unit and specific gravity. Feeding Allzyme® SSF enzyme has an economical benefit of $8/t and feeding 30% DDGS has an economical benefit of $6/t of feed compared to the basal diet (0% DDGS).

Key Words: DDGS, Allzyme® SSF, laying hens, Hy-Line

373P Results of a survey on the occurrence of mycotoxins in DDGS. U. Hofstetter*, Biomin Holding GmbH, Herzogenburg, Austria.

The inclusion of DDGS (dried distillers grains with solubles ) in animal feed is an increasing trend for the last few years. The rising prices for feedstuffs and feeds worldwide demanded the development of alternative sources of energy and proteins in animal diets. DDGS seems to gather these characteristics. However, mycotoxins which might be present in maize are not eliminated by the fermentation processes during bioethanol production. Mycotoxins are toxic metabolites formed by fungi species that colonize crops and thus pose a potential threat to human and animal health as many of these toxins are acutely toxic, immunosuppressive, genotoxic and show estrogenic effects. Mycotoxin contamination of crops may cause economic losses at all levels of food and feed production. Contamination is carried-over and even increased during bioethanol production. This study was initiated and backed by BIOMIN to provide customers insights in the occurrence of mycotoxins in DDGS samples worldwide. More than 250 samples were analyzed for the major mycotoxins of interest (aflatoxins, zearalenone, deoxynivalenol, T-2 toxin and fumonisin). Aflatoxins, ZON and total FUM were analyzed by HPLC (High Pressure Liquid Chromatography) whereas DON values were obtained by TLC (Thin Layer Chromatography). For the purpose of data analysis, non-detect levels were based on the quantification limits of the test method for each toxin: Aflatoxin B1 <0.5 μg/kg, ZON <10 μg/kg; DON <150 μg/kg; T-2 toxin <30 μg/kg and FUM <25 μg/kg. Almost all samples were tested positive for at least one mycotoxin. About 90% of the analyzed samples have shown a simultaneous contamination of two...
or more mycotoxins. From all samples analyzed, ZON accounted for a 84% contamination rate; 70% of tested DDGS were positive for DON, only 10% for T-2 toxin and 89% for FUM. Only 19% of the samples were positive for aflatoxin with an average contamination level of 1.3 μg/kg. However the presence of field mycotoxins (ZON, DON, FUM) produced by _Fusarium_ sp. which - despite Good Agricultural Practice cannot be avoided totally is very frequent and the contamination levels can be considered as medium to high.

**Key Words:** DDGS, mycotoxins, occurrence

### 374P WITHDRAWN.

### 375P Chemical composition and metabolizable energy values of the guava waste for broiler chicks.

C. B.-V. Rabello*1, R. C. Lira1,2, M. B. de Lima1, E. P. da Silva1, P. V. Ferreira2, J. V. Ludke1, and F. G. P. Costa1, 1Universidade Federal Rural de Pernambuco, Recife, PE, Brazil, 2Universidade Federal de Alagoas, Maceió, AL, Brazil, 3EMBRAPA-Suínos e Aves, Concórdia, SC, Brazil, 4Universidade Federal da Paraíba, Areia, PB, Brazil.

The aim of this study was to determine the chemical composition and energy of the guava waste for broiler chickens. The waste was collected from processing industry of guava and analyzed the chemical composition in the laboratory of animal nutrition and after was conducted two metabolism assay, through the method of total excreta collection. Male Cobb chicks (180), with 100 birds in the experiment with chicks from 1 to 8 days old (Phase 1) and 80 birds in the 10 to 18 day period (Phase 2). Both experiments had two treatments and 5 replicates, with 10 and 8 chickens per experimental unit, respectively. The birds were distributed according completely randomized design. The treatments were: a reference diet (corn and soybean meal) and a test diet (80% of guava waste + 20% of residual guava) for each assay (experiments).

The values of the chemical composition of the waste were: 60.34, 9.82, 11.68, 2.45, 60.08, 84.30 and 69.53% for dry matter, crude protein, ether extract, ash, crude fiber, neutral detergent fiber and acid detergent fiber, respectively. Gross energy was 5357 kcal/kg, as-fed. The age of the birds did not influence the values of apparent metabolizable energy (AME), apparent metabolizable energy corrected for nitrogen (AMEn) and apparent coefficient of metabolism of gross energy (ACMGE) studied the ingredient. The values of AME, AMEn and ACMGE were: 1,416 kcal/kg, 1,331 kcal/kg, 27.10% and 1,392 kcal/kg, 1,358 kcal/kg and 26.65% for phase 1 and 2, respectively.

**Key Words:** alternative foods, broiler chickens, chemical composition, guava, metabolizable energy

### 376P Effect of different tomato waste levels on broiler performance.

R. C. Lira1,2, C. B.-V. Rabello*1, P. V. Ferreira2, E. P. da Silva1, J. V. Ludke1, M. C. M. M. Ludke1, and F. G. P. Costa1, 1Universidade Federal Rural de Pernambuco, Recife, PE, Brazil, 2Universidade Federal de Alagoas, Maceió, AL, Brazil, 3EMBRAPA-Suínos e Aves, Concórdia, SC, Brazil, 4Universidade Federal da Paraíba, Areia, PB, Brazil.

The objective of this work was evaluated the effect of inclusion of the tomato waste (TW) on performance and carcass yield of broilers. A total of 300 Cobb broilers males (1 d of age) were distributed according with randomized design with five levels of inclusion of the TW and five replicates. One reference diet based on corn and soybean meal was formulated and four test diets containing 5, 10, 15 or 20% TW. Feed intake, weight gain and feed conversion were evaluated weekly. Carcasses were evaluated (weight and yield) at 42 d, when eviscerated carcass (with head and feet), eviscerated carcass (without head + feet), thighs, drumsticks, wings, back, edible offal (liver, heart and gizzard), and abdominal fat were measured. Data underwent regression analysis.

The inclusion of the TW caused a linear decrease in feed intake during 1 to 7 and a linear increase during 36 to 42 d of age and a quadratic effect (Y=462.85+1.988TW-0.1764TW2) in the 8 to 14 d period with higher consumption estimated when the inclusion was of 5.64%, and consequently the weight gain from 1 to 7 days (quadratic effect, Y=173.31+0.3759TW-0.1101TW2) with higher weight gain when only 1.71% of TW was included, and the linear effect decreased for the others weeks until 28 d and for the total period (1 to 42 d of age). The feed conversion did not differ significantly after 28 d. However, there was a linear decrease in eviscerated carcass weight, carcass without head and feet and the parts (thigh, drumstick) and viscera (heart and liver) with increased dietary TW. In conclusion, TW can be used as a broiler diet ingredient in the final period of rearing, 29 to 42 d, without loss in performance.

**Key Words:** alternative food, by-products, carcass, productive performance, tomato

### 377P The effect of using different levels of guava waste in broiler diet.

C. B.-V. Rabello*1, R. C. Lira1, P. V. Ferreira2, J. V. Ludke1, W. M. Dutra Junior1, and F. G. P. Costa1, 1Universidade Federal Rural de Pernambuco, Recife, PE, Brazil, 2Universidade Federal de Alagoas, Maceió, AL, Brazil, 3EMBRAPA-Suínos e Aves, Concórdia, SC, Brazil, 4Universidade Federal da Paraíba, Areia, PB, Brazil.

The objective of this work was evaluated the effect of inclusion of the guava waste (GW) on performance and carcass yield of broilers. 300 broiler chicks, one day of age, male, Cobb lineage, were distributed according with randomized design with five levels of inclusion of the residue and five replications. One reference diet based on corn and soybean meal was formulated and others four with the inclusion of: 3, 6, 9 and 12% of GW. The feed intake, weight gain and feed conversion were evaluated weekly. The carcass were evaluated (weight and yield) with 42 days old: eviscerated carcass (with head and feet), eviscerated carcass (without head e feet), thighs, drumsticks, wings, back, edible offal (liver, heart and gizzard), abdominal fat. The data were submitted to regression analysis (P<0.05). There was only a quadratic effect (Y=199.29+1.0955GW-0.0889GW2) to indicate that the inclusion of 6.2% GW maximized the response of weight gain of animals. This response can be due to a decreased linear response (Y=177.79-0.5306GW) for feed intake in the same period. For the others experimental periods (8 to 21, 22 to 35 and 36 to 42 days) and total period (1 to 42 d of age), a lack of significant differences indicated that inclusion levels of 12% GW does not affect the performance of animals, except in the pre-starter phase where suggested inclusion is low. However, the 6.2% GW level promoted maximum performance of birds on these corn and soybean meal diets. The yield of the thigh decreased linearly (Y=14.664-0.1025GW) and the weight of abdominal fat had increased with a linear effect (Y=63.306+1.0703GW) possibly due to increased soybean oil in the ration.

**Key Words:** alternative food, broilers, by-products, guava, productive performance
378P  Tomato pomace and safflower meal as ingredients in non feed removal molt diets.  D. S. Patwardhan*1, A. J. King1, A. Mireles2, and J. M. Pisenti1, 1University of California, Davis, 2Foster Farms, Livingston, CA.

Induced molting by feed deprivation was determined to be detrimental to the welfare of laying hens and has been linked to human health concerns. Thus, alternative non feed removal diets have been developed and evaluated. In California, where over 90% of processed tomatoes in the U.S. are produced and fifty percent of the U.S. production of safflower seeds are grown, there is an abundance of tomato pomace, an agricultural by-product from tomato processing, and safflower meal from decorticated safflower seeds. Diets with these two ingredients may produce molt and post molt measurements comparable to a recommended no added salt non feed removal diet. Therefore, molt and post molt measurements from third cycle Single Comb White Leghorns fed non feed removal diets containing no added sodium (NS), safflower meal (SM), and elevated quantities of tomato pomace (TP) were compared to those from hens fed a corn/soybean meal diet (C8) (p≤ 0.05). During the 28-d molt phase, feed consumption for TP was similar (p≤ 0.05) to NS and SM, but lower than C8. Body weight for TP was lower (p≤0.05) than that of all other diets; weights for NS and SM were similar and lower than C8 (p≤0.05). Mortality did not differ (p>0.05) across the diets though TP had the highest numerical value. Post molt feed consumption was highest (p≤0.05) for CS compared to values that were similar for NS, SM, and TP consumption. There were no differences among diets for post molt body weight, mortality, specific gravity of eggs, and eggshell thickness (p>0.05). Egg production was different (p≤0.05) among diets with a ranking of C8>NS>SM>TP. SM and TP had similar and lower egg weights than C8 and NS (p≤0.05). Haugh units for non feed removal diets were higher (p≤0.05) than those for C8, with TP having the highest numerical value. Overall, SM yielded results for feed consumption and body weight more comparable to those of NS during the molt. However, except for egg production, post molt measurements were equivalent among TP, NS, and SM diets.

Key Words: molting, non feed removal diet, tomato pomace, safflower meal, egg production

379P  The effect of using graded levels of sugar syrup in broiler rations on growth performance and blood biochemical parameters.  A. S. Hussein*1, J. Al Ghurair2, and P. G. K. John2, 1University of California, Davis, 2Foster Farms, Livingston, CA.

The dietary energy for broiler chicken is provided through the inclusion of cereal grains and vegetable fat in the ration. Sugar syrup is a new concept for the dietary energy for chicken. The objectives of this study were to investigate the efficacy of sugar syrup as an energy feed and its effect of replacing part of the corn & fat in broiler chicken rations with graded levels of sugar syrup, on growth performance and blood/tissue biochemical parameters of broilers. One-day old Hubbard commercial broiler chicks were randomly assigned to four dietary treatments. Birds were housed in floor pens, with three replicate groups of 100 birds/pen for each treatment. The experimental treatments consisted of feeding on an ad libitum basis the corn-soy basal diet alone or with graded levels of sugar syrup to provide increments of 5, 10 and 15%. All starter diets were isonitrogenous (22% CP) and isocaloric (3000 Kcal/Kg), and the finisher diets were all isonitrogenous (20% CP). The data showed that body weight gain and efficiency of feed utilization (Feed/Gain) of chicks fed the control basal diet alone was not significantly (P<.05) different from chicks fed diets supplemented with either 5 or 15% sugar syrup. In this present study, the supplementation of sugar syrup to broiler diets has no significant effect on blood plasma glucose, creatinine, total protein, alanine aminotransferase, aspartate aminotransferase, calcium, phosphorus, sodium, potassium and iron. This experiment showed that adding 5 - 15% sugar syrup to broiler rations could replace part of the corn and about 55% of the fat in starter and 27% of the finisher diets.

Key Words: sugar syrup, energy, broilers, performance, biochemical parameters

380P  The nutritional value of Australian sweet lupin varying in particle size for broilers.  V. Ravindran*, G. Ravindran, and A. M. Amerah, Massey University, Institute of Food, Nutrition and Human Health, Palmerston North, New Zealand.

The aim of this study was to examine the effect of particle size (fine, medium and coarse) on the apparent metabolizable energy (AME) and apparent ileal digestibility (AID) of amino acids in Australian sweet lupins (Lupinus angustifolius). The three particle sizes were achieved by grinding lupin seeds, with hulls, in a hammer mill to pass through 1, 3 and 7mm screen sizes. The geometric mean diameter of the three grinds were determined to be 0.450, 0.880 and 1.220 mm, respectively. In the amino acid digestibility assay, the assay diets were based on dextrose and lupin to supply 20% dietary protein and contained titanium oxide as an indigestible marker. Each diet was fed to four cages of five male broilers from day 28 to 35 post-hatch. Digesta from the terminal ileum was collected on day 35 and the AID of amino acids were calculated using marker ratios in the diet and digesta. For the AME assay, the assay diets were formulated by substituting the lupin 25% (w/w) of a corn-soy basal diet. Each diet was fed to four cages of five male broilers from day 28 to 35 post-hatch and total collection of excreta was carried out during the last 4 days. Particle size influenced (P<0.05) the AME and the AID of amino acids in lupins. The AME of fine, medium and coarse grinds were 2235, 2310 and 2210 kcal/kg dry matter, respectively. The AME of coarsely ground lupin was lower (P<0.05) than that of medium grind. In general, the AID of amino acids were highest (P<0.05) in the medium grind and lowest (P<0.05) in the coarse grind. The average AID coefficients of amino acids of fine, medium and coarse grind were 0.76, 0.80 and 0.73, respectively. These results showed that, for optimum energy and amino acid utilization in lupins, medium grinding is advantageous over fine or coarse grindings.

Key Words: lupins, broilers, particle size, metabolizable energy, amino acid digestibility

381P  WITHDRAWN.

382P  Responses of broiler chickens to the addition of whole sorghum or wheat to the ration.  M. L. Angeles*, S. Gómez, and M. A. Islas, CENIDFyMA - INIFAP, Ajuchitlán, Colón, Querétaro, México.

Two experiments were carried out to evaluate the growth performance and the nutrient balance of broiler chickens fed diets added with 20% whole sorghum or wheat. In both experiments birds were allocated individually. In experiment 1, diets based on sorghum or ground corn (S or C) were combined with the inclusion of 20% sorghum or wheat (20S or 20W) in either ground or whole form (G or W). The experiment...
lasted two weeks. The average daily gain and feed conversion ratio were improved with the combinations S-20S-W, S-20W-G and S-20W-G (P < 0.01). The lowest weight and yield of carcass (P < 0.01) and lowest weight and yield of breast were found with the combinations of S-20S-G and C-20W-G. The weight of the gizzard was higher in 20S than in 20W and was also higher in W than in G. In experiment 2, a diet based on ground sorghum (GS) was added with 20% whole sorghum (WS), and a diet based on ground corn (GC) was added with either 20% ground sorghum (GC-GS) or 20% whole sorghum (GC-WS). Diets were fed during three weeks. No differences were observed on the performance responses. The retention of nitrogen was higher for (WS) but the retention of hashes were lower for WS and GC-GS (P < 0.05). In summary, broiler chickens fed diets added with 20% whole sorghum were able to increase or maintain a similar growth performance compared to birds fed the ground grain. The inclusion of whole sorghum to poultry diets is an energy saving alternative aimed to reduce the cost of feed processing.

Key Words: broiler chickens, whole sorghum, whole wheat, performance, nutrient balance

383P Evaluation of broiler performances according to the feed form supplemented or not with a crumbled red color pre–starter. N. Hervé*, D. Caron, and Y. Martel-Kennes, La Coop Fédérée, Montréal, PQ, Canada.

The purpose of this trial was to compare broiler performances according to the physical presentation of the 3 feed phases, crumbled/pelleted form (starter and grower in crumble; finisher in pellet) or mash (all phases in mash). The effect of a crumbled red color pre–starter (CRPS; 100g/bird, fed at arrival on the farm) was evaluated in order to validate if it could improve performances of birds on mash feeds. We had 8 treatments: A: CRPS + starter-grower-finisher in mash; B: CRPS + starter-grower in crumble, finisher in pellet; C: starter–grower–finisher in mash; D: starter–grower in crumble, finisher in pellet; E: starter–grower in mash, finisher in pellet; F: starter in crumble, grower–finisher in mash; G: CRPS + starter–grower in mash, finisher in pellet; H: CRPS + starter in crumble, grower–finisher in mash.

We compared 2,048 Cobb 500 males for their body weight, feed intake, and total cost (TC = total fixed cost (TFC)+total variable cost (TVC)). Using CRPS or starter in crumble improved (P≤0.05) BW at d7 (55g and 60g), d18 (36g and 65g), d27 (56g and 74g) and d39 (55g and 60g). After receiving 100g/bird of CRPS, chicks lowered their feed intake of starter in mash (FI = –3.06% from d0 to d18 compared to the crumble; p<0.05). Performances with a starter and grower in crumble and a finisher in pellet improved bird’s BW by 144 g at d39 compared to all mash phases in mash (p<0.05). Interestingly, the finisher in pellet did not improve performances with mash starter and grower feeds (p>0.05). By conclusion, providing a CRPS or a starter in crumble with grower–finisher feeds in mash improved broiler performances compared to all mash feeds.

Key Words: broiler, red pre–starter, mash, crumble, pellet

384P Effect of feed sample weight on pellet durability index. W. J. Pacheco*, 1 C. R. Stark, 2 Murphy Brown LLC, Laurinburg, NC, 3 North Carolina State University, Raleigh.

The accepted method for measuring pellet quality of feed is the pellet durability index (PDI). The PDI test is used to predict pellet degradation and estimate the percentage fines of the feed. Feed mills often customize the method by adding modifiers (hex nuts) to improve the correlation between PDI results at the feed mill and actual percentage fines in the feeders. The PDI test specifies 500 g of whole pellets; however due to sample submissions that contain fines, there may not be 500 g of whole pellets after the initial sieving. The objective of this study was to evaluate the effect of the initial sample weight on PDI results with the standard and a modified ASAE S269.4 method. The experimental design was a 2 x 4 factorial arrangement of treatments: PDI method (standard and modified (two 19 mm hex nuts)) and initial sample weight (300, 400, 500, and 600 g). There were four replications per treatment. The feed was pelleted with a 4.4 mm x 35 mm pellet mill die. Pellets were screened with a #5 US sieve before and after tumbling for 10 min in a 4-chamber PDI tester. Two studies were conducted with a corn–soybean meal diet. Study 1 had 0% (NF) and study 2 had 1% (MF) fat added in the mixer. Results of the studies showed a direct relationship between initial sample weight and PDI with both methods showing an interaction between sample weight and method. The PDI results of the NF diet showed a linear increase in the standard PDI (87 to 90%) and modified PDI (47 to 78%) as initial sample weight increased. The PDI results with the MF diet exhibited a similar trend, but the PDI of the standard and modified methods were shifted down when fat was added in the mixer. The PDI results with the MF diet showed a linear increase in the standard PDI (85 to 87%) and modified PDI (35 to 69%) as the sample weight increased. The results of this study confirm that a 500 g initial weight is required in both the standard and modified method in order to compare PDI values between experiments or feed mills.

Key Words: feed manufacturing, pellets, pellet durability index, PDI, feed mill

385P Economic modeling for optimizing broiler profitability on bird size. N. Sriperam*, G. M. Pesti, and M. E. Wetstein, University of Georgia, Athens.

Similar to the economy as a whole, the broiler industry is in a recession as reflected in declines of broiler company stock prices. Managing broiler production in this economic environment requires tools for minimizing losses. This study provides an approach for evaluating optimal bird size for maximizing profitability or minimizing losses for the grower and processing management. An economic model was generated using the management guide of the primary broiler genetic suppliers which provided body weight, cumulative feed intake, age of broiler, and carcass yield (male, female and straight-run). The function for maximizing profit per kilogram of live broiler is Max [P = (Pbw * BW) – (Pfi * FI) – TC]; where [P] is equal to net revenue, live broiler price (Pbw), live broiler body weight (BW), broiler feed price (Pfi), feed intake (FI) and total cost (TC = total fixed cost (TFC)+total variable cost (TVC)). BW is a function of FI, FB; broiler sex (Male or Female) and sexing (sexed, non-sexed). Similarly, optimizing carcass weight is a function of maximizing profit per kilogram of carcass as Max [P = [(Pcs * CS) – (Pcs * FI) – TC]; where CS is equal to carcass weight on a kilogram basis and Pcs is carcass price per kilogram. This study illustrates that a company raising broilers smaller than the optimal broiler size (either...
live weight for grower or carcass weight for processor), would miss an opportunity to maximize profitability from its’ broiler production. The range of body weights to maximize profitability, at the same carcass price, is lower at a high feed cost ($500 per ton) compared with a low feed cost ($200 per ton). These extremes in feed-price reduction yield much higher profits per carcass. The impact of increasing carcass prices, at a fixed feed cost, influenced the optimal carcass weight and profitability. When the analysis is based on carcass weight instead of body weight and costs for feed, chicks, vaccination, housing and processing are included, the revenue of carcass weight that maximizes profits was lower than for live body weight.

**Key Words:** broiler, modeling, profitability, broiler size

**386P**  

Potential differences in body composition in breeders and an improved efficiency of energy utilization for progeny lead to a question, “What is the daily ME requirement for today’s broiler breeder hen?” A thousand Cobb 500 breeders were reared as follows; a control group (SBW) reared according to Cobb guidelines and 2 other groups reared 20% heavier (HBW) and lighter (LBW). At 21 wks, 324 pullets of each group were moved to breeder cages and fed 1 of 6 diets (each diet had 2860 kcal ME and 20.8-14.3% CP). The feed intake for each diet was adjusted every 7% increase in production to provide final intakes of 330, 360, 390, 420, 450 and 480 kcal ME/hen/d and 24 g of ideal protein/d at 65% production. Performance, body weight, body composition were monitored through 35 wk.

Differences were found in age of maturity and for numbers of total eggs and hatching eggs. The LBW birds reached sexual maturity 7d later than the SBW and were behind by 5 hatching eggs at 35wk. All birds reached ≥70% production at wk 27. From wk 21 to 30, all birds gained weight (1121-1506 g; 52-69%). Between wk 30 to 35 only the birds fed 330 kcal/d lost weight (-24 g; -0.73%), the rest of the groups increased body weight (27-206 g; 0.80-5.65%). At peak production (wk 30) breeders fed 330 and 360 kcal/d were lighter and birds fed 450 and 480 kcal/d were heavier than any of the other groups.

The body composition of 8 birds per treatment was determined at 30 and 35 wks of age by DXA technology. Differences (P<0.05) were found in body mass, fat% and lean%. Breeders fed 330 kcal/d had the lowest fat% and the highest lean%. Breeders fed 480 kcal/d had the highest fat% and the lowest lean%. Although breeders fed 330 kcal/d lost weight, they achieved ≥80% egg production at peak and laid equal number of total eggs when compared to the other groups. The present study shows that breeders in cages perform well with an energy intake of 360 kcal ME/day during peak production.

**Key Words:** broiler breeder, energy, body weight, performance, calories

**387P**  
Phase-feeding in a big bird production scenario: Impact of strain on growth and uniformity. V. B. Brewer*, C. M. Owens, and J. L. Emmert, University of Arkansas, Fayetteville.

Phase-feeding (PF) has been effective at maintaining broiler growth while reducing production cost, but the impact on different broiler strains has not been assessed. An experiment was conducted using four commercial broiler strains grown to 60d of age comparing a PF approach to an industry-type diet. Birds were fed a common starter diet from 0-17 d. At d 17 birds began either the industry or PF regimen. Industry regimens consisted of average industry nutrient levels with periods from 17-32 (Grower), 32-40 (Finisher 1), 40-49 (Finisher 2), and 49-60d (Withdrawal). For PF, diets contained Lys, SAA and Thr levels matching the predicted requirements for birds at the beginning (high nutrient density) and end (low nutrient density) of PF. Pelleted high and low nutrient density diets were blended to produce rations containing AA levels that matched the predicted PF requirements over two-day intervals. Treatments were replicated in 6 pens; each pen contained 15 males and 15 females. Weight gain, feed intake and feed efficiency (FE) were calculated. During the starter period differences seen are only attributed to strain and gender as a common diet was used. Strain 3 gained more during the starter period with strain 2 having the lowest gain. During the grower period again strain 3 had highest gain and there is no difference attributed to PF regimen. Differentiation of PF and industry regimens is seen during the finisher 1 period. Strain 3 industry regimen has lower weight gain than all other strains however, strain 3 PF regimen is no different than other strains. During finisher 2 and withdrawal periods strain 2 has the highest gain and strain 3 is of the lowest; there are no differences attributed to PF. Because of this it appears that different strains have different growth curves: some grow rapidly during the early stages of grow-out and some more rapidly at the end. In conclusion, PF had no negative impact on weight gain and often had improved feed efficiency compared to its industry counterpart. It appears that strains react differently to the PF approach. It appears that strains have different growth curves.

**Key Words:** phase-feeding, strain, gain, feed efficiency

**388P**  

The effects of breeder hen age and dietary oils on yolk lipids, fatty acid content, tocopherols and thiobarbituric acid reactive substances (TBARS), egg quality aspects, fertility and hatchability were investigated. A total of 884 eggs were collected at week 30, 38, 45 from Cobb breeder hens fed diets containing 3.5% sunflower oil (Low n-3), 1.75% fish oil + 1.75% sunflower oil (Medium n-3) or 3.5% fish oil (High n-3). Significant decreases in egg and yolk weight were observed for High n-3 when compared with Medium and Low n-3 eggs (P<.05). Yolk weight (%) was lowest for Medium and High n-3 eggs while shell weight (%) was highest in High n-3 eggs. Albumen weight (%) was lowest in Low n-3 eggs. No difference was noted in egg fat content due to diet. However, a 7.5% increase in fat was observed in the eggs from 38 vs. 30 wk-old hens. Total n-3 fatty acids, docosahexaenoic acid (DHA), and DHA:arachidonic acid ratios were higher in High n-3 when compared with Low n-3 eggs. The peak incorporation of DHA was at week 38 for Medium and High n-3 eggs. Essential fatty acids (linoleic, linolenic) and other polyunsaturated fatty acids were higher at 38 and 45 weeks than at 30 weeks of hen age (P<.05). Eggs from High n-3 diet had reduced tocopherols compared with Low and Medium n-3 eggs (P<.0001). As the hens aged, over 67-94% reductions in egg yolk tocopherols were observed in Low, Medium and High n-3 eggs (P<.0001). Egg from High n-3 diet had higher TBARS values (P<.001) than those from Low and Medium n-3 diets. Overall fertility was 99, 97, and 98.3% and hatchability of fertile eggs was 80, 82.3 and 85% for Low, Medium and High n-3 eggs, respectively. Dietary treatments did not affect fertility or hatchability. Egg production was 53, 46 and 48% for
Low, Medium and High n-3 hens, respectively. Both diet (P=.004) and age (P<.0001) had a significant effect on egg production. Considering the role of egg yolk fat, essential fatty acids and tocopherols in chick pre-and early post-hatch growth and development, strategies that can modulate yolk lipid components in eggs could lead to an improvement in chick pre and early post-hatch health.

Key Words: egg, fatty acid, tocopherol

389P Tissue polyunsaturated fatty acid content, vitamin E status and cyclooxygenase-2 (COX-2) protein expression during lipopolysaccharide challenge in broiler chickens: Effects of dietary lipids and time of feeding. D. Gonzalez1, D. Mustacich2, M. G. Traber2, and G Cherian*1, 1Oregon State University, Department of Animal Science, Corvallis, 2Oregon State University, Linus Pauling Institute, Corvallis.

Recently hatched chicks are often subjected to 48- to 54-h delayed access to feed and water due to shipment distances. Delayed access to feed has been reported to reduce growth and development of the immune system in birds. Dietary fatty acids play an essential role in the immunity and health of the chicks because polyunsaturated fatty acids (PUFA) are components of cell membranes and the type of PUFA in the diet will determine type of eicosanoids formed. The current study investigated the effects of early vs. late access to feed and dietary lipids (n-3 vs. n-6) on lipopolysaccharide (LPS)-induced alterations in tissue PUFA, vitamin E status, and cyclooxygenase-2 (COX-2) protein expression. A total of 64 chicks were assigned to 4 different treatments. The chicks were fed a high or low n-3 diet within 5 h (early) or after 48 h (late) of hatching. LPS challenge compared to saline injection increased n-6 fatty acids in late low n-3 diet-fed birds (P<0.05). Total PUFA and vitamin E content were lower in the lung and plasma of birds fed high n-3 diets. Liver vitamin E content were higher in early compared with late birds fed high n-3 diets, but they decreased after LPS challenge (P<0.05). LPS challenge increased lung vitamin E contents in birds fed low n-3 diets (P<0.05). Vitamin E content in the small intestine were highest in LPS-challenged birds fed the low n-3 diet (P<0.05). We observed that spleen COX-2 expression was highest in the early-fed low n-3 diet group. Increased COX-2 expression can elevate the production of proinflammatory eicosanoids in low n-3 diet-fed birds. Dietary and management strategies directed at modulating tissue tocopherols, n-6 PUFA and COX-2 expression might be beneficial in reducing immune and inflammatory responses in broiler chickens.

Key Words: fatty acids, tocopherol, cyclooxygenase-2

390P Diurnal core body temperature patterns in feed restricted broiler breeder pullets housed at different temperatures. D. Paul*, M. J. Zuidhof, A. Pishnamazi, and R. A. Renema, University of Alberta, Edmonton, AB, Canada.

An experiment was conducted to identify the relationship between environmental temperatures and diurnal core body temperature (CBT) patterns in feed restricted broiler breeder pullets. A total of 800 Ross 708 pullets were housed in 8 temperature-controlled environmental chambers, each containing 4 pens. Standard breeder BW targets were followed using feed restriction (daily) from 14 d of age. Humidity was maintained at 60%. Beginning at 28 d, duplicate environmental temperature treatments (15, 19, 23, or 27°C) were applied for 14 d periods. Every 14 d, temperature treatments were randomly reassigned to the chambers. Telemetric devices that transmitted CBT every 10 min were surgically implanted in the right side of the abdominal cavity of 64 pullets (2/pen) at 13 wk of age. Feed restricted pullets had a strong diurnal CBT pattern, with a 2°C range. Maximum, minimum and mean CBT in the 27°C treatment were 0.10 to 0.17°C higher (P<0.05) than the 15 and 19°C treatments. Coolest CBT occurred between midnight and 04:00, when CBT in the 27°C treatment were 0.20 to 0.27°C higher than mean temperatures in 15 and 19°C treatments (P<0.05). Around 05:00, prior to lights-on at 07:00, CBT began to rise. Feeding occurred at 07:30, and peak CBT occurred very shortly thereafter, at 08:00. Treatments did not affect CBT from 05:00 and 11:00, between 15:00 and 20:00 (immediately following lights-off), and at 22:00 and 23:00. Minimum CBT occurred from 17:00 to 18:00 (39.92 to 40.09°C). At all other times, the 27°C group was warmest, the 23°C treatment was intermediate, and the 15 and 19°C treatment being lower, but similar to each other. The effect of environmental temperature on CBT was not as important as photoschedule and feeding. The similarity of CBT requirements because more energy is required to maintain homeostasis in colder environments.

Key Words: core body temperature, ambient temperature, management, broiler breeders, feed allocation

391P Quantitative effects on the morphology of small intestine and the performance of broiler chickens supplemented with L-glutamine and L-glutamate. Y. Avellaneda*, J. Hernández2, C. Ariza-Nieto1, and G. Añanador-Tellez1,2, 1Corpoica, Bogotá, Colombia, 2Universidad Nacional, Bogotá, Colombia, 3Disan-Ajinomoto, Bogotá, Colombia.

The gastrointestinal tract (GIT) suffers profound changes in the mucosal during the early growth development which determine the genetic potential for growth of broiler chickens. In this sense, active biomolecules have positive tropic effects on GIT and they have been associated with the productivity of broiler industry. The present study evaluated the supplementation of L-glutamine and L-glutamate (Gln+Glu) on the performance of broilers and their intestinal growth development. A total of 910, 1-d old Cobb broiler chickens (male and female) were placed in brooder cages. The birds were completely randomized distributed with a 3x2x2 factorial arrangement in twelve treatments: inclusion level (0.5, 1.0, 1.5%), age of supplementation (7, 14-d) and sex of the bird. Broiler performance was determined at 1, 8, 15 and 25-d of age. Three chicks of each treatment were randomly selected for morphology measurements. Intestinal tissues were collected from duodenum, jejunum and ileum to measure both crypt depth and villus height. Broilers supplemented with Gln+Glu grew faster (36.2 g/d) than birds without any supplementation (35.0 g/d) (P<0.05). Gain to feed ratio was better in females supplemented at 1.0 or 1.5% (1.39 g/g), compared to females supplemented at 0.5% and control (1.44 and 1.45). Males supplemented at 1.5% showed a better gain to feed ratio (1.35 g/g) compared to the other male groups (1.42 g/g). The mortality of broilers supplemented until day 7 was 5.38%, while the group supplemented until day 14 was 3.1% (P=0.081). The villus surface area (VSA) of duodenum at 25-d of age was greater (P<0.05) in male 1.5% (0.456 mm2) and 1.0%, (0.487 mm2) compared to other female groups (0.386 mm2). Females showed no differences in this parameter. VSA of jejunum was smaller (P<0.05) in the control group (0.28 mm2) compared to the supplemented groups (0.33 mm2). In summary, supplementation of Gln+Glu was inherent to the sex of the bird and affects positively both the small intestinal development and the performance of broilers.

Key Words: quantitative morphology, L-glutamine, L-glutamate, supplementation
**392P** Duodenal morphometry in broilers fed diets containing mannan oligosaccharides and/or enzymes. M. C. Oliveira*1, R. H. Marques2, R. A. Gravena3, and V. M. B. Moraes4, 1University of Rio Verde, Rio Verde, GO, Brazil, 2State University of Sao Paulo, Jaboticabal, SP, Brazil.

Mannans are components of Saccharomyces cerevisiae wall, and act as a microflora modifier and stimulating the intestine wall growth. Enzymes can improve diets digestibility and broiler performance. This study evaluated the effect of including mannanoligosaccharides (MOS), and/or enzymes in broiler diets on morphometry of broiler’s duodenum at 42 days of age. A total of 750 one day-old Cobb chicks were distributed into a completely randomized experimental design in a 2 × 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 promoters and 51 ppm of salinomycin as anticoccidial, totaling five treatments and five replicates. Enzyme contained cellulase, protease, and amylase. When the birds reached 42 days of age, five birds per treatment had jejunum fragments obtained for Optical Microscopy analysis. There was no effect (P>0.05) due the treatments on villi perimeter, villi height, crypt depth and goblet cells number. However, the villi density were higher in birds from positive control treatment, probably due the antibiotics reduce bacteria number in intestines of these birds. With a low bacteria concentration, some damages to the intestinal mucosa are also reduced. In conclusion, the inclusion of MOS and enzymes in broiler diets did not improve the duodenal mucosa at 42 days of age.

**Key Words:** additives, enzymes, goblet cells, optical microscopy, prebiotic

**393P** Ileum morphometry in broilers fed diets containing mannan oligosaccharides and/or enzymes. M. C. Oliveira*1, R. H. Marques2, R. A. Gravena3, and V. M. B. Moraes4, 1University of Rio Verde, Rio Verde, Go, Brazil, 2State University of Sao Paulo, Jaboticabal, SP, Brazil.

Mannan oligosaccharides (MOS), are a prebiotic that can stimulate intestine cell proliferation. Enzymes can improve diets digestibility, and also influence the intestine wall growth. This study evaluated the effect of including MOS, and/or enzymes in broiler diets on morphometry of broiler’s ileum at 42 days of age. A total of 750 one day-old Cobb chicks were distributed into a completely randomized experimental design in a 2 × 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 promoters and 51 ppm of salinomycin as anticoccidial, totaling five treatments and five replicates. Enzyme contained cellulase, protease, and amylase. When the birds reached 42 days of age, five birds per treatment had ileum fragments obtained for Optical Microscopy analysis. There was no effect (P>0.05) due the treatments on villi perimeter, villi height, crypt depth and goblet cells number. However, villi density were higher in birds from positive control treatment, probably due the antibiotics reduce bacteria number in intestines of these birds. With a low bacteria concentration, some damages to the intestinal mucosa are also reduced. In conclusion, the inclusion of MOS in broiler diets increased the villi perimeter and length in the ileum at 42 days of age.

**Key Words:** additives, enzymes, goblet cells, optical microscopy, prebiotic

**394P** Effects of early neonatal development and delayed feeding immediately post-hatch on the hepatic lipogenic program in broiler chicks. M. P. Richards*1, M. Proszkowiec-Weglarz2, R. W. Rosebrough3, J. P. McMurtry1, and R. Angel2, 1USDA-ARS, Beltsville, MD, 2University of Maryland, College Park.

The embryo to neonate transition is a critical period of development that has significant impact on broiler production. During this time important genetic programs governing metabolism and growth are established. The goal of this work was to study the effects of early post-hatch (PH) development and time of initiation of feeding on activation of the genetic program regulating hepatic lipogenesis. A comparison of liver total RNA samples at hatch and 7 d PH was performed using the Affymetrix chicken genome array. During the first wk PH there was significant up-regulation of key lipogenic genes including: ATP citrate lyase (ACL), malic enzyme (ME), fatty acid synthase (FAS), acetyl-CoA carboxylase a (ACCa), stearoyl-CoA desaturase-1 (SCD-1), sterol regulatory element binding protein-2 (SREBP-2) and thyroid hormone responsive spot 14 (S14) among others. These findings were confirmed using gene-specific RT-PCR assays. In a follow-up study, we investigated the effects of withholding feed for the first 48 h PH (delayed feeding, DF) on lipogenic gene expression through 8 d PH. Body weight gain was significantly depressed by DF. Plasma levels of the major metabolic hormones that regulate lipogenic gene expression (insulin, glucagon and T3) changed significantly during PH development but were largely unaffected by DF. Plasma glucose was significantly lower in the DF group at 24 h PH but recovered thereafter. In general, DF inhibited the up-regulation of lipogenic genes until feeding was initiated. Delayed up-regulation was also observed for the lipogenic transcription factor genes, SREBP-1 and SREBP-2, but not for carbohydrate response element binding protein (ChREBP) or liver X receptor (LXR). Our results offer additional insight into the transcriptional programming of hepatic lipogenesis in response to the transition from high fat (yolk) to high carbohydrate (feed) nutrition that occurs during early PH development.

**Key Words:** feeding, gene expression, lipogenesis, liver, microarray

**395P** WITHDRAWN.

**396P** Cloning of adipose triglyceride lipase cDNA in poultry and expression of adipose triglyceride lipase during development of adipose in chickens. K. Lee1,2, J. Shin1,2, J. Latshaw3, Y. Suh1, and J. Serr1, 1The Ohio State University, Department of Animal Sciences, Columbus, 2The Ohio State University, Columbus.

Increasing the breakdown of stored fat in adipose tissue leads to reducing fat content, enhancing feed efficiency and, consequently, decreasing the production cost of poultry. The processes of lipolysis are not completely understood, and the proteins involved in this process need to be identified. An adipose triglyceride lipase (ATGL), recently identified in several species, has not been studied in avian species. We have cloned the full-length coding sequences of ATGL cDNA for the chicken, turkey,
and quail. Sequence comparisons among mammals and these avian species showed that the avian ATGL have 2 conserved domains, the patatin domain and the hydrophobic domain. The patatin domain contains lipase activity, and the hydrophobic domain exhibits lipid droplet binding. The high levels of chicken, turkey, and quail ATGL mRNA and protein are exclusively found in subcutaneous and abdominal adipose tissues. In addition, chicken ATGL (gATGL) is mainly expressed in the fractionated adipocytes compared with stromal-vascular cells that mostly contain preadipocytes (P < 0.001). Furthermore, ontogeny of gATGL mRNA and protein expression in adipose tissue showed induction of gATGL immediately after hatching before access to food (P < 0.05), suggesting that an energy deficit due to posthatching starvation may increase breakdown of stored fat via increasing gATGL expression in adipose tissue. Our studies showed that expression of the chicken ATGL is adipose specific and regulated developmentally, suggesting that a possible modulation of ATGL expression would regulate fat deposition in avian species.

Key Words: adipose triglyceride lipase, adipose tissue, lipolysis, fat binding. The high levels of chicken, turkey, and quail ATGL mRNA and protein are exclusively found in subcutaneous and abdominal adipose tissues. In addition, chicken ATGL (gATGL) is mainly expressed in the fractionated adipocytes compared with stromal-vascular cells that mostly contain preadipocytes (P < 0.001). Furthermore, ontogeny of gATGL mRNA and protein expression in adipose tissue showed induction of gATGL immediately after hatching before access to food (P < 0.05), suggesting that an energy deficit due to posthatching starvation may increase breakdown of stored fat via increasing gATGL expression in adipose tissue. Our studies showed that expression of the chicken ATGL is adipose specific and regulated developmentally, suggesting that a possible modulation of ATGL expression would regulate fat deposition in avian species.

Key Words: adipose triglyceride lipase, adipose tissue, lipolysis, fast

397P Regulation of adipose triglyceride lipase expression in adipose tissue during fasting and refeeding in poultry. J. Serr*, Y. Suh, and K. Lee, The Ohio State University, Department of Animal Sciences, Columbus.

Lipolysis in fat tissue is a process that is not fully understood. Increasing knowledge of the process could allow for increased feed efficiency and reduced fat content, which would lower feeding costs for poultry production. Adipose triglyceride lipase (ATGL) is an adipose-specific enzyme which cleaves at the Sn-1 position of triglycerides, releasing non-esterified fatty acids into the bloodstream. ATGL has recently been cloned in avian species. For further understanding of how ATGL responds to environmental stimuli, we have taken 21 day old broiler chickens and fasted them for 24 hours. Tissues were collected prior to the fasting period and at its conclusion, as well as, 4, 8, 12, and 24 hours after being re-fed. Blood samples were also collected at these time points. Additionally, tissue samples were collected from 30 quail subjected to the same fasting period, with re-feeding time points of 2, 4, and 8 hours. ATGL in tissue samples was analyzed via western blot and quantitative Real-Time PCR (qRT-PCR). Protein and RNA levels of ATGL were high in the birds after the fasting period. RNA levels quickly returned to control levels following re-feeding. Protein levels, however, remained high in the chicken throughout the 4 and 8 hour refeeding time points. For the quail samples, ATGL returned to normal levels at 8 hours. To confirm the release of NEFA into the blood, serum analysis was done. NEFA was significantly high after the fasting period and returned to control levels by 4 hours following re-feeding. The quick return of the RNA to control levels suggests that ATGL production was stimulated during the fasting period, but inhibited once food was reintroduced. The immediately lowered NEFA levels confirm that the residual high amounts of ATGL shown by western blot were no longer functioning. This suggests the existence of a mechanism to inactivate the active form of ATGL, possibly through post-translational modification of the protein.

Key Words: adipose triglyceride lipase, adipose tissue, lipolysis, fasting

398P Development of PepT1 shRNA lentiviral vectors for knockdown of PepT1 in chickens. C. R. Mott* and E. A. Wong, Virginia Polytechnic Institute and State University, Blacksburg.

The intestinal peptide transporter, PepT1, mediates the absorption of di- and tri-peptides across the apical membrane of enterocytes. The functional role of PepT1 can be evaluated using RNA interference (RNAi), a method of post-transcriptional gene silencing, which can be mediated by short-interfering RNA (siRNA) or DNA vector-based short-hairpin RNA (shRNA). The objective of this research is to develop lentiviral vectors for shRNA mediated knockdown of chicken PepT1 (cPepT1). To validate target sequences in cPepT1, four siRNA sequences were tested individually and in combination using a luciferase based assay in which luciferase activity is inversely proportional to cPepT1 knockdown. The cPepT1 siRNAs or negative control siRNA were co-transfected into chick embryo fibroblasts (CEF) individually at 50 or 100nM with a vector that produces a cPepT1/luciferase fusion transcript (cPepT1 HUSH) or a control vector which lacks the cPepT1 part of the transcript (HUSH Luciferase). All cPepT1 siRNAs tested caused 46 to 77% knockdown compared to negative control siRNA (P < 0.05). The combination of cPepT1 siRNA 5 plus cPepT1 siRNA 6 showed the greatest knockdown. A shRNA construct based on the cPepT1 siRNA 5 and 6 sequences was generated using a standard stem-loop-stem design. A control shRNA construct was also generated with two non-targeting shRNA sequences. The shRNAs were transcribed from the pol III promoters U6 and 7SK. The shRNA genes were cloned into an FIV vector generating the cPepT1 shRNA 5/6 and Control shRNA lentiviral vectors. These vectors were cotransfected into CEFs along with cPepT1 HUSH or HUSH Luciferase. The cPepT1 shRNA caused 64% knockdown compared to control shRNA (P < 0.05). In conclusion, functional cPepT1 shRNA lentiviral vectors have been developed. These vectors will be used for the development of cPepT1 shRNA expressing transgenic chickens to evaluate the function of cPepT1 in vivo.

Key Words: chicken, PepT1, shRNA

399P Intestinal PepT1 and PPARα gene expression in response to fasting in broilers. S. L. Madsen*, C. R. Mott, and E. A. Wong, Virginia Polytechnic Institute and State University, Blacksburg.

The intestinal peptide transporter 1 (PepT1) transports di- and tripeptides and thus plays an important role in controlling amino acid uptake. The nuclear hormone receptor peroxisome proliferator-activated receptor alpha (PPARα) is thought to play a role in the activation of PepT1. The objectives of this study were to evaluate the effect of a fasting-refeeding regimen and feeding a ligand of PPARα on expression of chicken PepT1 and PPARα mRNA. Broiler chickens at 10 d of age were fasted for 24 hr and then divided into 3 groups: Continuously Fasted (CF), Refed 1 hr/ Food Withdrawn (RFW), and Refed Ad lib (RA). Samples of duodenum, jejunum, and ileum were collected from birds 1, 2, 3, 5, and 7 hr after the 24 hr fast. Expression of PepT1 and PPARα mRNA was measured using real-time PCR. The CF group showed a parallel rise in both PepT1 and PPARα expression as expected. The RFW group showed an increase in PepT1 up to 3 hrs post-fasting and then a decline at 5 and 7 hrs. In contrast PPARα expression increased. The RA group had an increase in PepT1 up to 2 hrs post-fasting, followed by a decrease and plateau in expression; again PPARα expression increased. These results show that PPARα may regulate PepT1 during fasting by increasing expression; however PPARα may not regulate PepT1 during a refeeding situation. The second objective was to evaluate PepT1 and PPARα expression after...
feeding the PPARα ligand WY14643. Chickens (d14) were gavaged with WY14643 at 50 mg/kg/d in 0.5% methylcellulose or gavaged with vehicle alone. After a 3 d gavage, samples were taken from duodenum, jejunum, ileum and expression of PepT1 and PPARα mRNA was measured using real time PCR. PepT1 mRNA was upregulated by treatment with the PPARα ligand WY14643, but surprisingly PPARα mRNA was downregulated. These results show that PPARα may play a role in regulating PepT1 mRNA during fasting and following treatment with a PPARα ligand.

Key Words: chicken, PPARα, PepT1, gene expression

**400P Furazolidone induced dilated cardiomyopathy in guinea fowl.** S. N. Nahashon*, K. E. Hill, N. Adefope, and A. Amenyenu, Tennessee State University, Department of Agricultural Sciences, Nashville.

Cardiomyopathy is a form of heart failure with few identifiable causes and is associated with great losses in the poultry industry. The disease is inducible by feeding furazolidone and it has been reported in chickens and turkeys, but not in guinea fowl. The purpose of this study was to induce cardiomyopathy in guinea fowl and to evaluate metabolic changes associated with the condition. In three replicates, 240 five-week-old Pearl Gray guinea Keets weighing approximately 330g each were fed corn-soy diets containing 0, 400, 600 and 800 parts per million (ppm) furazolidone for four weeks. The experimental diets contained 3,000 kcal of metabolizable energy (ME)/kg and 24% crude protein (CP) at 0-5 weeks of age (WOA) and 3,100 ME kcal/kg and 24% CP at 5-9 WOA. At nine WOA, the experimental birds were weighed, and blood samples were collected from the brachial vein. Fifty percent of the experimental birds from each treatment were euthanized and liver and heart tissue were collected, weighed and immediately frozen in liquid nitrogen. Ascites fluid was collected from the abdominal cavity and weighed. Total RNA was extracted from the liver and heart tissues and reverse transcribed to complementary DNA (cDNA). The expression of the cardiac troponin (cTNT) and phospholamban (PLN) genes which serve as markers for cardiomyopathy were evaluated. Feeding guinea keets 600 and 800 ppm furazolidone significantly (P<0.05) decreased their feed consumption, body weight gain, and feed efficiency. Also, feeding the 600 and 800 ppm furazolidone significantly (P<0.05) increased the expression of cTNT and PLN in the heart muscles. Liver hyperplasia and severe ascites were also observed in birds fed furazolidone. Serum total proteins, albumin and glutamic pyruvic transaminase were elevated, whereas serum glutamic oxaloacetic transaminase and alkaline phosphatase were significantly lower in birds fed furazolidone. Therefore, feeding 600 and 800 ppm furazolidone successfully induced cardiomyopathy in guinea fowl and the condition was associated with enlargement of the heart and liver, poor bird performance and significant changes in metabolic indices of guinea fowl.

Key Words: guinea fowl, cardiomyopathy, ascitis, poultry, metabolic indices

**Poster Session: Pathology**

**401P False negative results using serology to diagnose Mycoplasma gallisepticum in turkeys.** J. P. Vaillancourt*,1 G. Hebert1, D. Ojki2, and D. Ley3, 1University of Montreal, St-Hyacinthe, PQ, Canada, 2University of Guelph, Guelph, ON, Canada, 3North Carolina State University, Raleigh.

A multi-age turkey breeder farm experienced elevated mortality in a flock in July 2008. Coughing and sinusitis were only observed in early August. The flock was slaughtered two weeks later. The diagnosis was airsacculitis caused by Mycoplasma gallisepticum (MG). A polymerase chain reaction (PCR) test was used for diagnosis.

In early September, a flock closest to the MG positive flock culled in August showed clinical signs and tested PCR positive for MG. Days later, two additional flocks were coughing. The three flocks were tested (15 sera) with RPA and PCR. All RPA tests were negative, but PCR results were positive. A second testing one month later with RPA remained negative. The same sera were then tested by hemagglutination inhibition (HI). Three were suspicious, but all were considered negative. Further testing with three different ELISA tests resulted in 3 positives out of 15 for one ELISA, and one positive out of 15 for each of the other two tests.

Several factors may explain the observed results. Antigenic variations: the field strain being much different from the ones used to develop the diagnostic tests. Some strains of MG are known to trigger a very limited immunogenic reaction, and turkeys have been reported to respond less than chickens. An investigation in North Carolina in 1999 showed that clinical signs and PCR positivity are detected before any seroconversion. The outbreak reported here shows that, although RPA is generally very sensitive, it is possible for this test to miss a case (false negative).


Turkey crop microbiota is highly diverse and normally composed of a stable and dynamic population. Avian pathogenic E. coli (APEC) and yeast are part the normal or healthy crop microbiota. Both organisms cause disease in the turkey that is transparent to the grower until clinical signs appear. APEC generated colibacillosis has been related to some specific virulence markers genes including iss, iucC, Ish, cvaC and irp2. C. albicans has been linked to crop mycosis. However, genotypic diversity of the two organisms has not been fully investigated in crop. Herein, crops from turkeys (n=37) were harvested and analyzed for level of total E. coli and yeast. E. coli were profiled for specific virulence gene content. Candida yeast species was determined using differential agar culture and 18S-rRNA analysis. APEC counts averaged 6.3x10^5 cfu/g. E. coli were tested (n=108) by multiplex PCR for the presence of
of iss, iucC, tsh, evaC and irp2. From the total, 55 isolates (50.9%) had two or more virulence genes. The most dominant gene was tsh, 87% followed by evaC 43.5%, irp2 28.7%, iss 19.5%. The least dominant gene was iucC 9.2%. Yeast counts averaged 1.7x10^6 cfu/g. and were composed of 45% C. catenulata, 30% of C. rhodotorula, 20% C. albicans 2% Saccharomyces cerevisiae, and 3% of unknown. A significant correlation between APEC level and yeast level was observed (r2=0.06 p<0.05) suggesting a coexistence between APEC and yeast in both the healthy and mycotic crop. This study demonstrated a significant level of APEC and potentially pathogenic yeast in the crop suggesting targeting the crop as a site for potential biocontrol.

**Key Words:** turkeys, crop mycosis, avian pathogenic E. coli, Candida albicans, yeast infection

403P A PCR-based survey of the prevalence of the netB gene in *Clostridium perfringens* isolated from broiler chickens diagnosed with necrotic enteritis. M. C. Hibberd, T. G. Rehberger, and G. R. Siragusa*, Agtech/Danisco, Waukesha, WI.

Necrotic Enteritis (NE) is a significant economic burden to the poultry industry, in terms of antibiotic costs and losses due to acute mortality. *Clostridium perfringens* Type A is the primary etiologic agent of NE; recently, research regarding the NetB toxin of this organism has challenged the implication that the *C. perfringens* α-toxin (Phospholipase C) is the main virulence factor in NE disease. A PCR assay for the netB gene was designed and integrated into a multiplex PCR procedure for detecting *C. perfringens* Type A and was used to assess the prevalence of netB in *C. perfringens* Type A isolated from broiler gastrointestinal tracts and the correlation of netB to the diagnosis of acute NE. The assay was validated by comparing known netB positive and netB negative *C. perfringens* and proper negative controls, and reliably and specifically detected the netB gene and the *C. perfringens* α-toxin (plc) simultaneously. To date, the survey includes 773 total isolates collected from the Upper Midwest, Upper East Coast, and Southern regions of the USA: 667 *C. perfringens* Type A collected from non-NE birds and 106 *C. perfringens* Type A collected from birds presenting symptoms of NE. Of the *C. perfringens* Type A isolated from birds with no NE symptoms, 389 of 667 (58.3% of total) were netB positive. *C. perfringens* Type A obtained by sampling birds from reported NE breaks and/or birds presenting characteristic symptoms possessed the netB toxin in 95 of 106 isolates (89.6% of total). Statistical correlation between the presence of the netB gene and the presence of observed NE disease was significant (P<0.0001, Fisher’s Exact Test). Our results support the hypothesis of a primary role for netB in the etiology of NE in broiler chickens, and warrants increased attention to the NetB toxin as a specific target for studying, treating, or preventing the disease.

**Key Words:** Clostridium perfringens, necrotic enteritis, netB, broiler, NE

405P Comparison study of an impedance biosensor and rRT-PCR for detection of avian influenza H5N2 from infected chickens. K. Lassiter*, R. Wang1, J. Lin1, J. Lunn1, B. Sriwicaksan2, L. Lin3, H. Lu1, B. Hargis1, W. Bottje2, J. Tung2, L. Berghman1, and Y. Li1,3.

1University of Arkansas, Department of Biological and Agricultural Engineering, Fayetteville, 2University of Arkansas, Department of Mechanical Engineering, Fayetteville, 3Department of Poultry Science, Center of Excellence for Poultry Science, Fayetteville, 4Pennsylvania State University, Animal Diagnostic Laboratory, State College, 5Texas A&M University, Department of Poultry Science and Veterinary Pathobiology, College Station.

The ongoing H5N1 highly pathogenic avian influenza (HPAI) outbreaks, originating from Southeast Asian countries, and spreading to Middle Eastern, European and African countries, have driven global attentions and battles in fighting with deadly H5N1 virus to domestic poultry and also humans. Early detection or rapid diagnosis and effective control measures are needed to control the HPAI outbreaks and prevent its spread to other areas. This study’s objective was to compare a newly developed impedance biosensor with real time RT-PCR (rRT-PCR) for detection of avian influenza virus (AIV) from tracheal and cloacal swab samples collected from experimentally H5N2 AIV infected specific-pathogen-free (SPF) chickens. After inoculation of 11-wk-old SPF chickens with H5N2 AIV, tracheal and cloacal swabs were collected daily for 7 days. rRT-PCR was performed on tracheal swab samples per NVSL protocol. The impedance biosensor was based on the use of a magnetic separator, magnetic nanobeads coated with AIV group and subtype specific monoclonal antibodies, and interdigitated microelectrodes in a polydimethylsiloxane (PDMS) microfluidic channel. After mixing the coated nanobeads with the swab sample, the target virus was captured, separated, and concentrated by the magnetic separator. Sample impedance was then measured using the interdigitated micro-electrode. The presence of the virus caused a change in the impedance, which is linearly correlated to virus concentration. Of the 15 positive samples tested using the impedance biosensor and rRT-PCR, 14 were tested positive by both assays, for only 1 sample the biosensor was not in agreement with the rRT-PCR results (false negative). Detection time for the impedance biosensor is less than 1 hour compared to roughly 3-4 hours for rRT-PCR. This study indicates that the biosensor was comparable to rRT-PCR in detection of live AIV virus in poultry swab samples. Also, the impedance biosensor is portable and has great potential for in-field use, which would dramatically reduce the turnaround time for AIV detection.

**Key Words:** avian influenza, impedance biosensor, rapid screening, rRT-PCR, infected chickens
In mammals, germ cells enter into meiosis and arrest at prophase I in the embryonic ovary, whereas the drop of retinoic acid (RA) by Cyp26b1 in the embryonic testis protects male germ cells from initiating meiosis until sexual maturity. Organ culture of embryonic gonads and the long-term culture of chicken PGCs was used to investigate if RA plays a conserved role in regulating entry into meiosis in the chicken and if RA acts directly or indirectly on PGCs. Using organ culture, the addition of RA to stage 27 chicken gonads of both sexes significantly increased the mRNA expression of the premeiotic Stra8, as well as the meiotic markers Sycc and Dmcl. Using long-term cultured chicken PGCs, RA dramatically upregulated Stra8 expression in both male and female PGCs with similar increases in the expression of Dmcl and Sycc. Flow cytometry analysis for DNA content showed that after 4 days of RA treatment, 29.5% male PGCs and 58.37% female PGCs were at sub G1 phase, indicating that the cells had entered meiosis. Analysis of g MEMsa stained cells suggested a small difference between female and male PGCs in their capability to enter into meiosis where male PGCs appeared to have a lower capability to progress beyond zygotene/pachytene stages. This study shows that RA could induce chicken PGCs of both sexes to enter meiosis and that RA acts directly on the PGCs of both sexes to enter meiosis.

Key Words: meiosis, germ cells, chicken, retinoic acid

Detection of SED1 and GalTase-I in rooster gonadal tissue: an investigation of two key molecules involved in sperm-egg fusion. A. P. Benson1, A. J. Davis2, and B. D. Shur1, 1Georgia Gwinnett College, Lawrenceville, 2University of Georgia, Athens. 1Emory University, Atlanta, GA.

Fertilization in eutherian mammals is dependent upon the binding of spermatozoon to the egg coat, or zona pellucida, prior to penetration of the ovum. Two key molecules, Beta 1,4-Galactosyltransferase-I (GalTase-I) and SED1, have been determined to play significant roles in fertilization binding and are thus critical in mediating sperm-egg interactions. Specifically, in mice, SED1 is involved in the initial binding of spermatozoa to the zona pellucida while the receptor protein GalTase-I promotes the acrosome reaction upon binding of the oocyte’s zona pellucida protein, ZP3. Due to the paucity of information that exists regarding the function of SED1 and GalTase-I in avian sperm-egg interactions, we investigated the presence of these molecules in the testes of the domestic rooster, Gallus gallus. Testicular tissue was isolated from 6-8 week old broiler breeder roosters. Total RNA was extracted and DNase treated for two step real-time PCR. Expression of SED1 and GalTase-I was examined using custom Taqman minor groove-binding probes and primers created based on chicken cDNA sequences for the two genes (Primer Express version 2.0). Detection of both genes was confirmed in the rooster’s testicular tissue in conjunction with previous findings in mammalian species. In addition to examining gene expression of GalTase-I in testicular tissue, immunohistochemistry with a chicken GalTase-I antibody also confirmed the localization of GalTase-I in the semiferous tubules of the rooster. Lastly, far-Western analysis determined that recombinant mammalian SED1 binds the avian sperm receptor protein ZP1 in zona pellucida from broiler breeder hens’ F1 hierarchical follicles. These results demonstrate the testicular expression of SED1 and the presence of GalTase-I at the level of both gene and protein expression in rooster gonadal tissue. As is the case in mammalian species, these molecules may play key roles in promoting fusion of spermatozoon and ova. Future studies will expand upon differences in GalTase-I and SED1 expression in roosters varying in fertility.

Key Words: SED1, GalTase-I, sperm, fertilization


Synthetic ice blockers have been used to prevent cryoinjuries in oocytes and embryos, and could help to decrease sperm membrane damage during the freezing process. Previous work showed that adding low-density lipoprotein liposomes (LDL) to the cooling diluent helped to maintain rooster sperm membrane integrity during refrigeration for 96 h at 5°C. The present work aimed to evaluate motility (MOT) and membrane integrity (MI) of rooster sperm frozen with dimethylacetamide (DMA), with or without synthetic ice blocker (SIB) and LDL in the freezing diluent. After collection, semen was pooled, split in four aliquots, and diluted 1:1 (vol/vol) in one of four solutions: Lake’s diluent (control, T1), Lake’s diluent + 3% LDL (T2), Lake’s diluent + 1% SIB (T3), or Lake’s diluent + 3% LDL + 1% SIB (T4). Treatments were equilibrated at 5°C for 10 min, and DMA (6% final concentration) was added. After 1 min exposed to the cryoprotectant, semen was packed into 0.25 mL straws, which were placed in nitrogen vapor for 1 min and then plunged into liquid nitrogen. Straws were thawed with swirling motion into water bath at 40°C for 15 s. After thawing, samples were maintained at room temperature for analyses. Semen was analyzed before and after cryopreservation. MOT was measured subjectively at microscope and MI was observed at fluorescent microscope after staining the samples with SYBR-14 and PI. Before freezing, MOT and MI had overall mean and SE of 93.3 ± 2.9 and 95.5 ± 0.8%, which markedly decreased in all treatments after cryopreservation. Means and SE for MOT after thawing were 7.5 ± 4.3 (T1), 9.2 ± 0.8 (T2), 20.0 ± 5.0 (T3), and 56.7 ± 1.7% (T4). For MI, means and SE were 6.7 ± 3.3 (T1), 15.0 ± 10.4 (T2), 25.0 ± 5.0 (T3), and 61.7 ± 10.1% (T4). Analysis of variance showed that T4 was superior to the other treatments in both semen parameters (Tukey test, p < 0.05). These results indicate that adding a combination of LDL liposomes and synthetic ice blocker to the freezing diluent improves rooster sperm motility and membrane integrity after thawing.

Key Words: LDL liposomes, synthetic ice blocker, sperm motility, sperm membrane integrity, rooster semen

Turkey line effect on avidin, avidin-related protein 2 and progesterone receptor expression in the hens oviductal sperm storage region following artificial insemination. O. T. Foye-Jackson*1, J. A. Long1, L. A. Blomberg1, M. R. Bakst1, M. V. B. Silva1,2, K. G. Becker2, W. H. Wood2, and J. P. McMurtry1, 1United States Dept. of Agriculture, Agriculture Research Service, Beltsville, MD, 2National Institute of Health-National Institute of Aging, Baltimore, MD, 3Embrapa Dairy Cattle, Juiz de Fora, MG, Brazil.

Current in vitro semen storage methods maintain turkey sperm fecundity for 6-8 h. In contrast, sperm can be stored in vivo in the turkey hens.
sperm-storage tubules (SST) up to 10 wk. Yet, little is known about the cellular and molecular mechanisms supporting sperm survival in the SST. It has been shown that the presence of sperm in the turkeys SST was associated with up-regulation of avidin. To determine if avidin was a SST-specific, sperm-responsive gene across turkey lines, mRNA expression of avidin and two avidin associated factors, avidin-related protein-2 (AVR2) and progesterone receptor (PR), was determined in the SST and adjoining vaginal epithelium (VGE). At 38 wks of age, turkey hens (Hybrid Grade Maker and Converter) were artificially inseminated with Beltsville Poultry Semen Extender with (AI) or without semen [sham-inseminated (SI)]. Forty-eight hr after insemination, total RNA was extracted from the VGE and SST of SI and AI hens. Real-time PCR was utilized to analyze the expression of the avidin, AVR2 and PR transcripts. Grade Maker hens exhibited a tissue-dependent effect on avidin and AVR2 mRNA expression, with a 40 to 70-fold increase in avidin expression in the SST versus VGE of AI and SI turkey hens, respectively. A sperm dependent effect was found only in the VGE tissues of Grade Maker hens. In contrast, only the tissue dependent effect was present in Converter turkey hens; avidin, AVR2 and PR mRNA expression were higher in the SST than in the VGE of AI and SI hens. The up-regulation of avidin and AVR2 within the sperm storage region indicates these factors may be involved in the sustained storage of sperm in the SST. Alternatively, there is no known metabolic role for avidin in the oviduct. Yet, avidins ability to bind biotin renders it antibacterial properties. Interestingly, Campylobacter and Salmonella enteritidis have been isolated from semen of commercial turkey toms. The possibility that avidin in and around the SSTs may inhibit infiltration of bacteria should be considered.

**Key Words:** sperm storage tubules, vaginal epithelium, uterovaginal junction

**410P Effects of chicken dexamethasone-induced Ras-related 1 (cDexras1) on growth hormone (GH) gene expression in embryonic pituitary cells.** J. Narayana* and T. E. Porter, University of Maryland, College Park.

Corticosterone (CORT) induction of GH in the anterior pituitary of the embryonic chicken requires ongoing protein synthesis, suggesting involvement of intermediary proteins in CORT regulation of GH expression. Microarray screening conducted on 14,053 unique chicken cDNAs, identified 14 candidate genes that may be involved in CORT induction of GH gene expression, including cDexras1. The aim of this project was to characterize the effects of cDexras1 on GH promoter activity and GH mRNA levels. The effect of over-expression of cDexras1 on GH promoter activity was tested using a luciferase reporter assay. A CORT-responsive 1727-bp 5'-flanking region of the GH gene was used as the reporter construct. Embryonic day 11 chicken pituitary cells were co-transfected with the GH-luciferase reporter, the cDexras1 expression vector and renilla luciferase control plasmid. The cells were then cultured with or without CORT. Dexras1 did not affect GH promoter activity. Effects of over-expression on endogenous GH mRNA levels was tested by co-transfecting cells with cDexras1 expression vector and a green-fluorescent protein (GFP) expression vector. Positively transfected cells were sorted and collected by fluorescence-activated cell sorting. Total RNA was extracted from the GFP-positive cells, and GH mRNA levels were measured by qRT-PCR. Over-expression of Dexras1 (1 μg of vector) significantly inhibited CORT induced GH expression (p<0.05). This effect was specific to GH, since Dexras1 did not affect mRNA levels of other genes tested. To determine if Dexras1 has a dose-dependent effect on GH regulation, varying doses of Dexras1 expression vector (1-100 ng) were tested, with or without CORT. Preliminary data indicate that Dexras1 at lower doses may stimulate basal GH expression. These results indicate that Dexras1 may play a key role in GH regulation that has not been identified before in any species.

**Key Words:** dexras1, pituitary, somatotroph, corticosterone, development


The effects of in ovo injection of L-carnitine on the meat yield of Ross x Ross 308 broilers hatched from eggs laid by a young breeder flock were determined. Fertilized eggs were injected in the amnion with L-carnitine (0.5, 2.0 or 8.0 mg dissolved in 100 μl of a commercial diluent) on Day 18 of incubation using an AviTech Intellilab™ egg injector. Three control groups (non-injected and injected with or without diluent) were also included. Incubation length ( hatch time) was recorded every 4 h beginning at 19.5 and ending at 21.5 days of incubation. Hatched chicks from each replicate treatment group were transferred to pens in Petersime batteries for brooding and further growout. Organ and muscle tissue samples were collected at frequent intervals during growout for determination of tissue nutrient profiles provided in a companion report. On Day 47 posthatch, approximately 4 birds from each pen were slaughtered and processed for determination of total carcass and abdominal fat pad weight. Furthermore, the slaughter yields of all major commercial cuts including the thigh, drumstick, wing, and breast muscle were determined. There were no treatment effects on relative carcass or abdominal fat pad weights, or for any of the commercial cut yields. Although the doses of L-carnitine used affected tissue nutrient profiles, as reported in a companion report, they had no effect on subsequent slaughter yield.

**Key Words:** amnion, broiler, in ovo injection, l-carnitine, slaughter yield


The effects of in ovo injection of L-carnitine on subsequent tissue nutrient profiles of Ross x Ross 308 broiler chicks from a young breeder flock were determined. L-carnitine at 3 dose levels (0.5, 2.0 or 8.0 mg dissolved in 100 μl of a commercial diluent) were injected into the amnion of fertilized eggs on Day 18 of incubation using an AviTech Intellilab™ egg injector. Three control groups (non-injected and injected with or without diluent) were also included. Hatch time was recorded every 4 h beginning at 19.5 and ending at 21.5 days of incubation. On Day 0 posthatch (day of hatch), samples of chick liver, and breast and thigh muscles were also collected and stored in perchloric acid. On Days 10 and 48 of posthatch growout, samples of chick liver, and breast and thigh muscles were also collected and stored in perchloric acid. Biochemical analyses were conducted on the samples collected to determine their glycogen, glucose, protein, and fat concentrations. On Day 0 posthatch, the 0.5, 2.0 and 8.0 mg doses of L-carnitine resulted in a significantly lower liver glucose concentration when compared to control eggs that were injected without diluent. On Day 3 posthatch,
the 0.5 and 2.0 mg doses of L-carnitine resulted in a significantly higher moisture content of the pipping muscle when compared to diluent-injected controls. Furthermore, on Day 48 of posthatch growout, L-carnitine at the 2.0 mg dose resulted in a significantly higher thigh muscle glycogen concentration when compared to all 3 control groups. However, the variations in the tissue nutrient profiles produced by the L-carnitine doses reported in this study did not have any subsequent effects on hatchability, posthatch performance, or slaughter yield that were reported in other companion reports.

Key Words: amnion, broiler chick, in ovo injection, L-carnitine, nutrient profiles

413P  **A comparative study of chickens’ auditory brainstem responses (ABR): The effect of age, sex and production type on the morphology of the waveforms.**  E. Otu-Nyarko1, P. Scheifele2, D. Miller1, and M. Darre1, 1University of Connecticut, Storrs, 2University of Cincinnati, Cincinnati, OH.

The Auditory brainstem response (ABR) comprises several amplitude deflections occurring within the the first 15ms after onset of an acoustic stimulus. These deflections are peaks and troughs which represent far-field synchronous activity produced by onset responses of neural elements in the neural fiber tracts of the eighth cranial nerve and the auditory brainstem pathway. The ABR provides a tool to reveal the collective activity of auditory neurons and an opportunity to evaluate the overall development of the auditory system. The hearing receptors along the auditory pathway are time locked with the passage of acoustic stimuli and indicate how well the chicken can hear. The objective of this study was to determine the latency-intensity function of the chicken ABR relative to age, sex and production type. Five White Leghorn chicks (4 weeks), hens (22 weeks), roosters (74 weeks) and broiler-breeder type chickens (10 weeks) were used for the study. To obtain electric potential along the auditory pathway, three subdermal needle-receiving electrodes were placed under the skin of the comb, auricular area and base of the skull. Using the GSI audera evoked potential screening system an ABR test was run to obtain evoked potentials. Stimulus intensities presented were 102, 82 and 62 dB peSPL. The study was designed as a factorial RCBD. PROC mixed procedure of SAS was used for the statistical analysis at a significance level of P<0.05. The morphology of the waveforms for all the categories of chickens tested showed up to seven peaks occurring within the first 10ms. Significant difference in the latencies of the peaks (I, III, V) between all age groups tested was observed. This is consistent with the fact that maturation of receptors for hearing along the auditory pathway occurs as the bird ages. Sex, however, did not significantly change the peak latencies in broilers. The waveforms of all the chicken categories tested showed specific morphology typical to the group.

Key Words: auditory brainstem response, waveform, latency, evoked potential


The premammillary nucleus (PMM) has been shown to direct an endogenous dual-oscillation in dopamine (DA)/melatonin (MEL) rhythm and c-fos mRNA expression associated with the photo-inducible phase of gonad growth in turkeys. In this study, avian clock genes (Bmal1, Clock, Cry1, Cry2, Per2 & Per3) mRNA were colocalyzed in the PMM tyrosine hydroxylase (TH) immunoreactive (ir) neurons using in situ hybridization (ISH), double-label ISH/immunocytochemistry (ICC). The expression of circadian-driven clock genes in the PMM was determined under short (8L:16D) and long (16L:8D) photoperiods relative to changes associated with the diurnal rhythm of DA and MEL. Constant darkness (0L:24D cycle) were also used to assess clock genes endogenous response. In addition, light pulses were given at zeitgeber time (ZT) 8, 14 & 20 to ascertain that clock genes are modulated by light pulses stimulation. In the PMM, the temporal clock gene expression profiles were similar under short and long photoperiods, except Per1 gene was phase shift induced in long photoperiod. In addition, Cry1 & Per3 genes were light-induced at ZT14 for reproductive stimulation while Clock gene was repressed. On a comparative basis, clock genes in the pineal gland were rhythmic under both photoperiods, but were not altered following light pulses at ZT14 which suggests that pineal clock genes may not be associated with the photosensitive phase and reproductive activities. In the vSCN, clock gene expression was phase shift dependent photoperiods by showing apexes at night in short daylength and during the day in long daylength. Also, light pulses induced Per2 gene while it repressed Bmal1 gene at ZT14. Taken together, Cry1 & Per3 could be the primary genes involved in the photic response associated with the PMM neuronal activation and stimulation of the reproductive neuroendocrine system.

Supported by National Research Initiative Grant (2007-35203-18072) from the USDA Cooperative State Research, Education, and Extension Service

Key Words: clock genes, photoperiod, DA-MEL neurons, reproduction

416P  **Changes in vasoactive intestinal peptide and gonadotropin releasing hormone-I immunoreactivity in the brain of nest-deprived native Thai hen.**  N. Prakobsaeng1, N. Sartoosnoen1, S. Kosonsiriluk2, I. Rozenboim1, M. E. El Halawani2, T. E. Porter3, and Y. Chaiseneh1, 1Suvarnareek University of Technology, Muang, Nakhon Ratchasima, Thailand, 2University of Minnesota, St. Paul, 3The Hebrew University of Jerusalem, Rehovot, Israel.

Hyperprolactinemia has been associated with incubation behavior in native Thai chicken. This study compared the changes in the numbers of vasoactive intestinal peptide-immunoreactive (VIP-ir) neurons in the nucleus infundibuli hypothalami (NIN) and nucleus inferioris hypothalami (NIH) and gonadotropin releasing hormone-I-immunoreactive (GnRH-I-Ir) neurons in the nucleus commissurae pallii (nCPa) of incubating native Thai hens (B) with those of nest-deprived hens (NB; n=4). Plasma prolactin (PRL) levels were determined by enzyme-linked immunosorbent assay. The numbers of VIP-ir neurons in the IN-IN on days 6 (B6), 10 (B10), and 18 (B18) of incubation were 128.5±13.0, 138.4±13.0, and 100.8±7.3 cells, respectively. When hens
were nest deprived, VIP-ir neurons decreased (P < 0.05, NB6 = 82.4 ± 11.2; NB10 = 53.9 ± 6.6; NB18 = 40.3 ± 5.7 cells). This disruption of broodiness was accompanied by a precipitous decline in PRL levels (P < 0.05, B6 vs NB6 = 329.8 ± 18.6 vs 34.1 ± 6.6, B10 vs NB10 = 481.5 ± 40.1 vs 15.4 ± 1.4, B18 vs NB18 = 101.1 ± 41.8 vs 24.8 ± 3.8 ng/mL). The numbers of GnRH-I-ir neurons in the nCPa increased after nest deprivation (B6 vs NB6 = 0.7 ± 0.5 vs 2.1 ± 0.7, B10 vs NB10 = 0.9 ± 0.3 vs 3.3 ± 1.6, B18 vs NB18 = 0.6 ± 0.3 vs 2.0 ± 0.6 cells). This study indicates an association between VIP neurons in the IN-III and GnRH-I neurons in the nCPa with the degree of hyperprolactinemia, suggesting that the differential expression of VIP neurons in the IN-III might play a regulatory role in year-round reproductive activity and subsequent PRL release. The increase in GnRH-I neurons may effect the changes in gonadotropins secretion that consequently affects egg production. Supported by The Royal Golden Jubilee Ph.D. Program; #PHD/0176/2547(YC/NP).

Key Words: birds, GnRH-I, nest-deprived, PRL, VIP

417P Cloning and characterization of chicken galanin type I receptors. J. C-W. Ho, D. Zhao, A. H-Y. Kwok, Y. Wang, and F. C. Leung*, University of Hong Kong, Hong Kong, HK-SAR, China.

In the present study, we report the identification of 2 chicken genes with considerable homology to galanin receptor type 1 (GalR1). Galanin, a 29- to 30-amino acid neuropeptide with diverse physiological effects, has been reported to be widely distributed in mammalian nervous systems and peripheral tissues. Through the interactions with the 3 known distinct G protein-coupled receptors (GPCRs), i.e. GalR1, 2 and 3, galanin was found to be involved in a broad spectrum of biological functions including modulation of hormone release, nociception, cognitive and feeding behaviour in mammalian species. To our knowledge, galanin receptors have yet to be cloned and characterized in any avian species. Using reverse-transcription polymerase chain reaction (RT-PCR), 2 full-length cDNAs of GalR1 homologues, which we termed GalR1a and GalR1b, were cloned from chicken brain and intestine tissue respectively. GalR1a encodes a 357-amino acid precursor protein that shares 84%, 82% and 84% sequence identities to the human, mouse and rat homologues respectively. On the other hand, GalR1b is 363 amino acids in length with comparatively lower homologies to the mammalian homologues (human, 53%; mouse, 53%; rat, 52%). Using RT-PCR, we also examined the expression of the two receptors in adult chicken tissues. Both GalR1a and GalR1b were found to be expressed in most of the tissues examined with similar patterns. Using a pGL3-CRE-luciferase reporter system, forskolin-stimulated luciferase activity in Chinese hamster ovary (CHO) cells expressing GalR1a was measured with a pGL3-CRE-luciferase reporter system, forskolin-stimulated luciferase activity in Chinese hamster ovary (CHO) cells expressing GalR1a and GalR1b. The same functional assay is used to evaluate the ability of different GalR1a variants to modulate luciferase activity in Chinese hamster ovary (CHO) cells expressing GalR1a and GalR1b.

Key Words: corticosterone, luciferase, reporter, GRE, embryonic

419P Involvement of Pit-1 isoforms in growth hormone gene expression in chickens: Characterization of a novel Pit-1β isoform. M. Mukherjee* and T. E. Porter, University of Maryland, College Park.

The transcription factor Pit-1 is expressed in three types of cells in the anterior pituitary gland, where it binds to specific consensus sequences present in the promoter region and activates transcription of Prolactin (Prl), Growth hormone (GH) and thyroid-stimulating hormone beta subunit (TSHβ) genes. Alternative forms of Pit-1 have been reported in mammals and in chickens, which differ from each other in their N-terminal transactivation domain. Pit-1 is known to regulate chicken GH promoter activity, but it is not known which of the three isoforms, α, β or γ are involved. The aim of this study was to functionally characterize the isoforms for their ability to transactivate GH gene expression. We identified a novel Pit-1β isoform containing a 58-bp β-specific insert instead of 84-bp as previously reported. This shorter cDNA makes the β isoform the shortest and is predicted to code for a 315 amino acid protein which shows homology to rat (72% identity), human (72% identity), sheep (71% identity) and mouse (68% identity) Pit-1. We used a dual luciferase reporter assay system to evaluate the ability of the three isoforms to individually regulate chicken GH promoter activation in HeLa cells. Expression vectors for each isoform (1000ng) were transfected into HeLa cells along with 1000ng of reporter vector containing 1727bp of the 5′-flanking region of the chicken GH gene, which contains the Pit-1 binding site. Both Pit-1α and the novel Pit-1β isoforms increased GH promoter activity (4.8 ± 1.6 fold and 7.6 ± 1.6 fold, respectively; n=3; p < 0.05), while Pit-1γ had no effect (1.1 ± 1.6 fold; n=3; p > 0.05). Thus, Pit-1α and the novel Pit-1β isoform identified earlier by treatment with the glucocorticoid, corticosterone (CORT). Inspection of 10 kilobase (kb) upstream and 5 kb downstream of the GH transcription start site (TSS) indicates no consensus full length glucocorticoid response element (GRE), only several imperfect half sites. Furthermore, induction of GH mRNA by CORT can be blocked by a protein synthesis inhibitor, indicating an indirect effect requiring synthesis of an intermediary protein(s). Identification of the unknown protein(s) would be aided by fine mapping of the CORT-responsive region of the GH gene using a luciferase reporter construct. Previous research showed that a luciferase reporter containing 1727 base pairs (bp) upstream of the chicken GH gene was minimally responsive to glucocorticoids (2-fold) in a rat pituitary cell line. In the present study, e11 chicken pituitary cells were transfected with the same 1727 bp GH reporter construct and treated with 100 nM CORT for 20 h. Reporter activity with the 1727 bp construct increased 12-fold over basal when treated with CORT (p < 0.05; n=5). Deletion of the 1727 bp region down to 1467 bp resulted in ablation of reporter activity (p > 0.05; n=5). 12 additional constructs (1663, 1620, 1544, 1496, 1477, 1430, 1398, 1201, 1042, 954, 807, and 382 bp) were made to aid in fine mapping of the GH gene. All constructs were CORT-responsive, except the 954, 807, and 382 bp constructs (p < 0.05; n=5), indicating the presence of a glucocorticoid-responsive region. The proximal glucocorticoid responsive region was found between 1042 and 954 bp upstream of the TSS (p < 0.05; n=3). Addition of this 8-base-pair region in the antisense direction to the 382 bp construct resulted in partial recovery of the CORT-response (n=3). This region is being tested for protein binding in gel shift assays. Positive identification of a glucocorticoid responsive region in the chicken GH gene will aid in understanding the regulation of GH cell differentiation during embryonic development.

Key Words: chicken, galanin, galanin receptor, GPCR
could stimulate chicken GH gene expression in a heterologous system. Future research in our laboratory will focus on potential synergistic or inhibitory interactions between these isoforms in the transcriptional regulation of genes controlled by Pit-1. Supported by USDA-CSREES Grant #2009-35206-05189.

Key Words: POU-homeodomain, Pit-1, growth hormone, anterior pituitary, promoter activation

420P Ghrelin and obestatin influence on food and water intake in lines of chickens selected for high or low body weight. P. Xu*, P. B. Siegel, and D. M. Denbow, Virginia Polytechnic Institute and State University, Blacksburg.

Ghrelin, a 28-amino acid peptide produced mainly by the stomach, is involved in the regulation of body weight and food intake in both mammals and chickens. Obestatin, a 23 amino acid peptide encoded by the same gene as ghrelin, was reported to reduce food intake and body weight gain in rats and is considered to be a physiological opponent of ghrelin. The aim of the present study was to investigate the role of ghrelin and obestatin on food intake in lines of chickens that had undergone long-term divergent selection from a common founder population for high (HW) or low (LW) eight week body weight. Ghrelin (0, 0.1, 0.2, and 0.4 nmole) and obestatin (0, 0.016, 0.032, and 0.064 nmole) were intracerebroventricularly (ICV) administered to males of each line. Ghrelin decreased food intake in both lines, with low doses of ghrelin being more efficacious in the LW chickens. Ghrelin had no effect on water intake in either line. Obestatin increased feed intake in HW chickens while obestatin had no effect on food intake in LW chickens. Water intake was not affected by obestatin in HW chickens while 0.016 nmole of obestatin significantly decreased water intake at 180 min post-injection in LW chickens. These data support the hypothesis that selection for body weight has resulted in alterations in the central ghrelin and obestatin system, and these differences may contribute to differences in body weight between these lines. This project was supported by National Research Initiative Competitive Grant no. 2007-35206-17899 from the USDA Cooperative State Research, Education, and Extension Service.

Key Words: ghrelin, obestatin, food intake

421P Differential response in feed intake regulation to centrally-administered insulin in layer-type versus broiler-type chicks. J.-I. Shiraishi*1, K. Yanagita1, M. Yanagawa1, R. Fukumori1, T. Sugino1, M. Fujita1, J. P. McMurtry2, and T. Bungo1, 1Hiroshima University, Higashi-Hiroshima, Japan, 2USDA-ARS, Beltsville, MD.

The aim of this study is to elucidate whether insulin (INS) acts differentially within the central nervous system (CNS) of two types of commercial chicks to control ingestive behavior. In trial 1, male layer-type and broiler-type chicks (4-day-old) were ICV injected with saline, INS (20 or 100 ng) under fed conditions. Feed intake was measured at 30, 60 and 120min after treatment. In trial 2, blood and hypothalamus were collected from both chick types after fasting for 24h. Plasma INS concentration was measured by time-resolved fluoro-immunoassay. Hypothalamic INS receptor (IR), pro-opiomelanocortin (POMC), agouti-related peptide (AGRP) and neuropeptide Y (NPY) mRNA expression levels were measured by quantitative RT-PCR. The ICV injection of INS significantly inhibited feed consumption in layer-type chicks when compared with saline (P<0.05), but not broiler-type chicks (P>0.1). Plasma INS concentration of both chick types significantly decreased following 24 h of fasting, while INS levels in the broiler-type were significantly higher compared to the layer-type under ad libitum conditions. Although hypothalamic IR mRNA expression levels in layer-type were unaffected by 24h of feed deprivation (P>0.1), significantly higher expression levels were evident in broiler-type chicks (P<0.05). Conversely, POMC, AGRP and NPY mRNA expression levels were changed in both layer- and broiler-type chicks following 24h of fasting (P<0.05). These results suggest that INS resistance exists in the CNS of broiler-type chicks, possibly due to persistent hyperinsulinemia, which results in a down-regulation of CNS INS receptor expression compared to that in layer-type chicks. In addition, possible dissimilarities in brain INS signaling mechanisms may be involved in the differences of feeding regulation and energy metabolism between layer- and broiler-type chicks.

Key Words: broiler-type chick, layer-type chick, feed intake, insulin, central nervous system

422P WITHDRAWN.


Isolation of postnatal chick muscle precursor cells is confounded by the inclusion of fibroblasts in the isolates. However, recent work has suggested that myogenic cells may also be located within the fibroblastic compartment. The objective of these studies was to assess the in vitro myogenicity of muscle cell isolates from chick Pectoralis thoracicus. The second objective was to assess the proliferative compartment of the total uni-nucleate cell population with age using 5-Bromo-2-prime-deoxyuridine (BrdU) labeling. Briefly, cells were isolated from the Pectoralis thoracicus of young (41 gram) chicks and mature chickens (15 weeks) and inoculated into culture. After a 24 hour attachment period, cells were fixed, and stained for Pax7, MyoD, myogenin, myosin, BrdU, and desmin. Furthermore, cells were also grown to confluence, induced to fuse into myotubes and a fusion index was calculated based upon the number of nuclei lying within myotubes. It was revealed for young chicks that 14 ± 4% were Pax7 positive, 17 ± 6% were myogenin positive, 74 ± 2% were MyoD positive, 100% (n=4 animals 6473 cells) were myogenin positive, and there was a fusion index of 99 ± 4%. In young chick muscle 1.3 ± 4 were BrdU positive, whereas in mature chicken muscle 4.9 ± 1.7% cells were BrdU positive. The results suggest that there is an age-related increase in the proportion of proliferating cells in the chicken, and that the majority of the cells chicken muscle cell isolates are myogenic in vitro.

Key Words: satellite cell, avian, muscle, myoblast, BrdU

424P Bone density of laying chickens fed increasing levels of omega-3 PUFA DHA (22:6) using algae as vehicle of diet enrichment. N. P. Johnston*, R. T. Davidson, C. Buckley, and C. B. Evans, Brigham Young University, Provo. UT.

In recent years a host of health benefits have been associated with the intake of omega-3 fatty acids in general and DHA (22:6 n-3) in particular for both and humans and animals. During a 12-wk feeding trial 60 SCWL pullets were fed omega-3 PUFA-rich diets with increasing
levels of docosahexaenoic acid (DHA) 22:6 (n-3) to determine the dietary effects on bone mineral density (BMD). Two of the diets were DHA-free including a corn oil-enriched control and a flaxseed-enriched diet and in the remaining four diets a portion of the diet was replaced with increasing levels of algae ranging from 10% to 50%. As a result-dietary DHA ranged from 0 to 0.94% of the diet. The birds were evenly divided by treatment and housed in individual cages in environmentally controlled rooms where they received feed/water ad libitum and a light-dark cycle of 14L:10D. It was hypothesized that with increasing levels of DHA there would be a corresponding increase in bone mineral density (BMD). At the conclusion of the feeding trial both leg quarters and wings were removed and scanned on a GE Lunar DEXA scanner for the BMD of the femur, tibia and humerus bones. Diet had no effect on the BMD of the humerus bones but appeared to positively impact femur and tibia BMD. The BMD of the femur (0.249 g/cm²) and tibia (0.227 g/cm²) of the 40% algae treatment was significantly (P<0.05) greater than the control femurs (0.215 g/cm²) and tibias (0.206 g/cm²) as well as that of all other omega-3 treatments. The 10, 20, and 50% algae-fed birds had more dense (P<0.05) femurs and the 10% and 20% had more dense (P<0.05) tibias than the controls. In conclusion, the replacement of flaxseed with DHA-rich algae had a beneficial effect on the weight bearing bone (femur and tibia) mineral density of laying chickens.

**Key Words:** bone, density, omega-3, algae

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Gelatin is an ingredient that is higher in crude protein (95%) compared to soybean meal (45%), and is rich in mucin-forming amino acids such as glycine, glutamine, proline and serine. Intestinal mucins are secreted by goblet cells located in the villi epithelium. Incorporation of gelatin into chick starter diets may enhance goblet cell size and numbers, and improve villi morphometric indices such as villi surface area and villi:crypt ratio (V:C ratio). Thus, two experiments were conducted, each with 112 day-old broiler chicks. In each experiment, chicks were randomly allocated to 2 dietary treatments. Treatment 1 (SB) consisted of chicks fed a conventional corn-soybean meal (SBM) basal as control, while treatment 2 (SBG) consisted of chicks fed the basal corn-SBM into which 2% gelatin was added. Each treatment consisted of 4 replicate pens with 14 chicks per pen. On day 7 in both experiments and day 14 in experiment 2, jejunal tissue samples were collected, fixed in buffered formalin, routinely processed, sectioned, and mounted on glass slides. The slides were stained with alcian blue, periodic acid-Schiff, or haematoxylin and eosin for the evaluation of acid mucin-producing goblet cells (AGC), neutral mucin-producing goblet cells (NGC), and villi morphometric indices, respectively. Results obtained showed that gelatin has an effect (P > 0.05) on AGC size or numbers. However, for NGC, a bigger size was recorded in SBG chicks (P< 0.05) compared to SB chicks at 14 days of age. Results for villi morphometric indices at 7 days of age showed that in comparison to SB treatment, chicks in SBG had higher intestinal surface area in Experiment 1 (P < 0.05), and higher V:C ratio in Experiment 2 (P < 0.05). However, by day 14 in experiment 2, no differences were observed in villi indices between treatments. It was concluded that dietary gelatin supplementation has the potential to enhance early posthatch intestinal development. Further determination of optimal inclusion level is necessary.

**Key Words:** gelatin, goblet cell, villi indices, broiler chicks

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**426P** Calcitonin directly increases adrenocorticotropin hormone-stimulated corticosterone production in the chicken adrenal gland. K. Nakagawa-Mizuyachi*, T. Takahashi2, and M. Kawashima1. 1The United Graduate School of Agricultural Science, Gifu, Japan, 2Department of Avian Endocrinology, Gifu, Japan, 3The United Graduate School of Agricultural Science and Department of Avian Endocrinology, Gifu, Japan.

In the chicken, calcitonin (CT) secreted from the ultimobranchial gland is known to regulate calcium homeostasis in an opposite manner to parathyroid hormone (PTH). In addition, adrenocortical cells which secrete glucocorticoids such as corticosterone and cortisol under the influence of adrenocorticotropic hormone (ACTH) have also been implicated in calcium homeostasis via the parathyroid gland. However, the possible role of CT on this axis has not yet been determined. Thus, the present study was performed to show that CT can have an effect on the adrenal gland function, and to determine its physiological role.

The binding site of CT in the membrane fraction of adrenal glands obtained from hens was determined using a [125I] CT binding assay system. The binding properties in the adrenal gland satisfied the criteria of a receptor-ligand interaction in terms of specificity, reversibility and saturation. These findings indicate that the CT receptor is present in the adrenal gland and that CT could directly impact adrenal function. When adrenocortical cells were incubated in vitro with chicken ACTH in the presence of CT, greater corticosterone production was observed. In summary, our results suggest that in the hen, by binding to its receptor, CT acts directly on adrenocortical cells to increase the responsiveness to ACTH, thus amplifying the production of corticosterone.

**Key Words:** adrenocortical cell, calcitonin, adrenocorticotropic hormone, corticosterone, calcitonin receptor

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The effects of salt on high blood pressure is well known and higher salt consumption can also have a negative influence on kidney, liver, and other metabolic activities including diabetes and obesity. The present investigation was carried out on Japanese quail (Coturnix japonica), a lab animal model that has been used in toxicology for a long time. Physiological responses of Japanese quail by feeding two different salt concentrations were studied. The following parameters were examined: blood glucose, total plasma protein, PCV, body weight, and cloacal gland for sexual behavior. Eighteen healthy Japanese quail males of similar body weights were randomly divided into three groups; Group I (Control): received regular water and no salt; Group II: received 0.5% salt (Sodium chloride solution; table salt); and Group III: received 2.5% salt solution. Birds were kept in 36x36x12 inch wire cages, 14:8 L:D photoperiod, and received regular feed ad libitum. All birds were looking good for the first two days of the experiment but the birds in Group III appeared disoriented by the morning of the third day. The daily feed consumption of Group III was drastically reduced but consumption of2.5% salt solution was not reduced. The average body weight, PCV and plasma protein were reduced; 17% of them died by the evening of the third day, 33% of them died within 4 days; and a total 50% birds died within 5 days. The salt solution was stopped and only water was provided to the rest of the birds. No birds died during the remaining part of the experiment. Group II birds tolerated 0.5% salt solution very well throughout the experiment of six weeks. The birds in this group consumed more feed and water as compared to control (Group I) In
addition, there was a gain in their body weights, their PCV and plasma protein had also increased. This investigation reflects that the table salt (sodium chloride) is fatal to birds in higher (2.5%) concentrations. However, drinking the lower (0.5%) concentration does increase the body weight, feed and water consumption of Japanese quail. Further investigations are underway.

Key Words: Japanese quail, Coturnix japonica, table salt (NaCl), health effects, lab animal


Two trials were conducted concurrently to determine and compare, blood pH, blood gases, hematocrit, and hemoglobin in F–strain Mycoplasma gallisepticum (FMG) inoculation layers, and FMG contact–infected broilers. FMG–inoculated layers had the highest partial pressure of O2 and the lowest partial pressure of CO2 as compared with the other treatment groups. Blood pH values were unaffected by FMG inoculation. Hematocrit and blood concentrations of hemoglobin were slightly higher and HCO3- levels were lowest in FMG contact–infected broilers in comparison to the other treatments groups. Mycoplasma gallisepticum inoculation layers also resulted in a significant increase in blood concentrations of K+, a decrease in Na+, but no significant effects on blood concentrations of Ca2+ and Cl-. There were no differences in plasma glucose, cholesterol, triglyceride, and anion gap, but osmolality was significantly reduced in FMG contact–infected broilers. Results indicate that inoculation of layers with FMG vaccine results in changes in plasma acid–base status along with changes in other blood metabolic variables. However, the FMG inoculation did not prevent homeostatic regulation of acid–base balance, as indicated by constant blood pH. There was a significant increase in pO2, which is generally associated with an oxygen–dependent improvement in tissue oxygenation. Elevated arterial partial pressure of oxygen is beneficial to maximize oxygen transport capacity along with high concentrations of hemoglobin and hematocrit to carry oxygen throughout the body. It was concluded that in addition to protecting birds from MG infection, an FMG vaccine may improve the layer chicken's ability to withstand the harmful effects of stressors on their performance and well–being.

Key Words: Mycoplasma gallisepticum, acid–base balance, broiler chickens


Obesity is a problem in broiler breeders. Developing strategies to control obesity requires a better understanding of its etiology, and recent evidence suggests that the gut microflora has an effect on body fat content. The aim of this study was to develop a real-time PCR quantification method as a tool to investigate whether gut microflora may contribute to obesity in a chicken model. Real-time PCR was used to monitor and compare E. coli and enterococcus populations of bacteria in fecal material from high- (HWS) and low-weight (LWS) selected lines of chickens. The HWS and LWS lines were selected for divergent body weight at 8 weeks-of-age for 50 generations. Samples of fecal material were collected from ten chicks from both high- and low-weight lines at weekly intervals from one to five weeks-of-age. The fecal samples were analyzed with real-time PCR using primers based on conserved genus–specific enterococcus 16S rRNA or E. coli mblB promoter gene sequences. Fecal material (250 μg) was mixed with water, and the suspension mixed using a stomacher. Then, 100 μl was applied to a CloneSaver Card with FTA technology. The filter was allowed to air dry, and a 2.0 mm punch was removed from the sample using a Harris micro-punch. The CloneSaver punch was transferred to a microcentrifuge tube and DNA eluted as per the manufacturer’s specifications. Real-time PCR was performed by fluorescence detection and melting-point analysis. For melting point analysis, the intercalating dye SYBR-Green (BioRad) was used for nonspecific labeling of target DNA. Pure strains of E. coli and enterococcus bacteria were used to prepare DNA for standard curves. A melt curve was plotted at the end of each run to verify the specificity of the amplification product. There appears to be no difference in enterococcal DNA between HWS males or females fed either ad libitum or restricted diets. However, enterococcal DNA concentration was increased in LWS birds at 4 weeks-of-age compared to high weight birds.

Key Words: obesity, E. coli, enterococcus

Poster Session: Processing, Products, and Food Safety Posters

430P Campylobacter jejuni, C. coli, and C. lari naturally present in Leghorn laying hens and the antibiotic resistance profiles of these organisms. N. A. Cox1,2, L. J. Richardson1, R. J. Buhr3, and P. J. Fedorka-Cray2, 1 USDA, ARS, PA3662, Russell Research Center, Athens, GA, 2 USDA, ARS, BEAR, Russell Research Center, Athens, GA.

Campylobacter spp. are present in the intestinal tract and internal tissues of broiler breeder and broiler chickens. The objectives were to determine 1) Campylobacter spp. presence within intestinal tissues and organs of commercial Leghorn laying hens, 2) species of Campylobacter present, and 3) antimicrobial resistance pattern of Campylobacter isolates. In study 1, three flocks ranging from 94-105 wk-of-age were sampled from a commercial laying complex. In study 2, two flocks, 82 and 84 wk-of-age were sampled from a separate complex. Hens (n=30/flock) were euthanized, de-feathered, aseptically necropsied, and 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. Samples were packed on ice and transported to the laboratory for evaluation. For speciation, a standard BAX® PCR method was used while susceptibility testing was performed using NCCLS standards and recommended quality control organisms. Isolates were examined for susceptibility using a semi-automated testing system (Sensititre™) to the following nine antimicrobials: azithromycin, clindamycin, ciprofloxacin, erythromycin, florfenicol, gentamicin, nalidixic acid, telithromycin, and tetracycline. In study 1, the isolation rate was 13, 67, 53, 3, 13, and 57% from the ovarian follicles, lower reproductive tract, upper reproductive tract, spleen, liver/gallbladder, and ceca, respectively. In study 2, the isolation rate was 17, 43, 33, 20,
17, and 73% from the ovarian follicles, lower reproductive tract, upper reproductive tract, spleen, liver/gallbladder, and ceca, respectively. Overall, 53% of isolates were \textit{C. coli}, 46% \textit{C. jejuni}, and 1% \textit{C. lari}. In study 1, all of the isolates were pan susceptible. In study 2, 37% of the isolates were resistant to tetracycline. Commercial table egg laying flocks have been compared to determine the relationship of poultry \textit{Salmonella} spp. within different tissues and do not display resistance to a broad range of antimicrobials.

**Key Words:** \textit{Campylobacter}, antimicrobial resistance, laying hens, reproductive tract, ceca

### 431P Influence of cultural methodology on \textit{Salmonella} serovar detection and serogroup recovery from broiler carcass rinses.

A. Cox*1, L. J. Richardson1, P. J. Fedorka-Cray2, S. R. Ladely2, and R. J. Buhr1, 1USDA, ARS, PMSRU, Russell Research Center, Athens, GA, 2USDA, ARS, BEAR, Russell Research Center, Athens, GA.

\textit{Salmonella} serovars recovered from human patients and poultry carcasses have been compared to determine the relationship of poultry to human illness. The objectives of this study were to evaluate the sensitivity of four methodology procedures for \textit{Salmonella} recovery from broiler carcass rinsates and influence of these procedures on the diversity of \textit{Salmonella} serogroups recovered. Two replications were performed, each with carcasses (n=26) procured directly from a commercial processing plant after defeathering. Carcasses were individually bagged and transported on ice to the laboratory. Each carcass was rinsed with 100 mL of buffered peptone for 1 min and the rinsate collected. Aliquots (1 mL) of rinsate were then inoculated into GN Hajna (GN) and Tetrathionate (TET) broth. Both broths were incubated at 37°C and at 24 h a 0.1 mL of GN broth was transferred to Rappaport-Vassiliadis (RV) media. At 48 h, 0.1 mL of the TET broth was transferred to RV. RV tubes were incubated at 37°C for 24 h then streaked for isolation onto two different selective agar plates, BG Sulfa (BGS) and XLT-4. Following 24 h incubation at 37°C, presumptive colonies (a maximum of 3/plate) were selected and standard conformational procedures performed. Of the 52 carcass rinsates, \textit{Salmonella} was recovered from 41, 46, 34, and 45 by the media combinations of GN-BGS, GN-XLT-4, TET-BGS, and TET-XLT-4, respectively. GN detected \textit{Salmonella} in 46/52 of the carcass rinsates and 45/52 by TET. \textit{Salmonella} was recovered from 49/52 carcass rinsates using XLT-4 plating media and 47/52 by BGS plating media. Five serogroups of \textit{Salmonella} were detected by all methods (B, C1, C3, D1, and E). GN broth in combination with either plating media selected for a significantly (P<0.05) greater number of group C3 \textit{Salmonella} but significantly (P>0.05) fewer group E \textit{Salmonella}. These data suggest that the enrichment and plating media used for \textit{Salmonella} detection from chicken carcass rinsates can influence the sensitivity of recovery as well as the serogroup recovered.

**Key Words:** \textit{C. jejuni}, \textit{C. coli}, methodology, poultry, dry-stressed

### 433P Modified ecometric technique (four-quadrant sequential streak) to evaluate \textit{Campylobacter} enrichment broth proficiency in suppressing background microflora.

L. J. Richardson*1, N. A. Cox1, R. J. Buhr1, J. A. Cason2, and M. E. Berrang3, 1USDA, ARS, PMSRU, Russell Research Center, Athens, GA, 2USDA, ARS, PPS, Russell Research Center, Athens, GA, 3USDA, ARS, BEAR, Russell Research Center, Athens, GA.

Ecometric technique is a semi-quantitative scoring method used for quality control of culture media. The objective was to modify the technique (four-quadrant sequential streak (FQS) procedure) and determine efficacy of procedure to measure broth suppression of background microflora. Acquisition of natural background microflora was achieved using post-pick carcass rinses and separating the rinses into 120 efficacy test samples. Aliquots (2mL) from each sample were transferred into 18 mL of Bolton and Tecra broth and incubated microaerobically at 42°C for 48 h. For the FQS procedure, an aliquot (10) was streaked for each type of sample was transferred onto campy-cefex agar. The initial aliquot (10) was streaked (five passes per quadrant) onto the plating media and designated quadrant 1. Then, from that quadrant streaked into another quadrant and designated quadrant 2 and repeated for quadrants 3 and 4. After incubation, growth of non-\textit{Campylobacter} colonies on campy-cefex was expressed as absolute growth index (AGI). Growth on all four quadrants (1 through 4) was nominated an AGI of 4; growth on quadrants 1-3 was an AGI of 3, and so forth. Standard dilutions (10⁶ to 10³) were prepared from each broth and spread plated onto campy-cefex for enumeration of background microflora. Significant (P<0.05) differences in background microflora suppression by the broths was observed using the FQS and enumeration procedure. The mean AGI was 0.17 and 2.84 for Tecra and Bolton broth, respectively. The mean AGI for the samples incrementally declined over the 24 h period from 0.89 to 0.30. Overall, recovery rate of \textit{Campylobacter} strains decreased gradually from 0 to 2 h, sharply from 2 to 4 h, with some recovery at 6 h, and undetectable at 24 h. Total recovery (for all sample times) for Cj-L papers was 30, 44, 44, 42, and 55% and for Cj-H papers was 40, 57, 54, 52, and 63% from procedures A, B, C, D, and E, respectively. Total recovery for Cc-L papers was 24, 34, 34, 31, and 36% and for Cc-H papers was 33, 40, 34, 41, and 45% from procedures A, B, C, D, and E, respectively. Overall, method E (Tecra with supplement added at 5 h) outperformed the second best procedure by 5.3% for resuscitating dry-atmospheric-temperature stressed \textit{Campylobacter} spp. that can be found in poultry production environments.

**Key Words:** \textit{Salmonella}, carcass rinse, methodology, serogroup

### 432P Evaluation of enrichment procedures to recover \textit{C. jejuni} and \textit{C. coli} from a dry-atmospheric-temperature stressful environment.

L. J. Richardson*1, N. A. Cox1, R. J. Buhr1, and M. A. Harrison2, 1USDA, ARS, PMSRU, Russell Research Center, Athens, GA, 2University of Georgia, Department of Food Science and Technology, Athens.

To accurately access the ecology of dry-stressed \textit{Campylobacter} spp. in poultry production environments, use of optimal resuscitation procedures is critical. The objective was to evaluate five different enrichment procedures for recovering dry-atmospheric-temperature stressed \textit{C. jejuni} (Cj) and \textit{C. coli} (Cc). In two trials, hatchery trayliner pads and Whatman filter papers (n=1120) were used. Trayliner pad and filter paper were inoculated with either a low (L) 10⁶ or high (H) 10⁹ CFU/mL inoculum of Cj or Cc. The paper squares (2.5cm²) were left at room temperature exposed to atmospheric conditions and sampled at 0, 0.5, 1, 2, 4, 6, and 24 h post-inoculation. The water activity of pads (n=5) were recorded at each sampling time. The enrichment procedures were as follows and all were incubated in a microaerobic atmosphere: A) Buffered peptone incubated at 42°C for 48 h, B) Bolton broth without supplement incubated at 42°C for 48 h, C) Tecra broth without supplement incubated at 42°C for 48 h, D) Bolton broth with supplement incubated at 42°C for 48 h, E) Tecra broth without supplement incubated at 37°C for 5 h then supplement added and incubated at 42°C for 43 h. The water activity for the samples incrementally declined over the 24 h period from 0.89 to 0.30. Overall, recovery rate of \textit{Campylobacter} strains decreased gradually from 0 to 2 h, sharply from 2 to 4 h, with some recovery at 6 h, and undetectable at 24 h. Total recovery (for all sample times) for Cj-L papers was 30, 44, 44, 42, and 55% and for Cj-H papers was 40, 57, 54, 52, and 63% from procedures A, B, C, D, and E, respectively. Total recovery for Cc-L papers was 24, 34, 34, 31, and 36% and for Cc-H papers was 33, 40, 34, 41, and 45% from procedures A, B, C, D, and E, respectively. Overall, method E (Tecra with supplement added at 5 h) outperformed the second best procedure by 5.3% for resuscitating dry-atmospheric-temperature stressed \textit{Campylobacter} spp. that can be found in poultry production environments.
log_{10} cfu/mL of background microflora was 0.39 and 4.69 for Tecra and Bolton broth, respectively. Relationship of AGI to log_{10} cfu/mL present within the broths were AGI 4 : 5.9, AGI 3 : 4.9, AGI 2 : 4.1, AGI 1 : 1.9, and AGI 0 : 0.2. A positive correlation between decreasing levels of background microflora within the broths was observed as the AGI declined. The AGI estimation of enrichment broth efficacy in suppressing background microflora without performing enumeration.

**Key Words:** ecometric technique, enrichment broth, background microflora, Campylobacter, absolute growth index

**434P WITHDRAWN.**

**435P Influence of dietary fat and packaging on shelf life of ground broiler breast and thigh meat.** B. Saenmahayak*, S. F. Bilgili, J. B. Hess, S. R. McKee, and M. Singh, *Auburn University, Auburn, AL.*

This study was conducted to determine the microbial quality and oxidative stability of ground chicken meat stored under refrigerated conditions. A 2 x 2 factorial arrangement of two dietary fat sources [corn oil (CO) vs. lard (LD)] and two inclusion levels (low; 2% and high; 6%) was designed for this study and each of the four dietary treatments was fed to 8 replicate pens of 10 birds (320 birds total) to 49 d of age. Upon processing, boneless-skinless breast and thigh meat (6 birds/pen) were ground separately, pooled, formed into patties and sealed in trays with either oxygen permeable or impermeable film (4 replicate pens dietary treatment/packaging type). Samples were analyzed for lipid oxidation (TBARS) and microbial spoilage (aerobic plate counts, *Pseudomonas*, lactic acid bacteria, and Yeast and Molds) following 1, 3, 6, 12 and 18 d of storage at 2°C. TBARS values increased during 18 d of storage and birds fed CO had significantly (P<0.05) higher lipid oxidation in thigh meat than those fed LD at 1 and 12 d of storage. TBARS value of breast meat was higher (P<0.05) in oxygen permeable packaging (3.27 MDA/kg of meat) as compared to oxygen impermeable packaging (2.77 mg MDA/kg of meat) at 3 d of storage. Interactions between fat sources, inclusion levels and packaging types were observed for thigh meat on day 1 of the storage period. Thigh meat with 6% CO showed higher (P<0.05) lipid oxidation than 2% CO packed in permeable film (2.43 vs. 0.89 mg MDA/kg of meat) which was similar to thigh meat from LD treatment. In both packaging types, meat with higher fat level (6%) had higher TBARS values irrespective of the fat source. Microbial profiles among the treatments were not significantly different (P>0.05), however, all samples reached 7 log_{10} CFU/g after day 6 of refrigerated storage. Oxidative rather than microbial changes dominate spoilage during the refrigerated storage of fresh ground chicken meat. These changes can be minimized by alterations in dietary fat source and level, as well as oxygen permeability of the packaging film.

**Key Words:** shelf life, lipid oxidation, packaging, fat source, broiler

**436P Antimicrobial activity of concrete sealant against Clostridium perfringens and Bacillus subtilis.** D. Paiva*, K. Macklin, S. Price, D. Conner, J. Hess, and M. Singh, *Auburn University, Auburn, AL.*

*Clostridium* and *Bacillus* can survive traditional sanitation and disinfection procedures due to their spore forming ability. They can lead to heavy economic losses due to recalls and food contamination. In this study, antimicrobial efficiency of BioSealed for Concrete™ to prevent bacterial attachment and colonization of *C. perfringens* and *B. subtilis* on concrete blocks was evaluated. Cement blocks were divided into four different treatments: A) No Biosealed application, B) Biosealed applied before inoculation, C) Biosealed applied after inoculation, or D) Biosealed applied before and after inoculation. The cultures were prepared by inoculating *C. perfringens* and *B. subtilis* into brain and heart infusion broth (BHI) and incubating at 37°C for 24 h. *C. perfringens* was incubated in anaerobic chamber. Cement blocks were inoculated by immersion in BHI containing one of the cultures and incubated at 37°C for 24 h (ca. 10^6 CFU/ml). External surfaces of the blocks were swabbed using sterile swabs and placed in 10 mL of 0.1% peptone water (PW). The blocks were then broken in half and interior surfaces were swabbed to determine viable counts. Samples were serially diluted and spread plated on TSC (*C. perfringens*) and MYP (*B. subtilis*) agar and incubated for 24 h at 37°C. Experiments were performed in triplicates and results were analyzed using SAS. On external surface of the blocks, significantly lower (P<0.05) populations of both microorganisms were observed for treatments C and D when compared to treatments A and B. When comparing treatments A and C; as well as groups B and D; the product was shown to be efficient for biofilm removal on concrete surfaces. No significant difference (P>0.05) was found when comparing groups A and B suggesting that the product has minimal residual effect. Results from this study indicated that Biosealed for Concrete™ is a potent antimicrobial and has the potential to be used in combination with other GMP’s and sanitation practices to control bacterial colonization on concrete surfaces.

**Key Words:** Clostridium, Bacillus, biofilm, concrete sealant, antimicrobial

**437P WITHDRAWN.**


A total of 861 nuggets in each of 2 trials were evaluated to determine the effectiveness of methylcellulose application in coating formulations of deep fat fried and oven baked breaded chicken nuggets to reduce oil uptake but retain quality and shelf-life stability. Nuggets made from equal portions of breast and thigh chicken were coated in either pre-dust (control) or pre-dust with 5% methylcellulose (MC) prior to batter and breading. After par-frying for 30 sec, chicken nuggets were either deep fat fried at 150 or 190°C for 30 sec, 1, 2, or 4 min or oven baked at 200, 220, or 240°C for 2, 4, or 8 min. Effect of MC on moisture loss and fat uptake was not significantly different between control and MC nuggets at 0 d, but were not significantly different from the controls after 6 mo. Peak force was not significantly different between fried control and MC nuggets at 0 d and 3 mo, but fried MC nuggets had higher TBARS than the controls at 6 mo of storage. Baked MC nuggets had lower TBARS than control nuggets at 0 d, but were not significantly different from the controls at 6 mo. Peak force was not significantly different between control and MC nuggets in both cooking methods at 0 d and 3 mo; however, at 6 mo, the MC nuggets had higher peak force than the controls. For sensory, the deep fat fried MC chicken nuggets were significantly different with...
control nuggets at 0 d, but not at 3 mo. Therefore, MC can be used in nuggets without significantly altering quality.

**Key Words:** chicken nuggets, methylcellulose, TBARS, pH, peak force

439P  **Can vitamin E and organic Se help stabilize omega-3 enriched eggs during cooking and storage?** Y. Ren*, J. Wu, R. A. Renema, T. Perez, M. Betti, and M. J. Zuidhof, University of Alberta, Edmonton, AB, Canada.

Vitamin E and Se are key components of the antioxidant system to reduce lipid peroxidation. In omega-3 eggs, polyunsaturated fatty acids (PUFAs) are susceptible to oxidative damage during cooking and storage. Furthermore, reactive oxygen species which appear during PUFAs oxidation can trigger the breakdown of cholesterol into cholesterol oxidation products (COPs). This research focussed on the stability of n-3 PUFAs enriched eggs fortified with vitamin E and/or selenomethionine (Sel-Plex) following cooking and storage. Eggs were collected from 120 laying hens (37 wk old), which were randomly allocated to one of four n-3 PUFAs enriched diets: Control (base diet only), Vitamin E (base + 200 IU/kg), Se (base + 0.3 mg/kg Sel-Plex), and E + Se (base + 200 IU/kg Vit E and 0.3 mg/kg Sel-Plex). Eggs were collected after 4 wk of feeding. Half of the eggs were sampled immediately, and half were stored at 4°C for 4 wk prior to sampling. Vitamin E content, COPs content, and TBARS were measured on raw, boiled and fried eggs.

The content of vitamin E in boiled and fried egg was reduced by 21% and 44%, respectively, compared to that of the raw eggs. Storage for 4 wk reduced vitamin E by 16%. In TBARS test, egg fortified with vitamin E produced less breakdown produced, such as MDA (1.233 ug/kg), than eggs from the low vitamin E treatment (1.446 ug/kg). Selenium-enriched eggs also reduced the content of MDA (1.305 ug/kg) compared to low Se eggs (1.374 ug/kg). Frying generated more oxidative damage than boiling compared to raw sample (Fried=2.022ug/kg; Boiled=1.435ug/kg; Raw=0.561ug/kg of MDA). Vitamin E and organic Se both protected cholesterol from oxidation. The total COPs were lower in vitamin E enriched eggs (10.32 ug/kg) than that of the control eggs (11.51 ug/g). Selenium-enriched eggs reduced appearance of COPs even more (High=10.23 ug/kg, Control=11.61 ug/g). Breakdown of PUFAs and cholesterol during cooking.

Key Words: omega-3 eggs, selenium, vitamin E, cholesterol oxidative products, TBARS

440P  **Alkaline solubilization process of broiler dark meat:** Effect on fat removal and lipid oxidative stability. V. Moayed Mamaghani*, J. Chan, Y. Xu, and M. Betti, University of Alberta, Edmonton, AB, Canada.

Over the past 25 years, emphasis has been placed on improved distribution and marketing of further processed breast meat products which has resulted in excess supplies and depressed returns for broiler dark meat. The major problems with broiler dark meat are dark color, high fat content and lipid oxidation. An approach to increase the utilization of dark meat is to remove fat and pigments to produce a more acceptable resulting product for the production of further processed meat products. The purpose of this experiment was to study the influence of alkaline solubilization on total fat, lipid classes and lipid oxidation of muscle proteins extracted from broiler leg meat. Meat was finely chopped with added water and proteins solubilized by adjusting the pH between 10.5 and 12.0 in 0.5 increments. Following solubilization, the pH was adjusted to the 5.2 to precipitate the myofibrillar proteins which were then centrifuged and recovered to determine total fat, lipid classes (polar and neutral lipids) and lipid oxidation (TBARS). The entire experiment from broiler leg meat through final product was replicated 4 times resulting in 16 extractions. Data were analyzed using analysis of variance and means were separated using Tukey’s HSD. The results indicated that approximately 50% of lipids were removed from broiler dark meat by alkaline treatments. pH 11.5 and 12.0 were the most effective (2.93 and 2.96 vs. 6.23%; P < 0.0001). Polari lipids (PL) did not change in response to the treatments, indicating that fat removal was mainly due to neutral fraction. Due to the inefficient removal of PL, extracted meat was more predisposed to lipid oxidation than the raw broiler leg meat, with extracted proteins from pH 10.5 being the most susceptible within the treatments (P < 0.0001). According to the results, higher removal of polar lipids is necessary for the efficient application of this technology.

Key Words: broiler leg meat, alkaline solubilization, neutral lipids, polar lipids, TBARS

441P  **Application of ultraviolet light as an in-process conveyor belt sanitation system.** A. Morey*, S. R. McKee, J. S. Dickson, University of Alberta, Edmonton, AB, Canada; M. Singh, Auburn University, Department of Poultry Science, Auburn, AL, Iowa State University, Department of Animal Science, Ames.

*Salmonella* is a major foodborne pathogen isolated from poultry and poultry products. Contaminated conveyor belts (CB) can be a potential source of *Salmonella* transmission in processing facilities. Cleaning and sanitation of CB is done generally once in 24 h, hence an online intervention step needs to be introduced to sanitize the CB when plant is in operation. Ultraviolet light (254nm) has been proven as a non-thermal eco-friendly microbialicidal method. Sanitation efficiency of UV to kill bacteria depends on the intensities, surface, exposure time, concentration and age of that microbe. This study was conducted to determine the efficacy of UV against *Salmonella* on conveyor belts. *Salmonella* Typhimurium cultures were grown in TSB by incubating at 37°C for 24 h. Pieces (14 sq cm) of CB (Ronayl DM 8/2 A2+ 04 Light Blue Thermoplastic polyurethane) were sanitized using 90% ethanol; inoculated with 1 mL of *Salmonella* Typhimurium (~10^4 cfu/mL) and dried under a biosafety cabinet for 30 min. These pieces were then exposed to UV (254 nm) for 1s, 3s and 5s at high (8.1 and 7.6 mW/sq. cm), medium (3.78 and 3.48 mW/sq. cm), low (2.73 and 2.52 mW/sq. cm) intensities. Survival populations (log_{10} cfu/ sq. cm) of *Salmonella* Typhimurium were determined by swabbing the surface of CB and spread plating on TSA and incubating at 35°C for 24 h. Students' T-test was performed to determine the significant difference at α=0.05. At high levels of exposure, there was no survival of bacteria after 1s whereas, medium levels significantly (p<0.05) reduced the *Salmonella* Typhimurium from 4.18 log_{10} cfu/ sq. cm to 1.33 log_{10} cfu/ sq. cm after 5s of exposure. As compared to other two energy levels, there was less reduction in bacterial counts on exposure of CB to 2.73-2.52 mW/sq. cm. Exposure of CB to UV light at specific intensities can eliminate/ reduce the load of *Salmonella* Typhimurium. Hence short exposures at high intensities can be used in an online operation.

Key Words: UV treatment, *Salmonella* Typhimurium, conveyor belt, intensity, mW/sq. cm
Holding GmbH, 24h at 37°C; subjecting strains to increasing concentrations of nalidixic acid resistant products. A series of experiments were conducted to determine the efficacy of microbial growth and increase consumer acceptability of poultry products. Marination of poultry meat is widely being done in the industry not only for value addition but also to enhance the shelf life. In addition to this the combination of spices in marinades has a potential to inhibit microbial growth and increase consumer acceptability of poultry products. A series of experiments were conducted to determine the efficacy of commercial teriyaki and lemon pepper marinades on survivability of multiple strains of nalidixic acid resistant Salmonella. Nalidixic acid resistant Salmonella (Typhimurium, Heidelberg and Senftenberg) cultures were developed by inoculating BHI broth and incubating for 24h at 37°C; subjecting strains to increasing concentrations of nalidixic acid in XLT4. As a result, S. Typhimurium and S. Heidelberg resistant to 60 μg of nalidixic acid were obtained. These strains were inoculated in 9ml of BHI and incubated for 24h at 37°C. This was followed by transferring 100 μl of inoculum into 40ml of BHI and incubating for 20h at 37°C. Each strain was individually inoculated (ca. 10^6-8 CFU/ml) into either teriyaki or lemon pepper marinade, maintained at 4 and 25°C, and samples were drawn after 0, 4, 8, 16, 24, and 32h. Serial dilutions of inoculated marinades were made and surviving populations (log_{10} CFU/ml) of Salmonella were enumerated by plating 0.1 mL onto XLT4 agar. Plates were incubated at 37°C for 24h. Teriyaki marinade significantly (p<0.05) lowered the counts of Salmonella as compared to Lemon pepper irrespective of the time and temperature of storage. S. Heidelberg and Typhimurium populations were significantly lowered (p<0.05) as a result of an interaction effect of marination time and type of marinade used whereas survival populations of S. Senftenberg were significantly lowered (p<0.05) as a result of a three way interaction between marination time, type of marinade, and temperature at which the marinades were stored. These findings suggest that Teriyaki marinade greatly helped in reduction of Salmonella spp. at both 4°C and 25°C for up to 32h indicating its antimicrobial effects.

Key Words: Salmonella, marinade, antibiotic resistance, temperature, poultry

443P Viability of Salmonella spp. in commercial marinades.
A. Pathania*, M. Singh, and S. R. Mckee, Auburn University, Auburn, AL.

Marination of poultry meat is widely being done in the industry not only for value addition but also to enhance the shelf life. In addition to this the combination of spices in marinades has a potential to inhibit microbial growth and increase consumer acceptability of poultry products. A series of experiments were conducted to determine the efficacy of commercial teriyaki and lemon pepper marinades on survivability of multiple strains of nalidixic acid resistant Salmonella. Nalidixic acid resistant Salmonella (Typhimurium, Heidelberg and Senftenberg) cultures were developed by inoculating BHI broth and incubating for 24h at 37°C; subjecting strains to increasing concentrations of nalidixic acid in XLT4. As a result, S. Typhimurium and S. Heidelberg resistant to 60 μg of nalidixic acid and S. Senftenberg resistant to 35 μg of nalidixic acid were obtained. These strains were inoculated in 9ml of BHI and incubated for 24h at 37°C. This was followed by transferring 100 μl of inoculum into 40ml of BHI and incubating for 20h at 37°C. Each strain was individually inoculated (ca. 10^6-8 CFU/ml) into either teriyaki or lemon pepper marinade, maintained at 4 and 25°C, and samples were drawn after 0, 4, 8, 16, 24, and 32h. Serial dilutions of inoculated marinades were made and surviving populations (log_{10} CFU/ml) of Salmonella were enumerated by plating 0.1 mL onto XLT4 agar. Plates were incubated at 37°C for 24h. Teriyaki marinade significantly (p<0.05) lowered the counts of Salmonella as compared to Lemon pepper irrespective of the time and temperature of storage. S. Heidelberg and Typhimurium populations were significantly lowered (p<0.05) as a result of an interaction effect of marination time and type of marinade used whereas survival populations of S. Senftenberg were significantly lowered (p<0.05) as a result of a three way interaction between marination time, type of marinade, and temperature at which the marinades were stored. These findings suggest that Teriyaki marinade greatly helped in reduction of Salmonella spp. at both 4°C and 25°C for up to 32h indicating its antimicrobial effects.

Key Words: Salmonella, marinade, antibiotic resistance, temperature, poultry
inability of these cultures to withstand colonization by the Salmonella.

Key Words: chicken, microflora, biofilm, planktonic, ceca


3University of Connecticut, Storrs, 2Agricultural Research Service, USDA, Fayetteville, AR, 3University of Arkansas, Fayetteville.

Salmonella Enteritidis (SE) is a major food-borne pathogen for which chickens serve as the reservoir host. Reducing the intestinal carriage of SE in chickens would decrease contamination of poultry meat and eggs with this pathogen. We investigated the therapeutic efficacy of feed supplemented with caprylic acid (CA), a natural, GRAS status, 8-carbon fatty acid for reducing SE colonization in chickens. In two separate 3- and 6-week trials, day-old, straight run commercial broiler chicks (N=70 per trial) were assigned to five treatment groups (n=14 per group): a positive control (SE, no CA) and two groups of 0.7% or 1% CA. Water and feed were provided ad libitum. On day 1, two birds from each group were sacrificed to ascertain that chicks were initially Salmonella negative. In the 3-week trial, birds were inoculated with 7 log CFU of SE on day 5, and 5 days post infection, two birds from each group were sacrificed to assure SE colonization. CA was supplemented from day 15 to 20 followed by sacrifice for tissue collection. In the 6-week trial, birds were challenged with SE on day 25, confirmed for SE on day 30, and sacrificed for tissue collection after 5 days of CA supplementation. CA at 0.7 and 1% consistently decreased SE population in treated birds. SE counts in the cecum, small intestine, cloaca, liver, spleen and crop of treated chicks were significantly lower (P < 0.05) than controls. Feed intake and body weight were not different between groups. Results suggest that therapeutic supplementation of CA through feed can effectively reduce SE colonization in chicks and market-age birds.

Key Words: Salmonella, caprylic acid, therapeutic, chicken, antimicrobial

446P Effect of bird age and muscle type on levels of carnosine recovered from chicken skeletal muscle. P. S. Manhiani, P. Dawson, J. K. Northcutt, and I. Han, Clemson University, Clemson, SC.

Carnosine is a water soluble dipeptide composed of β-aniline and histidine. It is found primarily in skeletal muscles of mammals, avian species and other animals, but may also be isolated from other tissues such as brain and skin. It is potent antioxidant, anti-aging compound and it has a lot of medicinal and therapeutic applications.

The objective of the present study was to compare the recovery of carnosine from broiler and spent fowl breast and thigh tissues and to test the hypothesis if carnosine acts as a stress protein or molecular chaperone like GRP78.

Grp-78 proteins (Glucose regulated proteins 78kDa) are stress proteins which are normally up regulated during starvation, thigh muscle normally has more muscular activity than breast therefore glucose depletion is faster and hence the expression of the above proteins might be more pronounced in thigh than breast.

Preliminary results have shown that carnosine content of broiler breast was 2.42 mM and thigh was 1.25 mM per 100gm of tissue which shows less carnosine presence under normal conditions while there could be speculated or totally reverse change under acute stress conditions such as starvation.

In future experimentation, breast and thigh meat will be harvested from male and female broilers and spent fowl (hens and roosters). Carnosine will be extracted using a hot water extraction method and will quantified by spectrophotometric method using diazotized p-bromoaniline. The effects of starvation will be correlated by with caspase3/ GRP78 proteins using electrophoresis. And lastly the results will be compared according to breed as well as gender and interpreted using SAS edition 9.2 software.

Key Words: carnosine, skeletal muscle, recovery, GRP78, bird age


Broiler breast fillets are sometimes characterized grossly by white parallel striations in the direction of the muscle fibers. The present study is intended to evaluate the histological characteristics of this white striping and to assess whether the condition is influencing the meat quality characteristics of the meat. The breast fillets were collected from 1112 birds (59-63d) of different commercial high yielding strains (males and females) processed over 3 days. According to the visual severity of white striping, the breast fillets were separated into three categories: 0 (normal), 1 (moderate striping) and 2 (severe striping). Representative samples were collected from each degree of white striping, immediately after slaughter, to prepare slides for histological studies. Ready-To-Cook (RTC) carcass weight, pH and color (L*, a*, b*) at 24h postmortem, dimensions of fillets (length-L, width-W, height at the top-H1, bottom-H2 and middle-H3), cook loss, and Meullenet-Owens Razor Shear (MORS) energy values of the fillets were collected. The examination of the histological slides under microscope showed a condition of myopathy with degenerative changes. The percentage of samples showing 0, 1 and 2 degrees of white striping in males were approximately 37, 53 and 10%, respectively, whereas those of females were 53, 42 and 6%, respectively. Within each strain, more than 50% of birds had some degree of striping (1 or 2 category) with the exception of strain D which had 41%. Interestingly, 72% of strain C birds exhibited striping (1 or 2 category); strain C also had the highest RTC weight. RTC weight and most of the fillet dimensions, except the length, were significantly higher for white striping samples compared to the normal ones. Furthermore, the samples with score 2 showed significantly higher values for W, H1, H2, H3, compared to score 0 and 1 samples. Muscle pH, color, cook loss and MORS energy were not significantly affected by the striping condition. The results of this study suggest that the white striping condition is associated with heavier birds, but that meat quality is not affected.

Key Words: meat quality, striping, myopathy, broiler, fillets
**448P** Development and application of a *Salmonella* serogroup D1-specific lateral flow test strip. M. Muldoon1, D. Onisk1, J. Stave1, D. Munro2, and S. Rankin2, 1Strategic Diagnostics Inc., Newark, DE, 2New Bolton Center, University of Pennsylvania, Kennett Square.

Monitoring and control of *Salmonella* serogroup D1 serotypes is a primary concern for both the National Poultry Improvement Plan (NPIP) as well as state-sponsored Egg Quality Assurance Programs (EQAP). Both programs involves testing the poultry house environment for *Salmonella* spp., serogroup testing all positives, serotype testing all serogroup D1 isolates, and phage-type testing of all *Salmonella Enteritidis* (SE) isolates. If found in either live birds or egg products, loss of SE-free certification, product, or diversion of product can occur and result in a significant economic loss to the producer.

In order to facilitate the timely classification of NPIP and EQAP samples, a *Salmonella* serogroup D1-specific lateral flow test strip method was developed. Monoclonal antibodies (MAbs) were made against various serovars from *Salmonella* serogroups D1 (O: 1, 9, 12) and D2 (O: 9, 46). These were screened against a panel of both *Salmonella* and potentially crossreactive non-*Salmonella* bacteria. MAbs were isolated that recognized specific somatic O-antigens (factors 9, 12, and 46). Surprisingly, the factor 12-specific MAb did not recognize representative strains from serogroup B (O: 1, 4, [5], 12, 27). Using this MAb on the test strip and coupled to a 24 hr sample enrichment protocol, an expanded panel of 351 *Salmonella* strains was analyzed including 141 from serogroup D1 (primarily SE) and 173 from serogroup B. We found 100% sensitivity and 93% specificity for *Salmonella* serogroup D1 strains. The method was evaluated as an alternative method for the detection of SE in a state-run EQAP program. Initial studies utilizing 50 egg pools from a previously SE-positive shell egg facility indicated results consistent with the established 4-day cultural method. The *Salmonella* serogroup D1-specific lateral flow test strip method should save time and cost for the analysis of SE in NPIP and EQAP applications.

**Key Words:** *Salmonella enteritidis*, serogroup D1, monoclonal antibodies, immunoassay, egg testing

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**449P** Postmortem cathepsin B activity in the breast muscle of non commercial chicken breeds. R. Currie1, B. M. Rathgeber2, and K. L. Thompson*1, 2, Nova Scotia Agricultural College, Truro, NS, Canada, 2Agriculture & Agri-Food Canada, Kentville, NS, Canada.

The early postmortem role of cathepsin enzymes in chicken breast meat and the contribution to meat quality is largely unknown. Some research indicates that increased proteolytic degradation of myofibrillar proteins may be associated with decreased protein functionality. An objective of this study was to investigate cathepsin B activity in breast muscle of four breeds of chickens subjected to immediate or delay chilling. Four males of each breed, Light Sussex (LS), Rhode Island Red (RIR), Barred Plymouth Rock (BR) and Brown Leghorn (BL), were euthanized by cervical dislocation. Both pectoralis muscles were excised 7 minutes following death and placed in bags. At 15 min postmortem the left breast muscle was chilled in ice water while the right was held at 40°C for 4 hrs, followed by 20 hrs at 4°C. Cathepsin B activity (5 min and 24 hr postmortem) was measured for each breast muscle filet in both the lysosomal extract and the soluble fraction. In the lysosomal extract statistical analysis indicated that the delay chilled treatment decreased the cathepsin B activity (P<0.05) compared to filets placed in ice water. BL (3944 units of activity (UA/g/ min) had significantly higher cathepsin B activity (P<0.05) than BR (2207 UA/g/ min), RIR (2059 UA/g/ min) and LS (1898 UA/g/ min). A breed x time interaction was found in the soluble fraction where LS cathepsin B activity increased from 5 min (2282 UA/g/ min) to 24 hrs (4471 UA/g/ min) with no differences between the other breeds (P>0.05) from 5 min to 24hrs. At 24 hrs post-mortem cathepsin B activity was greater in LS than RIR (P<0.05) with no other breed differences in the soluble fraction. The difference in the level of cathepsin B activity in these birds can serve as a natural source of variation to determine the impact this enzyme has on the quality of breast meat in chickens.

**Key Words:** cathepsin, chicken, meat quality, carcass chilling, protein degradation

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**450P** Effect of different levels of calcium and vitamin D on egg quality of commercial and heritage breeds from twenty-two to thirty-three weeks of age. R. Kaur*1, B. M. Rathgeber2, K. L. Thompson2, M. Jendral1, and R. Robinson1, 1Nova Scotia Agricultural College, Truro, NS, Canada, 2Agriculture & Agri-Food Canada, Kentville, NS, Canada.

The avian egg shell is a mineralized bioceramic material, containing organic and inorganic constituents. Calcium and vitamin D play a major role in influencing the size of the egg as well as shell thickness. The objective of this study was to examine the effect of three levels of Ca (3.35, 4.10 and 4.85%) and two levels of vitamin D (200 and 2500 IU) on crystalline structure of eggshell in different breeds of chicken. In one trial, two commercial egg laying strains (white and brown egg shell), and two heritage breeds (Fayoumi and Light Sussex) were kept in same cage following a split plot design. The birds were subjected to six combinations of diet from twenty seven to twenty nine weeks of age. Eggshell quality traits were determined and eggshell ultrastructure were examined under scanning electron microscope (SEM). Specific gravity of Light Sussex eggs was significantly (P<0.05) lower than other breeds and shell thickness, shell weight and egg weight were found to vary between breeds. Treatments with the high level of vitamin D (2500 IU) increased shell thickness (0.436 mm) significantly (p<0.05) in commercial and heritage breeds. Round B type bodies known to affect eggshell quality were observed in the mammillary layer of commercial White Leghorn and Fayoumi breeds under SEM. Mammillary layer thickness was significantly (P<0.05) higher in Fayoumi breed whereas the thickness of palisade layer was higher in commercial hens observed at control diet (4.10% Ca and 200 IU vitamin D). The substitution of 2500 IU vitamin D in a layer’s diet can increase the shell thickness and may help avoid shell breakage.

**Key Words:** egg shell, vitamin D, calcium, heritage chicken, shell ultrastructure

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**451P** Scald tank water and foam as sources of *Salmonella* contamination for poultry carcasses during early processing. K. Lijibjejjele*, K. Ingram, A. Hinton, and J. Cason, USDA-ARS-RRC, Athens, GA.

*Salmonella* remains one of the leading causes of bacterial foodborne illness in the United States, and is often associated with poultry consumption. Despite significant reductions in the percentage of *Salmonella*-contaminated carcasses since the implementation of HAACP, continued reductions in *Salmonella* prevalence depend on identifying sources of contamination during poultry processing in order to develop and refine control programs. *Salmonella* was isolated from scald and dip tank water, surface foam, and defeathered carcasses obtained from a commercial poultry processing plant during the second processing shift over nine
weeks. A variety of serotypes were isolated from whole carcass rinses, water, and foam samples, including several serotypes that are known human foodborne pathogens, including; Typhimurium, Enteritidis, Heidelberg, Schwartzengrund, Infantis, and Thompson. *Salmonella* was isolated from between 70 - 100% of twelve carcasses sampled at each collection. Both the variety and numbers of serotypes differed from one sampling to another, reflecting the differences in serotypes present in poultry flocks on farms. Multiple serotypes were isolated from individual carcasses, and were isolated against a background of serotype Kentucky, a serotype not in the top 20 causes of human salmonellosis. Despite high temperatures in the scald tanks (50 - 53°C), and dip tank (63°C), *Salmonella* do survive in the water and in surface foam. The thick organic foam layer that builds up on the scald tanks during processing may serve as a source of contamination when carcasses pass through the foam on exit from the scald and dip tanks, as *Salmonella* isolates were obtained from foam samples (40%) more frequently than from water samples (13%). These data will provide valuable information on the prevalence and variety of *Salmonella* serotypes present within integrated broiler production, in addition to identifying an important source of carcass contamination in early broiler processing.

**Key Words:** *Salmonella*, processing, broiler

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452P Comparison of the statistics of *Salmonella* testing of chilled broiler chicken carcasses in the United States and Europe. J. A. Cason*, N. A. Cox, R. J. Buhr, and L. J. Richardson, USDA/ARS, Russell Research Center, Athens, GA.

Whether a required *Salmonella* test series is passed or failed depends not only on the presence of the bacteria, but also on the methods for taking the samples, the methods for culturing the samples, and the statistics associated with the sampling plan. The pass-fail probabilities of the two-class attribute sampling plans used for testing chilled broiler carcasses in the United States and Europe were compared in a Monte Carlo simulation. HACCP tests in the United States use 400-ml whole carcass rinses, with 30 ml cultured for *Salmonella*. Twelve is the maximum number of positives out of 51 samples for passing the sample set and there are milder consequences for as few as seven positives per set. The numbers (n=51 samples and c=12 positives) were chosen so that a plant operating with a *Salmonella* prevalence of 20%, the national baseline result for broiler carcasses sampled before the introduction of HACCP, would have an approximately 80% probability of passing the test series with 12 or fewer positive results. The European Union (EU) requires taking neck skin samples of approximately 8.3 g each from 150 carcasses, with the necks skins cultured in pools of three and with seven positives as the maximum passing score for a set of 50 composite samples. For each of these sampling plans, 100,000 complete sampling sets were simulated using a random number generator. Under HACCP rules with 20% as the mean prevalence rate, 79.3% of the sample sets passed with 12 or fewer positive carcasses per set of 51, very near the expected 80% rate. A *Salmonella* prevalence of 9.5% on individual carcasses gave a 79.3% probability of passing with six or fewer positive carcasses. Under the EU test conditions, *Salmonella* prevalence of 3.96% in individual neck skin samples yielded a passing rate of 79.1%. Without testing the different sampling methods and cultural procedures using appropriately processed carcasses, it is not possible to determine how a 20% *Salmonella* incidence in whole carcass rinses compares to a 3.96% incidence in neck skin samples.

**Key Words:** *Salmonella*, chilled carcasses, sampling plans, statistics, simulation
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