

egg production was lower in pellet fed birds primarily due to mortality in one subclass. Strains reacted differently to feed form in body weight (43 and 66 wks), feed intake and feed per egg mass. Strain differences were significant in hen day egg production, egg weight, specific gravity, body weight, feed intake, feed efficiency on a dozen egg basis, feather score and mortality. In conclusion, feeding whole wheat in laying hen diets is not detrimental to egg production, and balancer portions of the ration should preferably be fed in a mash rather than pellet form.

Key Words: Laying hens, Whole wheat, Pelleting

198 Development of successful alternative induced molting programs for commercial layers. J. Brake*, *North Carolina State University, Raleigh, NC USA.*

Much work was carried out from 1930 to 1990 to develop commercially viable induced molting techniques for commercial layers but animal welfare concerns curtailed this work in recent years. Fasting was found to be the method of choice and gained widespread acceptance in the laying hen industry. Under commercial conditions the key aspect of fasting methods is a BW loss of 30-35% over a period of time that generally exceeds 12 days. A mixture of fasting and restricted feeding has been successfully employed to deal with molting during cold weather when BW loss would otherwise be too rapid. Recent concern over the shedding of *Salmonella enteritidis* (SE) during a fasting-induced molt of commercial layers has renewed interest in alternative molting techniques. Commercial acceptance of alternative techniques will depend upon ease of implementation and achievement of performance equal to fasting methodology on both a reproductive and economic basis. Given the fact that SE shedding appears to be associated with the absence of feed in the gastrointestinal tract a successful alternative molting method must presumably maintain a reasonable intake of compound feed of a composition similar to what is normally consumed in order to not significantly impact the gut microflora nor create a feed milling or delivery problem. One such approach would be to utilize the known anti-gonadal effects of excess dietary zinc and anti-gonadotropic effects of low dietary calcium in concert. In research and commercial studies using such an approach for 14 days laying hens appear to consume about 60% as much compound feed as normal but go through the normal metabolic changes previously identified as being essential to a successful induced molt.

Key Words: Induced molt, Fasting, Body weight loss, Zinc, Calcium

199 Globalizing a senior level poultry production course. J. D. Firman*, *University of Missouri.*

Poultry Production at the University of Missouri is taught as a senior level elective following background courses prior to the senior year. Each

of the senior level production courses are taught as writing intensive as well as capstone experiences. Globalization of capstone courses is encouraged for those faculty that have significant international experience. Globalization of the course has been accomplished through routine use of examples from other countries as well as the capstone project. The project revolves around the evaluation of individual countries as potential locations for a new integrated broiler complex. Groups of students are expected to select a country and research the potential for such a complex. Areas that are covered include population, per capita income, road systems, local economic conditions, customs that may affect poultry meat consumption and penetration of markets by local firms. At various stages during the work they will have board meetings to check progress and develop sound evaluation strategies. They will then provide a written and oral presentation on their country with a go-no go decision. Those countries that appear to be favorable environments are then evaluated further in a discussion setting and a single country is selected. Utilization of this and similar teaching strategies has resulted in increased student satisfaction as well as dramatic increases in enrollment in an elective poultry course.

Key Words: Teaching, Education, Poultry production course

200 Estimating the time of death of broiler DOA using breast muscle pH. C. W. Ritz*, D. L. Fletcher, and A. B. Webster, *The University of Georgia.*

Previous efforts to determine the time of death of processing plant dead on arrival (DOA) birds have been to estimate carcass temperature decline and subjective scoring of rigor development. Carcass temperature, however, is often a function of environmental conditions, and rigor development can not be accurately measured. Muscle pH was thought to be a more stable indicator for time of death determinations. Studies were conducted to compare carcass temperature and breast muscle pH to the length of time following death. Birds were stunned, killed, and held without scalding and picking (to simulate commercial DOA conditions). At 15, 30, and 45 minutes and at 1 through 8 hours postmortem, birds were evaluated for core body temperature and breast muscle pH using a meat-penetrating probe. All birds exhibited rigor within 15 minutes of slaughter and remained rigid during the entire 8 hour period. Body temperature decreased linearly (R-square 0.97) over the 8 hour period. The rate of temperature decline slowed as body temperature neared the ambient temperature. Breast muscle pH decreased from approximately 6.2 at 15 minutes postmortem to less than 5.9 at 4 to 5 hours postmortem. These results indicate that breast muscle pH may be a more sensitive method to determine the relative time of death of DOA arriving at processing plants than carcass temperature measurements or rigor scoring.

Key Words: Broiler, DOA, Breast muscle pH

Genetics II

201 Breast meat quality and composition in unique chicken populations. S. M. Lonergan, N. Deeb, C. A. Fedler, and S. J. Lamont*, *Iowa State University.*

The objective of this project was to examine the diversity of breast meat composition and quality traits among unique resource populations. Birds from five groups (inbred Leghorn (n=10), inbred Fayoumi (n=10), commercial broilers (n=6), F5 broiler-inbred Leghorn cross (n=10), and F5 broiler-inbred Fayoumi cross (n=10)) were utilized. Contemporary stocks (broilers, inbreds, and crosses) were grown in a single house but in separate pens. Birds were harvested at 8 weeks of age. Breast muscle weight, moisture content, lipid content, protein content, color, pH, and Kramer-Shear force values were determined on birds from each group. Breasts from broilers contained lower percentages of protein ($P < 0.05$) and greater percentages of lipid ($P < 0.05$) compared with all other groups. The five genetic stocks did not differ for Hunter L values or pH. The data indicate that the Leghorn inbred line had a more pure and more intense red color than its crossbred contemporary ($P < 0.05$). Kramer Shear force (kg/g sample) was higher ($P < 0.05$) in breasts from broilers than in breasts from the inbred lines. Our results demonstrate that the five genetic groups differed markedly in breast meat composition and quality characteristics. The described outbred by inbred advanced intercross lines will be useful in searches for genes affecting meat quality traits. Definition of the molecular factors that influence these traits will

enhance our ability to make improvements in composition and quality of poultry meats.

Key Words: Genetic lines, Meat quality, Composition, pH, Kramer Shear Force

202 Inheritance of the bioavailability of Phytate phosphorus and the genetic correlations with growth and feed utilization traits in random-bred poultry. W. Zhang*, S. Aggray, G. Pesti, H. Edwards, Jr., and R. Bakalli, *The University of Georgia.*

Several studies suggested that there was genetic variance for bioavailability of phytate P (PBA) in chickens. This paper focused on the estimation of the heritability of PBA and the genetic correlations between the character with growth rate, feed consumption, feed conversion efficiency and content of phytate P in excreta. The experimental birds sourced from Athens Canadian Randombred. A data set of the experimental records of 901 birds was used for this study. Chickens of 4-5 week of age were fed .35% P diet in metabolism individual cages. After an acclimatization period of 3 days, the excreta produced in next three days was collected and for measuring the phytate that was not hydrolyzed and calculating PBA in the experimental birds and the feed consumption was measured. PBA was calculated as the percent of phytate that

was not hydrolyzed during the passage of feed through the total tract. REML method with average information matrix algorithm was used for the estimation of variance component. The estimates for the heritability of PBA were .10(.03) from univariate model and .09 (.02) from multivariate model. PBA with growth rate and feed consumption had modest negative genetic correlations.

Key Words: Phytate, Phosphorous, Bioavailability, Genetics, Chickens

203 Components of feed efficiency in broiler breeding stock: The use of fasted body temperature as an indicator trait for feed conversion in broiler chickens . D. O. Skinner-Noble* and R. G. Teeter, *Department of Animal Science, Oklahoma State University.*

Previous studies in the authors' laboratory have demonstrated relationships among energy traits related to feed conversion ratio (FCR) in broilers. These studies have indicated that good and poor converters of feed to gain have similar basal metabolism and body composition, but differ in ability to extract dietary ME, net energy from the diet, and in baseline fasted body temperature (BT). The correlation between fasted BT and subsequent FCR indicated that BT may serve as a useful indicator trait for FCR and other energy traits. Five trials were conducted to evaluate the usefulness of BT measured under conditions of mild handling stress as an indicator trait for FCR. The trials used males from four lines of broilers (a randombred control population and three heavy broiler lines). Birds were reared to approximately 6 wk of age, then "selected" for FCR testing based upon BW and conformation. At the start of the FCR test, birds were fasted for periods lasting from 18 to 48 h, their BT measured, followed immediately by initiation of an FCR test lasting 1 wk. The correlation between FCR and BT was significant in only 2 of the 5 trials. Differences between good and poor converters were generally attributed to greater gains of BW on similar amounts of feed intake. The results of these trials indicate that BT is not a reliable predictor of FCR.

Key Words: Feed conversion, Body temperature, Energy

204 Reestablishment of a transgenic chicken line 0.ALV6 at the Avian Disease and Oncology Laboratory. H. M. Zhang*, L. D. Bacon, and G. Kulkarni, *USDA-ARS, Avian Disease and Oncology Laboratory.*

The first transgenic chicken line, 0.ALV6, was produced at the Avian Disease and Oncology Laboratory (ADOL) in 1989. Blastoderms of fertile freshly laid line 0 eggs were injected with the long terminal repeats of the endogenous Rous-associated virus (RAV-0) and the envelope gene (env) of a subgroup A avian sarcoma virus. The biological importance of the line 0.ALV6 is that it represents the first example of pathogen derived resistance in any animal created by transgenic techniques. The presence and expression of the env gene results in the absence of tumor development and mortality when line 0.ALV6 chickens are infected with subgroup A avian leukosis virus (ALV), in contrast to line 0 chickens. Line 0.ALV6 embryo cells are only resistant to subgroup A and E ALV. In 1998, during a change in farm management, line 0.ALV6 was not reproduced. In 1999, only two hens with limited egg production existed. To retain the line it was necessary to mate a 0.ALV6 homozygous male to line 0 hens. In 2000, the old ALV6 homozygous male was mated to ALV6 heterozygous hens to produce males. In 2001, four sires known to be ALV6 homozygous or heterozygous were mated to line 0 hens to produce 110 chicks. These chicks' DNA was analyzed using Southern blot analysis with a U3N probe developed at ADOL. In 2002, the adult ALV6 heterozygous hens were mated to an ALV6 homozygous male. To identify ALV6 homozygotes, the adult offspring were progeny tested by matings to line 0, and the test chicks' DNA was analyzed by a recently reported PCR-based procedure to identify the inserted proviral DNA. The PCR based test improved the efficiency and reduced the cost of identifying ALV6 homozygotes without compromising accuracy. In 2003, 130 chicks were hatched from non-sib matings of four males and nine females homozygous for ALV6. Eight males and 32 females will be selected for breeding to reestablish the 0.ALV6 homozygous line. Line 0.ALV6 chickens and embryos remain available to the public upon request.

Key Words: Transgenic chicken, Avian leukosis virus, Genetic resource

205 A PCR based SNP analysis of the chicken TVB receptor gene. H. M. Zhang*, H. D. Hunt, H. H. Cheng, and L. D. Bacon, *USDA-ARS, Avian Disease and Oncology Laboratory.*

In the early 1970s, multiple alleles of the chicken *TVB* receptor gene were defined in domestic chickens. A specific functional receptor is required for successful cellular infection by a particular subgroup of avian leukosis virus (ALV). The *TVB**S1 allele encodes a receptor for exogenous ALV subgroups B and D, and endogenous ALV subgroup E. *TVB**S3 encodes a receptor for the subgroups B and D but not for subgroup A. In contrast, the *TVB**R allele does not encode a functional receptor for any ALV subgroup. Recent reports indicate that two single nucleotide polymorphisms (SNP) are responsible for the allelic differences. To expedite the genotyping of the *TVB* locus, two sets of PCR primers were developed to amplify chicken genomic DNA encompassing the SNPs. One of the two sets employed a mutagenic primer to introduce an *Xba* I restriction enzyme site during PCR amplification to facilitate direct endonuclease analysis of the first SNP. Following digestions of the two amplicons with restriction endonucleases *Nal* III and *Xba* I and agarose gel electrophoresis, specific *TVB* genotypes, defined by the reported SNPs, were determined by examining the banding patterns of one or both amplicons. Results to confirm this rapid genotyping system in experimental chicken crosses will be presented. If the phenotypes agree with the genotypes, then this PCR-based system may be useful for screening *TVB* alleles susceptible or resistant to specific ALV subgroups in other chicken lines and populations.

Key Words: Chicken, Avian leukosis virus, *TVB* gene, Genotypes

206 Functionally important non-synonymous single nucleotide polymorphisms in the chicken ovotransferrin gene for quantitative trait locus (QTL) mapping studies. M. G. Emara* and H. Kim, *University of Delaware, Newark, DE/USA.*

Economically important traits, such as disease resistance are affected by several genes (quantitative trait loci or QTL) that are located throughout the genome. Some of these genes are difficult to identify in genome-wide scans of well-characterized resource populations due to low penetrance, epistasis, pleiotropy, and low statistical power. To facilitate the identification of genetic polymorphisms that are functionally-important, our laboratory applied a bioinformatics approach to identify candidate non-synonymous single nucleotide polymorphisms (nsSNPs) that are more likely to affect protein structure and thus, the phenotype. In our study, we identified two nsSNPs in the ovotransferrin (OVT) gene and we mapped these nsSNPs to the OVT structural protein in the protein data bank (PDB; <http://pdb.bic.nus.edu.sg/pdb/>). Based on a conservation index of 0.19 and a relative accessibility of 8, at least one of the OVT nsSNPs (G/A; position 540 in PDB ID 1OVT) was prioritized as a mutation to more likely affect protein structure. The other nsSNP in OVT (T/G; position 33 in PDB ID 1OVT) had a lower ranking, with a conservation index of - 2.033 and a relative accessibility of 8. Interestingly, OVT is reported to have important functions in bacteriostasis, modulation of macrophage and heterophil function, inflammation, and anti-viral activity against Marek's disease virus. Both of the OVT nsSNPs in this study have been validated in a limited number of chickens, including individuals that were used to establish a resource QTL mapping population for Marek's disease (MD) resistance. Analysis of the OVT nsSNPs in this MD resource population may provide insight into the role of OVT as a candidate gene for Marek's disease resistance.

Key Words: Chicken, SNP, Ovotransferrin, Structural mapping, QTL

207 Mapping quantitative trait loci affecting economic traits in layers. J. Wang*¹, J. Fulton², and J. Dekkers, ¹*Iowa State University,* ²*Hy-Line International.*

A three-generation resource population was developed to detect quantitative trait loci (QTL) affecting egg production and egg quality traits in layers, by crossing a male and a female from two partially inbred commercial lines. A total of 192 F2 females were produced from 11 full-sib families. All F2 individuals were measured for early and late egg production, shell puncture score, egg weight, albumen height, egg color and body weight, and for sexual maturity. Selective DNA pooling was first employed to screen 184 microsatellite markers across the genome, which showed evidence of QTL on chromosomes 4 and Z, among others. To confirm these QTL, individual genotyping for the entire family was done for 45 markers on these two chromosomes. Analysis was by least squares

regression interval mapping with full-sib family and hatch as fixed effects. Chromosome-wise thresholds were determined by permutation. A 0.1% significant QTL for sexual maturity and early puncture score and a close to 1% significant QTL for early body weight were found on Chromosome Z. A 20 cM region on chromosome 4 was found to harbor 0.1% significant QTL for early and late body weight, and for early egg weight, 1% significant QTL for late puncture score, late egg weight and late albumen height, and a 5% significant QTL for early egg production. A 1% significant QTL for sexual maturity was found in another region of chromosome 4. Mapping results from selective DNA pooling was very similar to results from individual genotyping. Thus, selective DNA pooling data is extremely useful in capturing most of the information for QTL detection with a substantial reduction in genotyping costs.

Key Words: QTL mapping, Egg production and egg quality, Selective DNA pooling

208 Effect of naked neck gene and crest gene on body weight and carcass measurements in chickens raised under low ambient temperatures. M. M. Fathi*, A. Galal, and A. Zein El-Dein, *Ain Shams University*.

An experiment was conducted to determine the effect of introducing naked neck (Na) and crest (Cr) genes and their interaction into chickens raised under low ambient temperatures on body weight and carcass traits.

Ten heterozygous naked neck cocks (NanacrCr) were mated with 100 heterozygous crested females (nanaCrCr) to produce F1. The produced offspring were segregated into four genotypes (normal, crest, naked neck and crested-naked neck). The chicks were raised under natural prevailing temperature (18°C Max. and 12°C Min.). Body weight was recorded on four-week intervals to 16 weeks of age. At the termination of the experiment (16 weeks), 160 males representing all genotypes (40 each) were assigned to carcass evaluation. The results revealed that, as expected under current low ambient temperature, Na gene significantly decreased body weight compared to normal type. On the other hand, introducing crest gene increased body weight in nanaCrCr genotype or enhanced growth performance in the combination type (NanaCrCr). Naked neck gene significantly increased comb and wattle length, while crest gene decreased these head appendages. However, introducing Na gene improved dressing carcass % by about 3%. Moreover, this improvement reached 4.5% in combination state (NanaCrCr). Compared to normal genotype (nanacrCr) as a control, breast meat was significantly increased by introducing of Na gene, while crest gene decreased this trait. Drumstick % significantly increased in all genotypes compared to normal one. On the other hand, abdominal fat % was reduced in all genotypes, especially in Na genotype compared to normal one. In conclusion, the results revealed that, although the Na gene decreased body weight under low prevailing temperature, carcass % and breast meat yield were improved. Also, introducing Cr gene may be useful in enhancement of naked neck genotype performance under low ambient temperature.

Key Words: Naked neck gene, Crest gene, Body weight

Nutrition

209 Comparison of traditional fasting molt versus non-fasting low density, low sodium molt diets and the requirement for cystine during molt and post-molt. L. F. LaBrash*¹ and S. Scheideler¹, ¹*University of Nebraska-Lincoln*.

Non-fasting molt is a management tool for laying hens that addresses current day animal welfare guidelines. Dietary requirements for optimal post molt production following non-fasting molt are not well defined. Two hundred forty 65 wk old ISA White laying hens were assigned to 60 cages (4 hens/cage) in a 2 × 4 augmented factorial (fasting or non-fasting molt with 250, 275, 300, or 325 mg Cys/hen/d). Post-molt Met level was 350 mg/hen/d. Molt diets were corn and wheat middlings based. Cystine supplementation was through feather meal. For the fasting molt, feed was withdrawn until 25% body weight loss was achieved (5 to 8 d) after which feed was increased to full intake (110 g/hen/day) by week 6 post-molt. The non-fasting molt treatment was based on a low energy, low sodium (0.05%) diet fed near 70% of ad libitum intake for 6 weeks. Photoperiod was 8 h for 6 wk of molt and then increased 30 min per wk after molt until a 16 hr photoperiod was achieved. A peak post molt second cycle corn and soybean meal diet was fed at 110 g/hen/d from week 7 to 26. Fasted hens ceased egg production (EP) 11 d sooner ($P \leq 0.05$) and were out of production 10 d longer ($P \leq 0.05$) than non-fasted hens. Non-fasted hens took 3 to 33 d to cease EP. The non-fasted hens had less body weight loss (10% of pre-molt weight) than the fasted hens ($P \leq 0.05$) which had a 25% body weight loss. There was decreased post-molt hen day production ($P \leq 0.05$) with increased supplementation of Cys. Cys had a linear effect on in egg weight ($P \leq 0.05$) and egg weight decreased with increasing levels of Cys. Total feed intake and hen mortality were not affected ($P \geq 0.05$) by treatment. From these results, non-fasting molt is an alternative for management of laying hens within animal welfare guidelines. However, increased Cys supplementation beyond 250 mg/hen/d had a negative effect on post-molt hen day production and egg weight.

Key Words: Molt, Cystine, Sodium

210 Evaluation of low-energy molt diets for induced molting of laying hens. P. E. Biggs*, M. E. Persia, P. L. Utterback, K. W. Koelbeck, and C. M. Parsons, *University of Illinois*.

An experiment was conducted using 576 Hy-Line W-36 hens (68 wk of age) to evaluate several low-energy non-feed withdrawal molting methods. Four treatments provided *ad libitum* access for 28 d to diets containing 94% wheat midds (WM), 47% corn-47% soy hulls (C-SH), 47% wheat midds-47% soy hulls (WM-SH), and 47% wheat midds-47% rice hulls (WM-RH). Two treatments provided *ad libitum* access for 14 d to

diets containing 95% soy hulls (SH) and 98% alfalfa meal (AM). After 14 d, hens on the latter two treatments were fed a 16% CP corn-soybean diet for 14 d. The final treatment consisted of feed withdrawal for 10 d followed by feeding a 16% corn-soybean meal diet for 18 d. At 28 d, all hens were fed a corn-soybean meal layer diet (16% CP) and production performance was measured for 20 weeks. Hens on the feed withdrawal, SH, and AM treatments ceased production on Day 6, and hens fed the C-SH, WM-SH, and WM-RH combination diets ceased production on Day 7. Hens fed the WM diet ceased production on Day 13. Body weight loss for hens fed the WM diet was 14% on Day 28. Hens fed the C-SH, WM-SH, and WM-RH diets had body weight losses of 27, 26, and 24%, respectively, on Day 28. Hens fed the SH and AM diets had respective body weight losses of 22 and 19% on Day 13. Egg production of all hens remained below 50% until Week 7. Although the rate of return to egg production varied among treatments, no consistent differences were observed among treatments for egg production, mortality, egg weight, egg specific gravity, feed efficiency, and feed consumption during the 20-wk post-molt period. When compared to the 10-d feed withdrawal, this research indicates that diets containing WM, RH, or AM and diets containing combinations of C-SH, WM-SH, and WM-RH are effective non-feed withdrawal methods for molting laying hens.

Key Words: Induced molting, Laying hens, Wheat midds

211 Effect of several levels of *Peniophora lycii* phytase on nutrient utilization in laying hens. S. Gomez¹, C. Mojica², and S. R. Fernandez*³, ¹*Mexico Agriculture Research Institute*, ²*Roche Vitamins Mexico*, ³*Roche Vitamins Inc*.

Under a Randomized Complete Block Design, 120 Hy Line W36 52-week-old laying hens were assigned to 60 cages. The blocking criterion was cage location in the hen house. The experimental treatments were; 0, 150, 300, 450, 600 and 750 *Peniophora lycii* phytase units (FYT) per kg of feed, added to a sorghum-SBM diet with 15% CP, 2.82 Mcal/kg MEn, 3.8% Ca, and 0.3 Av. P. Each diet had 10 replicates, being the experimental unit the cage with two hens. The birds were adapted to diet composition by 10 days, followed by 4 days of total excreta collection. Feed intake was adjusted to 90 g/hen/day to assure that all hens ate completely their feed. Following, the actual means and variation obtained per treatment obtained for two of the variables. Metabolizable energy (AMEn), 0 FYT, 2,754; 150 FYT, 2,793; 300 FYT, 2,819; 450 FYT, 2,833; 600 FYT, 2,846; and 750 FYT, 2,856; SEM = 21.89. Phosphorus Ret., 0 FYT, 48.71; 150 FYT, 51.83; 300 FYT, 54.89; 450 FYT, 57.85; 600 FYT, 57.9; and 750 FYT, 61.2; SEM = 2.404. The relation between the level of *Peniophora lycii* phytase as FYT/kg (x), on nutrient utilization was linear ($P < 0.05$) as follows; Dry Matter Ret. (%) = 0.0058x + 72.611 R² = 0.81; N Ret.