

wk). Birds grew 819 g during the 4 to 8wk period (CV = 15.0 %), as compared to only 389 g in the 8 to 12 wk period (CV = 15.3 %). Although there was no difference in the variation on a population basis, drastic changes are apparent when data was expressed in relative gains. The variation for relative gains ranged from a low of 17.2 % in the 4 to 8 wk period to a high of 41.0 % in the 16 to 18 wk period. Males which died had a 5 % lower growth trajectory by 4 wk of age as compared to males which survived past 38 wk. The mortality prior to 18 wk was low (total of 2 %). By 38 wk of age, mortality or culling now represented 19.5 % of the 550 males which had been placed. The major causes of death were male kills and septicemia. Growth profile during rearing may have a role in determining which males will survive in the breeder barn.

Key Words: growth profile, relative growth, male mortality

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

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

than 58 wk males (0.04% and 16.8 %, respectively). Males cannot be pre-selected for the breeding barn until wk 15 at the earliest. Selecting larger BW males suggest that producers will be selecting a male with larger testis weights.

Key Words: growth rate, male selection, broiler breeders

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

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

Key Words: molting, economics, energy/protein

Metabolism and Nutrition: Nutrition A - Minerals and Vitamins

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

Vitamin U (DL-methionine methylsulfonium chloride) has previously been found to modulate the immune system and to protect the membrane systems of living cells within the intestinal tracts of humans

and swine. Two separate trials were run to determine the effect of Vitamin U on growth performance, feed efficiency, and gut integrity on healthy birds (Trial 1) and coccidia challenged birds (Trial 2). The three Eimeria that made up the cocci cocktail administered in Trial 2 were *E. acervulina* (125,000/ml), *E. maxima* (25,000/ml), and *E. tenella* (15,000/ml). The birds were administered 1 ml of this cocktail on day 10 via oral gavage. For each trial, 384 commercial day-old broiler chicks were randomly allotted to six treatments with eight pens per treatment and eight birds per pen. A corn-soybean meal basal diet

including vitamin U at a level of 0, 200, 400, 600, 800, or 1000 ppm was used. A starter diet was fed from 0-28 d (21.5% CP, 3142 kcal/kg) and grower diet from 28-42 d (19.5% CP, 3153 kcal/kg). Bird and feed weights were taken on days 0, 14, 28, and 42 to determine growth and feed performance. Intestine samples were collected and measurements were determined from four birds per treatment. These samples were taken on day 42 in Trial 1 and day 21 (ten days after initial cocci challenge) for Trial 2. In addition, for Trial 2 fecal scores were administered from day 4 to 10 post coccidia challenge. Trial 1 results indicated no significant effects ($P>0.05$) on body weight, body weight gain, feed consumption, or feed efficiency due to dietary additions of Vitamin U from days 0-14 and 28-42. Significant effects ($P<0.01$) were found on the aforementioned factors from 14-28 d, with a decreasing trend in each as Vitamin U levels increased. There were significant differences in duodenal, ileal, and jejunal villi length and width, crypt depth, and mucosal depth between control and vitamin U treated birds. For trial 2, results indicated no significant effects ($P>0.05$) on body weight, body weight gain, feed consumption, or feed efficiency due to dietary additions of Vitamin U, with the exception of feed efficiency for 10-21 d ($P = .0317$), which increased. There were no significant fecal score differences ($P>0.05$) among the different Vitamin U levels throughout the seven day observation period. Results indicated that Vitamin U is not effective at positively influencing growth and feed performance overall. Results indicate that Vitamin U has an effect on the intestinal tract mucosal secretion, which may be associated with gastrointestinal protection.

Key Words: vitamin U, broilers, *Eimeria* spp.

27 Maternal dietary 25-OH vitamin D₃ improves chick early innate immunity. J. L. Saunders-Blades* and D. R. Korver, *University of Alberta, Edmonton, Canada.*

The innate immune system of broilers is immature at hatch, making the chick susceptible to infection. The effects of maternal dietary 25-OH vitamin D₃ (25-OH D₃) on the innate immune function of the chick were determined. Ross 308 hens (N=98) were placed in 4 floor pens and fed diets supplemented with either 69µg of 25-OH-D₃ or 2,760IU vitamin D₃ (D₃) per kg feed (2 pens/treatment) starting at 23 wk of age. At 46-48 wk (mid-production) and 61-63 wk (late production), hens were artificially inseminated and the eggs were hatched. *In vitro* innate immune function was assessed in chicks at d1 and d4 post-hatch at each breeder age. Chick whole blood bactericidal activity against *E.coli* was assessed. Phagocytosis of *E.coli* and heterophil oxidative burst were measured by flow cytometry. Previously we reported that 25-OH D₃ improved total bactericidal ability of chicks at d4 from early production (31-33 wk) broiler breeders. Total killing of *E.coli* in the 25-OH D₃ group was greater than the D₃ group at d4 (74 vs 72%, $P=0.03$, SEM=2.37) for the mid-production hatch and d1 (54 vs 51%, $P<0.001$, SEM=2.89) and d4 (57 vs 51%, $P<0.001$, SEM=2.68) for the late production hatch. This was due to the greater number of *E.coli* phagocytosed by the 25-OH D₃ birds at d1 in the late production hatch; there were no differences in phagocytosis between the treatments at the mid-production hatch. Oxidative burst of cells from the 25-OH D₃ chicks was greater than from the D₃ chicks at d1 for the mid-production hatch; no treatment effects were observed for the late production hatch. Chicks from the mid production hatch had greater phagocytosis at both d1 and d4 than chicks from the early and late production hatches ($P<0.0001$). The bactericidal activity and oxidative burst response was lower for the late production hatch than the early and mid-production hatches. Maternal 25-OH D₃ improved aspects of the innate immune

system in the young broiler chick, indicating an earlier maturation of the cells.

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

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

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

Key Words: vitamin A, Japanese quail, egg production

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

Research has shown that folic acid plays a role in reducing the incidence of neural tube defects. Additionally, folate supplementation has been found to decrease plasma homocysteine, a risk factor for cardiovascular disease. Previous research has shown that supplementing laying hen diets with 4 mg/kg folic acid leads to folate-enriched eggs (3 fold increase) over a short term feeding period. As consistent egg folate deposition is the key to successful marketing, the current study was designed to address the following objective: Can a lower level of folic acid supplementation maximize egg folate content over the full production cycle? To address this objective, 1248 Hy-Line CV20 laying hens (n = 416 per diet), in a completely randomized design, received a barley-based ration containing 0, 2, or 4 mg/kg of crystalline folic acid for eleven 28-day periods. Response criteria included production parameters and measures of egg folate content. Data was analyzed as a repeated measures experiment using the mixed procedure. The analysis revealed a significant ($P<0.0001$) main effect of folate supplementation on egg folate content. Significant egg folate content differences ($P<0.0001$) were evident between each of the three rations. As the level of supplemental crystalline folic acid increased in the diets, the egg folate content significantly increased. Average egg folate levels

over 11 periods were 1.4, 2.9, and 3.4 micrograms/gram of yolk for respective rations containing 0, 2, and 4 mg of crystalline folic acid/kg of diet. Production parameters including egg production, egg size, feed consumption, feed efficiency, and egg shell quality were not significantly ($P > 0.05$) affected by dietary folic acid supplementation. This study confirms that egg folate content is maximized when crystalline folic acid is supplemented to the hen's diet at 4.0 mg/kg diet. Furthermore, folate levels from eggs supplemented with 4.0 mg/kg diet were consistent throughout the production cycle.

Key Words: folate, egg

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

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

Key Words: laying hens, vitamin E, oxidative stress

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

Phase-feeding (PF) is effective at maintaining broiler growth and yield while reducing cost of production (\$/kg gain or breast), but attempts to incorporate a 0.2% reduction in dietary Ca and P levels into a PF regimen have reduced growth. The objective of this experiment was to compare the growth performance of broilers fed PF diets containing

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

Key Words: phase-feeding, broiler, amino acids

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

Two experiments were conducted to confirm that variation in broiler phosphorous (P) utilization is due to hen's age and egg storage time. Experiment 1 was conducted with chicks hatched from eggs laid by Ross × Ross 308 hens (27 vs. 61 wk old) and stored for 0 or 10 d. The diets were based on corn, soybean meal and soybean oil and contained 1.00 % Ca and 0.25 % available P. Six replicates of 5 chicks from each hen age and egg storage time combination were placed in battery brooders. Hens' age had significant effects ($P < 0.05$) on 0 - 16 d chick growth (309 ± 17 vs. 226 ± 10 for 27 and 61 wk old hens, respectively). The longer egg storage time of chicks from older hens resulted in higher P rickets score and incidence, but the longer egg storage time of chicks from younger hens resulted in lower P rickets score and incidence ($P=0.0455$). The longer egg storage time of chicks from older hens resulted in lower bone ash (%), but the longer egg storage time of chicks from younger hens resulted in higher bone ash (%). Experiment 2 was conducted with chicks hatched from eggs laid by Ross × Ross 308 hens (26 vs. 60 wk old) and stored for 0 or 10 d. The diets were same as Experiment 1, but with or without 1α -OH Cholecalciferol (1α -D₃). Six replicates of 10 chicks from each hen age and egg storage time combination were placed in battery brooders. The P rickets-inducing diet without 5 μ g/g 1α -D₃ resulted in a much higher P rickets score ($P < 0.0001$) and incidence ($P < 0.0001$) than P rickets-inducing diet with 5 μ g/g 1α -D₃. Hens' age had significant effects ($P < 0.0001$) on 0 - 16 d chick growth (272 ± 7 vs. 339 ± 8 for 26 and 60 wk old hens, respectively), and egg storage time had significant effects ($P < 0.05$) on 0 - 16 d chick growth (295 ± 11 vs. 316 ± 9 for 26 and 60 wk old hens, respectively). The chicks from the older hens showed higher P rickets score ($P=0.0186$), but egg storage time did

not affect P rickets score and incidence. The factors influencing the incidence of P rickets in broilers should include hen's age and egg storage time as well as genetics and dietary levels of Ca, P, and Vitamin D.

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

33 Calcium particle size effects on excreta, and urinary Ca and P changes in broiler breeder hens. M. K. Manangi* and C. N. Coon, *University of Arkansas, Fayetteville.*

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

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

34 Performance and egg quality of laying hens fed Egg Shell 49 or Replamin. M. T. Farran*¹, A. N. Kadi¹, and G. W. Barbour², ¹*American University of Beirut, Beirut, Lebanon*, ²*Lebanese Agricultural Research Institute, Beqa'a, Lebanon.*

An experiment was conducted to study the effect of Eggshell 49 2X (ES49), produced by Alltech, and Replamin powder (RP), produced by Albion Laboratories Inc., on performance and egg quality of 60 wk old Single Comb White Leghorn layers of ISA White strain for a period of 24 wk. One hundred ninety two laying hens of similar body weight were selected from a floor-reared flock and housed in individual layer cages equipped with a common drinker trough and individual feeders for two weeks, during which body weight and egg production were recorded. The birds were divided into three groups with 64 hens each whereby body weight and egg production means were similar among the three groups. The control group was fed a balanced corn-soybean meal diet containing 2900 kcal ME/kg and 16% CP, whereas the other two groups were fed a similar diet but supplemented with 0.05% ES49 or 0.1% RP to replace corn. Feed intake, egg production, and feed conversion were determined every 28 d sub-period. Egg weight, specific gravity, shell thickness, and Haugh unit and yolk color scores were recorded on all eggs collected during the last three days of each sub-period. Also hen body weight was

recorded at the end of the experiment. Sub-period data were pooled and statistically analyzed as one way ANOVA and treatment means separated by Duncan's Multiple Range test. Body weight change, daily feed intake, egg production, feed conversion, and Haugh unit and yolk color scores were not affected by any of the dietary treatments. Egg weight of birds fed the control and ES49 diets was comparable (69.4 g), but lower ($P < 0.05$) than that of the RP diet (73.1 g). Specific gravity of control eggs was the lowest (1.0750) but significantly different only from that of ES49 (1.0778); RP had an intermediate specific gravity value (1.0771). Egg shell thickness of both RP (0.345 mm) and ES49 (0.342 mm) was higher ($P < 0.05$) than that of control (0.329 mm). Although RP and ES49 in the current trial resulted in comparable performance and egg quality parameters, RP produced larger eggs.

Key Words: laying hen, feed additive, egg quality

35 Benefit of MINTREX® P blend of organic trace minerals on breaking strength, ash content, tibial dyschondroplasia, synovitis and pododermatitis in heavy weight tom turkeys. J. Richards*¹, M. Quiroz¹, W. Williams², and J. Dibner¹, ¹*Novus International, Inc, St. Louis, Missouri*, ²*Akey, Lewisburg, Ohio.*

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

Key Words: organic trace minerals, MINTREX, pododermatitis

36 Growth and mineralization of the femur of the male turkey. T. J. Applegate*¹, P. Jaynes¹, J. J. Dibner², M. Quiroz², and J. D. Richards², ¹*Purdue University, West Lafayette, Indiana*, ²*Novus International, Inc., St. Charles, Missouri.*

Turkey femurs were collected from two commercial turkey complexes from 5 to 18 wk of age (n=5-28 per wk). The trial evaluated the

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

Key Words: bone ash methodology, femur, turkey

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

An experiment was conducted to study the relationship between the growth of commercial toms (Nicholas) and linear skeletal development. All toms were fed a commercial turkey starter diet for the entire experiment. At two week intervals, 10 toms were randomly selected and weighed. The right half of the Pectoralis major (PMAJ) breast muscle was removed and weighed and the tibia and femur were removed for further measurements. All tissue was removed from each bone by boiling and the length was recorded. The width of the bone was determined at the point calculated to be 50% of its respective length. Body weight increased from 405 g at 2 wk to almost 8 kg by 10 wk of age, a 20-fold increase, and there was a consistent 2 to 3 kg increase in BW every two wk between 10 and 22 week (24.1 kg), representing a three fold increase in BW between these ages. The percentage PMAJ (one side only) almost doubled between 2 wk (3.8%) and 10 wk (7%) but thereafter the increases in relative breast muscle size, while incremental with age, were small and the terminal muscle percentage at 22 wk was 9.04 %. In both the tibia and femur, there was a 5-fold increase in bone length between hatch and 10 wk (tibia, 3.53 to 18.15 cm; femur, 2.48 to 12.74 cm) with only a 20 - 30% further increase in length through 22 wk (tibia, 24.3 cm; femur, 15.6 cm). From 18 to 22 wk, there were minimal changes in tibia or femur length but BW increased 6 kg. The age associated changes in tibia and femur width were even more dramatic. From hatch to 10 wk, the width of

the tibia and femur increased 8 fold (tibia, 1.97 to 16.51 mm; femur, 1.95 to 16.86 mm) with a only a 20 to 25% further increase through 22 wk (tibia, 20.84 mm; femur, 20.41 mm). From 14 to 22 wk, there was only a 2 mm increase in tibia and femur width but BW increased 10 kg during the time period. In conclusion, the greatest absolute and relative changes in long bone development occur within the first 10 weeks of age. The skeleton is subject to tremendous physical stress from increased BW from 10 to 22 wk (16 kg) and this emphasizes the importance of early skeletal development with respect to minimizing leg weakness at later ages.

Key Words: turkeys, femur, tibia

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

Leg-related mortality can be >1% per week starting about 15 wk in turkey toms. Dietary MINTREX Pse (MIN) and 25-hydroxycholecalciferol (HyD) supplementation may improve growth performance and reduce the incidence of leg abnormalities. Day-old Nicholas 85X700 toms were randomly distributed among 48 pens (4 dietary treatments (trt) x 12 replicates) of 15 poults each. Trts were a 2x2 factorial (0 and .1% MIN; 0 and 92 mcg/kg HyD). MIN provided 40 ppm Zn, 40 ppm Mn, and 20 ppm Cu as methionine hydroxy analogue complex and .3 ppm Se as Se yeast. Diets were formulated to be equal in nutrient content and fed ad lib as 8 feed phases until 20 wk. Body weight (BW) and feed intake were measured at 3, 6, 8, 10, 12, 17 and 20 wk. Incidence of valgus, varus, and Shaky leg defects were determined at 12, 15, 17 and 20 wk. There were no trt effects on BW (Mean 20 wk BW 21.2 kg). At 6 wk, cumulative feed:gain (cFCR) was improved by MIN when HyD was included in the diet (1.432 vs 1.416, $p < .05$). Only MIN significantly reduced cFCR from 8 wk through 20 wk (20 wk cFCR 2.802 vs 2.722, $p < .01$). Cumulative mortality at 3 wk was higher among the MIN birds (1.2% vs 5.3%, $p = .0001$), but it was lower by 20 wk (18.3% vs 15.6%, $p < .1$). MIN reduced varus defects at 17 wk (1.8% vs 0.3%, $P < .05$), shaky leg incidence at 12, 15 and 17 wks (13% vs 2.1% at 17 wk, $p < .001$), and valgus defect incidence at 15, 17 and 20 wk (21% vs 4.3% at 17 wk, $p = .0001$). In contrast, HyD increased valgus defects at 20 wk (11.7% vs 20.5%, $p < .05$). There were no MIN x HyD interaction effects on leg problems. MINTREX Pse supplementation for turkeys may be an effective way to improve feed conversion, likely by reducing leg problems and late-term mortality. [®]MINTREX is a registered trademark of Novus International, Inc.

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

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

An experiment was conducted to compare the effect of organic and inorganic sources of Se on productive performance and egg quality of Hy-Line laying hens (28-40 weeks of age). Dietary treatments consisted of adding 0, 0.3, or 0.5 ppm organic and inorganic Se and

one diet including equal mix of these two sources (0.15+0.15), to basal diet free of Se. The basal corn-soybean meal diet was formulated to meet nutrient requirements. Ninety six birds were randomly allocated in twenty four cages in a completely randomized design. Egg production and egg weight were recorded weekly and bi weekly, respectively. Body weight and shell weight, shell thicknesses, yolk weight, albumen height of fresh eggs were evaluated monthly and every six week. Some eggs were produced in 34 and 40 weeks, kept in storage egg room for 14 days and then egg quality test was accomplished. At 40 weeks 2 hens per pen dissected and Pectoralis major and Pectoralis minor, liver, abdominal fat pad, oviduct, and ovary were removed and individually weighed. Responses were statistically significant, for egg production (31.3%), egg weight (9.6%) and body weight (5.6%) and eggs quality

(fresh and stored) with increasing amounts of both two sources of selenium in the diet. Dietary supplementation with organic Se increased ($p < 0.05$) shell thickness of fresh eggs at 34 weeks. Sources and levels of Se had no significant effect on body weight, egg production and egg weight, although trend was toward improved with organic Se. Stored eggs quality were not affected by source or levels of Se. The Se level in the diet affected the weights of the Pectoralis major, minor and liver. Reproductive parameters were also not different among the treatments. Birds fed 0.3ppm inorganic or organic Se had more numbers small yellow follicle. The results of this experiment indicated that organic Se increase egg production, yolk weight and shell thickness compared with inorganic Se.

Key Words: organic selenium, laying hens, reproduction

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

40 Growth performance, gut health, and feed passage of *Salmonella*-challenged chickens reared on litter floors or in cages. D. Bohorquez*, R. Plunzke, E. Oviedo, and P. Ferket, *North Carolina State University, Raleigh.*

The growth and health response of chickens to enteric pathogens, such as *Salmonella* spp. may differ whether they are raised on litter floors or in cages. This difference may be due to the degree of colonization challenge and its effect on gut health and feed passage. Male Ross 308 broilers were randomly assigned to 32 litter floor (L) pens in a curtain-sided house or 32 cages (C) in a total confinement house (25 birds/pen or cage). All the birds were orally inoculated with 106 cfu of a mixture of *S. enterica* subspp. at 3 d of age. *Salmonella* colonization levels (MPN), body weights (BW), feed/gain (FCR), bursa, spleen, and liver weights were determined, and gut health was evaluated at 14, 28, and 42 d. Organ weights and health of intestine (incidence of thin and inflamed gut tissues) was scored on 32 birds/house. In comparison to L, C reduced 42 d BW (2748 vs. 2668 g, $p < .001$) and increased 1-42 d FCR (1.84 vs. 1.93, $p < .001$). There were no house effects on mortality rate. *Salmonella* MPN was higher in L than C at 14 d (6.452 vs. 5.152 log/g, $p < .01$), which corresponded with a higher incidence of mucoid (14.1 vs. 1.5%, $p < .01$) jejunum mucosa, and greater relative spleen and liver size at 28 d by 13% and 11%, respectively ($p < .05$). In contrast, C had higher incidence of ileal grain chips than L at 14 d (68.4 % vs. 31.5%, $p < .05$), indicating inferior gizzard function. Although birds reared on litter floors may have greater *Salmonella*-challenge than cage-reared birds, they demonstrate greater disease resistance and less feed passage, resulting in better growth performance.

Key Words: broilers, *Salmonella*, feed passage

41 Immune, growth and carcass responses to dietary threonine of broilers raised in different litter conditions. A. Corzo*¹, M. T. Kidd¹, G. T. Pharr¹, W. A. Dozier III², and E. A. Koutsos³, ¹Mississippi State University, Mississippi State, ²USDA-ARS Poultry Research Unit, Mississippi State, Mississippi, ³California Polytechnic State University, San Luis Obispo.

Needs for dietary threonine in growing broilers have been well documented, but needs for growth, carcass and immunity reared in different litter conditions are not. Two studies were simultaneously done in the same house, and evaluated digestible threonine (d-Thr) needs of Ross x Ross 708 male broilers reared under two different

litter conditions: new vs. used wood shavings (used for 4 previous flocks). Separated by a center aisle, all floor pens from one side of the close-sided house were provided new litter while the other side received used. These broilers were grown in common diets up to 21 d of age, and then fed one of six dietary d-Thr levels that ranged from 0.43 to 0.78%. At 42 d of age birds were processed, and carcass and breast meat yield were measured. As measurements of immunity, a bird from each experimental unit corresponding to either the 0.43% or 0.64% d-Thr were inoculated with SRBC at 28 d of age, and the corresponding primary response measured at 35 d of age. Additionally, at 35 d of age, a blood sample was collected from another bird per experimental unit and analyzed for white blood cell count, peripheral blood monocyte nitric oxide, and HD-11 macrophage nitric oxide. Spleen, thymus and bursa relative weights were measured at 42 d of age from one bird per pen fed either 0.43 and 0.64% d-Thr. Results for live performance and carcass traits are in close agreement with previously reported values in the literature. Quadratic responses were observed for BW gain, feed conversion, carcass and breast meat absolute and relative weights. Depending on the variable, these responses were maximized (95% of maximum response) between 0.63 and 0.66, and 0.65 and 0.70% d-Thr when broilers were raised in new and used litter, respectively. It should be noted that dietary digestible Lys was 1.00%, thus Thr to Lys ratios oscillated between 63 and 66, and 65 and 70 d-Thr for new vs. used litter, respectively. Low d-Thr (0.43%) was without effect on most immune parameters. However, low d-Thr decreased relative thymus weight and increased monocyte nitric oxide production in dirty and clean environments, respectively.

Key Words: litter, threonine, immunity

42 Denaturing gradient gel electrophoresis analysis of 16S ribosomal DNA amplicons to analyze changes in ileum bacterial population of turkeys fed different diets and after infection with *Salmonella* spp. A. A. Santos Jr.*¹, P. R. Ferket¹, F. B. O. Santos¹, N. Nakamura², C. Collier², and H. R. Gaskins², ¹North Carolina State University, Raleigh, ²University of Illinois, Urbana.

Non-starch polysaccharides (NSP) and dietary exogenous enzyme supplementation may modulate enteric microflora and discourage *Salmonella* spp. (SAL) colonization by influencing the degree of competitive exclusion. Changes in ileum bacterial populations of SAL-infected turkeys fed different diets were analyzed using polymerase chain reaction (PCR) denaturing gradient gel electrophoresis (DGGE).