

starter from 0 to 2 wk, grower from 2 to 4 wk, and finisher from 4 to 6 wk. Feed consumption, body weight and feed conversion were measured at 2, 4 and 6 wk. Carcass yield and weights of abdominal fat, gizzard and ceca were also determined at 6 wk. All birds were intramuscularly immunized with killed vaccine of Newcastle and Avian Influenza (H9 N2) at 8 d and antibody titer responses to Newcastle and Influenza were determined by hemagglutination inhibition (HI) test at 18 and 28 d. Body weight and feed intake of broilers reared on rice hulls decreased compared to other litters ($P < 0.05$). Litter materials had no significant influence on feed conversion, carcass yield, gizzard and ceca weights. Percentage of abdominal fat were significantly lower for birds reared on paper roll than birds reared on rice hulls. Antibody titer against Newcastle and Influenza vaccine at 18 d elevated in broilers reared on sand. In conclusion, broilers reared on sand and paper roll perform as well as those reared on wood shavings.

Key Words: litter material, performance, antibody titer

80 Ultrastructural diversity of eggshell quality in some Egyptian local breeds of chicken. M. M. Fathi*¹ and Y. K. Afifi², ¹*Ain Shams University, Cairo, Egypt*, ²*Animal Production Research Institute, Alexandria, Egypt*.

Ultrastructural variations of eggshell in some Egyptian local breeds (Bandara, Mandara, and Norfa) were evaluated using scanning electron

microscopy (SEM). A total of 120 laying hens representing the different breeds were used in this experiment (40 each). Hens were housed in individual wire cages in an open sided house. At 48 weeks of age, 240 eggs were collected from all breeds (80 each) to measure internal and external egg quality traits. In addition, ultrastructural variations in eggshells were assessed. The current results revealed that eggshell of Norfa breed recorded the highest shell thickness compared to the other breeds. With respect to eggshell strength, it is of interest to note that the eggshells of Mandara and Norfa chickens had a highly significant strength compared to that of Bandara siblings. According to scanning electron microscopy data, the incidence of certain structural variants is more common in eggshells of Bandara breed suggesting poor shell strength. In general, the eggshells of Mandara and Norfa chickens had highly significant better total score for overall ultrastructural traits compared with those of Bandara breed. Alignment appearance was more prevalent in Bandara eggshells compared to the other breeds suggesting lower resistance to breakage. Also, type B abnormalities were obviously prevailing in Bandara breed. On the other hand, early fusion and narrow interstitial spaces of palisade layer indicating increase resistance to fracture were observed in eggshells of Mandara and Norfa chickens. In conclusion, although the shell thickness of Bandara and Mandara breeds was equal, the last one recorded higher shell strength and better ultrastructural measurements of the mammillary layer. Thus, the ultrastructural measurements of the eggshell must be taken into consideration through poultry breeding programs and crossbreeding systems.

Key Words: scanning electron microscopy, ultrastructure, eggshell

Metabolism and Nutrition II: Feed Ingredients

81 Quality characteristics of distillers dried grains with solubles: Wheat and corn DDGS comparison. B. A. Slominski*, A. Rogiewicz, C. M. Nyachoti, and K. M. Wittenberg, *Department of Animal Science, University of Manitoba, Winnipeg, Canada*.

A comprehensive evaluation of the nutritive profiles of wheat-based DDGS in comparison to corn DDGS was undertaken. Two samples of wheat DDGS from the Husky Energy Lloydminster Ethanol Plant in Canada and 4 samples of corn-based DDGS from VeraSun, Aurora, ND, Glacial Lakes Energy, Watertown, SD, Minnesota Energy, Buffalo Lake, MN, and Archer Daniels Midland, Walhalla, ND, USA, were used in the study. On dry matter basis, a high level of protein (40.7%), and minimal levels of simple sugars (0.9%) and starch (1.8%) were found in wheat DDGS. This was not the case for the corn DDGS samples showing, on average, a much higher starch (7.1%) and simple sugar (2.1%) contents, and lower protein (30.5%) content. The total fiber content averaged 33.2% for the 2 wheat DDGS samples and was lower than that of corn DDGS (35.5%). This was followed by even a higher magnitude of difference in the NDF content, which averaged 27.3% for wheat and 32.6% for the corn DDGS samples. Compared to wheat, the corn DDGS samples were found to be much higher in fat (4.5 vs. 10.7%), which along with the high starch content would contribute to the high energy content of this products. The nonphytate P content was found to be much higher in wheat DDGS (0.85 vs. 0.62%) which could be of importance and benefit in monogastric nutrition. A carbohydrate fraction deriving from nonstarch polysaccharides hydrolysis by viscosity-reducing enzymes used in the fermentation process accounted for 4.3% in wheat DDGS and was much higher than that of corn DDGS (1.2%), and distinct in

component sugar profile. The total amino acid content averaged 37.0% in wheat and was much higher than that of corn DDGS (30.4%). This was not necessarily followed by the lysine content which averaged 1.0% and was identical, on average, to that of corn DDGS. Although consistent for wheat DDGS, the lysine content among the corn DDGS samples differed significantly (from 0.79 to 1.12%). Similar levels of methionine were found in wheat (0.80%) and corn (0.77%) DDGS.

Key Words: wheat DDGS, corn DDGS, chemical composition

82 Quality characteristics of wheat distillers dried grains with solubles (DDGS). A. Rogiewicz*¹, B. A. Slominski¹, C. M. Nyachoti¹, A. L. Brule-Babel², and K. M. Wittenberg¹, ¹*Department of Animal Science, University of Manitoba, Winnipeg, Canada*, ²*Department of Plant Science, University of Manitoba, Winnipeg, Canada*.

The quality characteristics of corn DDGS have been extensively evaluated. Current ethanol production in Western Canada uses wheat as a primary feedstock. However, little is known about the chemical composition and nutritive value of wheat-derived DDGS. Therefore, a comprehensive evaluation of the nutritive profiles of wheat-based DDGS from the new-generation Husky Energy Lloydminster Ethanol Plant in Canada was undertaken. The results revealed good quality characteristics of the DDGS samples ($n = 2$) showing, on dry matter basis, a relatively high level of protein (40.7%), fat (4.5%), a very good proportion of nonphytate to phytate P (0.79 vs. 0.22%), and minimal levels of simple

sugars (0.4%) and starch hydrolysis product (i.e., maltose, 0.3%), which along with the starch content of 1.8% are indicative of an effective conversion of starch to ethanol. The color of the DDGS samples was yellowish indicating good drying practices. This was reflected in a relatively high lysine content, which averaged 0.99% and was much higher than that of 0.68% observed in the wheat DDGS product originating from another plant utilizing the old drying technology. Total fiber content averaged 33.1%, with nonstarch polysaccharides (NSP) accounting for 19.9%. This value appeared to be lower than that calculated based on the average NSP content in Canadian wheat (i.e., 10.1%) and the assumption that a 3-fold increase in any nonfermentable component should occur in the final DDGS product. An interesting carbohydrate fraction derived from NSP hydrolysis during the fermentation process has been identified and accounted for 4.3%. A preliminary experiment with broiler chickens has shown promise for supplemental enzymes as a useful tool for enhancing the feeding value of wheat DDGS. Although not statistically significant, a trend toward improved BWG (328 vs. 360 g/14 d) and FCR (1.38 vs. 1.33) was observed in broilers fed enzyme supplemented diets containing 10% wheat DDGS.

Key Words: wheat DDGS, chemical composition, enzyme supplementation

83 Dietary corn distillers dried grains with solubles does not affect generic *E. coli* numbers in the laying hen ceca. S. Roberts^{*1}, H. Xin¹, D. Trampel¹, H. Medina², and K. Bregendahl¹, ¹Iowa State University, Ames, ²Sparboe Companies, Litchfield, MN.

Escherichia coli has been implicated as a cause of peritonitis in laying hens. An experiment was conducted to determine the effect of dietary corn distillers dried grains with solubles (DDGS) on generic *E. coli* numbers in the ceca of laying hens. Two proprietary commercial laying-hen diets were formulated with either 0 or 15% DDGS. Seventy-two Hy-Line CV20 hens at 91 wk of age were obtained from a commercial farm and were housed 3 per cage in 24 cages. Each cage was assigned to 1 of the 2 dietary treatments (n = 12) according to a completely randomized design. After the hens were fed the respective diet for 6 wk, they were euthanized by CO₂ and the ceca were aseptically removed. The contents from 1 randomly chosen cecum of each hen were removed, mixed in a 1:10 dilution with buffered peptone water, and serially diluted to 10⁻⁶. Dilutions were plated once onto Petri film and in duplicate to BioRad Rapid *E. coli* 2 agar and MacConkey agar. All media were incubated at 44°C for 24 h (agar plates) or 18 h (Petri films). The average number of colony forming units (CFU) per gram of cecal contents among the 3 hens in each cage was calculated and logarithmically transformed. Data were analyzed using ANOVA with $P \leq 0.10$ considered significant. There were 6.4 log CFU of generic *E. coli* per gram of cecal contents in the hens fed the 15% DDGS diet compared to 6.0 log CFU per gram in the hens fed the 0% DDGS diet (SEM = 0.27; $P = 0.32$). This study shows that inclusion of 15% DDGS in a laying-hen diet does not cause a change in the generic *E. coli* numbers in the hen's ceca.

Key Words: distillers dried grains with solubles, *E. coli*, laying hens

84 Evaluation of limit feeding corn and DDGS in nonfeed withdrawal molt programs for laying hens. L. Mejia^{*}, P. L. Utterback, C. W. Utterback, C. M. Parsons, and K. W. Koelkebeck, University of Illinois, Urbana.

An experiment was conducted using 504 Hy-Line W-36 hens (69 wk of age) to evaluate if limit feeding of corn and DDGS diets would provide for acceptable postmolt performance in a nonfeed withdrawal molt program for laying hens. Treatment 1 consisted of feeding a 47% corn: 47% soybean hulls diet (C:SH) ad libitum for 28 d. Treatments 2, 3, and 4 received a 94% corn diet at a rate of 36 g/hen/d (C36), 45 g/hen/d (C45), or 55 g/hen/d (C55), respectively for 28 d. Treatments 5, 6, and 7 were fed a 94% DDGS diet at the same rates as Treatments 2, 3, and 4 (DDGS36, DDGS45, DDGS55) for 21 d, followed by feeding a 16% CP corn-soybean meal layer diet for 7 d. The intent was to feed the DDGS diets for 28 d; however, all hens on these diets stopped eating feed on Day 19 and were switched to the layer 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 22. All hens fed the 3 DDGS treatments and those on the C36 treatment reached 0% egg production by Day 14. Egg production of hens fed the C:SH, C45, and C55 treatments dropped to 5% or less by Day 14. Body weight (BW) loss of hens on the C:SH and C36 treatments was 21 and 22%, respectively, on Day 28, whereas hens on the C45 and C55 treatments lost 17 and 14% BW, respectively. The hens fed the DDGS diets lost an average of 24% BW by Day 20. Feed consumption was greater for hens fed the C:SH diet during Weeks 1 to 4 of the molt period. Postmolt egg production (Weeks 5 to 22) was the lowest for hens on the C55 treatment, compared to hens on the DDGS36 and DDGS55 treatments. Egg weights (Weeks 8 to 21) were also lower for hens on the C55 treatment. When compared to feeding the C:SH diet, the results suggest that limit feeding hens with corn or high DDGS diets can be effective nonfeed withdrawal methods for molting laying hens.

Key Words: molting, laying hens, DDGS

85 Dried distillers grains with solubles in laying hens ration (Phase II). M. K. Masa'deh^{*}, P. Weber, and S. E. Scheideler, University of Nebraska, Lincoln.

A study was conducted to test the effect of dried distillers grains with solubles (DDGS) inclusion rates in laying hens on feed intake, body weight and egg parameters for phase 2 of egg production. Two hundred eighty-eight Bovan White laying hens were fed diets containing 0, 5, 10, 15, 20, or 25% DDGS from 47 to 76 weeks of age. The diets were formulated to provide 2,816 kcal/kg ME (metabolizable energy), 16.0% protein, 0.80% lysine, and 0.44% methionine. Six hens were placed per cage with 8 replicate cages per dietary treatment in an unbalanced randomized complete block design. Average feed intake was similar ($P > 0.1$) between treatments with an average of 101 g/hen/d. Average hen weights were different ($P < 0.05$) between dietary levels of DDGS with the greatest weight for hen fed 5% DDGS. However, there was no difference in hen weight gain ($P > 0.1$) between treatments. Egg production was not affected by dietary DDGS levels ($P > 0.1$) averaging 83% EP. Egg weight was not significantly ($P > 0.1$) affected by DDGS treatments. Hens fed 0, 5, 10, 15, 20, or 25% DDGS had an average egg weight for the trial of 63.1, 62.9, 63.3, 62.0, 62.0, and 62.0 grams, respectively. There was no difference ($P > 0.1$) in egg Haugh unit, albumen height, and specific gravity between the levels of DDGS. Yolk color increased with increasing DDGS level with the highest Roche color fan score ($P < 0.05$) of 7.2 for hens fed 25% DDGS. In summary, feeding up to 25% DDGS during phase 2 of production had no negative effects on feed intake, egg production, egg weight, Haugh unit, and specific gravity; and improved yolk color at the highest levels. Using 25% DDGS has an

economical benefit of 12\$/ton of feed compared to the basal diet (0% DDGS) when DDGS was priced at 136 \$/ton.

Key Words: DDGS, distillers grains with solubles, laying hens

86 Replacement of soybean meal with high-protein corn distillers grain in broiler diets. T. J. Applegate^{*1}, C. Troche¹, Z. Jiang¹, and T. R. Johnson², ¹Purdue University, West Lafayette, IN, ²Dairy and Animal Nutrient Management Systems, Noblesville, IN.

Two experiments were conducted with a by-product of corn endosperm fermentation (HP-DDG; 54% CP). The first experiment determined nutrient digestibility of the HP-DDG after feeding semi-purified diets to 6 cages of male broiler chicks (8/cage) from 15 to 22 d of age. The AME_n of HP-DDG was determined to be 2,526 kcal/kg while standardized ileal lysine, methionine, and threonine digestibility was determined to be 73.0, 84.9, and 73.0%, respectively. A subsequent broiler grow-out experiment was conducted from 0 to 42 d of age with 8 pens of 39 male broilers/pen. An industry control diet (I) regimen was compared to that of either a 25 or 50% replacement for the level of 48% CP SBM inclusion in the diet utilizing the amino acid digestibility and AME_n determined from the first experiment. From 0–14, 14–28, and 28–42 d of age, the HP-DDG in the 50% SBM replacement diet was added at 25, 20 and 21% of the diet, respectively. In order to meet digestible amino acid needs, the diet containing 50% SBM replacement with HP-DDG contained 4.1, 3.3, and 3.8%-units more CP than the I diet regimen from 1–14, 14–28, and 28–42 d of age, respectively. Similarly, the diet containing 50% SBM replacement with HP-DDG contained 0.06 and 0.04% supplemental L-tryptophan from 1–14 and 14–28 d of age but did not need any supplemented to meet digestible tryptophan needs from 28–42 d of age. Dietary replacement of up to 50% replacement of SBM inclusion with HP-DDG had no effect on bird performance at 14, 28, or 42 d of age or breast meat yield at 42 d of age (mean 42 d BW = 2.87 kg; cumulative FCR = 1.76).

Key Words: amino acid digestibility, broiler, high-protein distillers grain

87 Impact of fiber separation on the nutritional value of distillers dried grains with solubles in broiler diets. R. E. Loar^{*1}, K. J. Mayo¹, R. Srinivasan¹, M. T. Kidd¹, W. A. Dozier III², and A. Corzo¹, ¹Mississippi State University, Mississippi State, ²USDA-ARS Poultry Research Unit, Mississippi State, MS.

In the corn-to-ethanol dry-grind process, starch is converted to ethanol, and the remaining corn nutrients (protein, fat, fiber, and ash) are recovered at the end of the process to form a by-product, distillers dried grains with solubles (DDGS). This by-product is currently used mostly as feed for ruminant animals, and is starting to be used at low inclusion levels in feed for broilers. Recently, Elusieve process, the combination of sieving and elutriation (upward air flow), was found to be effective in separating fiber from DDGS. The objective of this study was to compare the performance of broilers fed conventional DDGS vs. DDGS derived from Elusieve process. Three different dietary treatments were fed to Ross × Ross 308 broiler male chicks from placement at d of hatch until 21 d of age. The first diet served as control and was composed primarily of corn and soybean meal. The remaining experimental diets were also corn-soybean meal based but contained 8% inclusion of DDGS;

this second diet served as negative control and contained conventional DDGS while the third and final diet was composed of the same source of DDGS but after being submitted to modification via Elusieve process. Data was analyzed as a randomized complete block design and Tukey's test was used to separate treatment means ($P < 0.05$). Body weight gain showed no effect between the dietary treatments fed ($P = 0.18$), but did observe a 4% increase for the Elusieve DDGS diet when compared to the control diet, while the conventional DDGS diet had intermediate gain. Feed intake and feed conversion were also unaffected by dietary treatments. A higher incidence in mortality ($P = 0.07$) at d 21 was observed in birds fed the control diet when compared to broilers fed the conventional DDGS diet. Results indicate that there may be potential for improving DDGS through the use of Elusieve technology, but perhaps these effects could be more apparent at later stages in life when feed consumption is higher, or when inclusion levels in the diet surpass 8%.

Key Words: broiler, distillers dried grains with solubles, Elusieve

88 Effect of high-protein distillers dried grains at various levels on performance of laying hens. B. Y. Jung^{*}, P. Sedlacek, and A. B. Batal, University of Georgia, Athens.

Sectors of the ethanol industry are starting to use a new bio-refining production technology which separates the corn into 3 fractions: bran, germ and endosperm prior to ethanol production. The endosperm is then used for fermentation, resulting in a new by-product, high-protein distillers dried grains (HP-DDG). Thus, an experiment (Exp.) was conducted to examine the effects of feeding HP-DDG on the performance of laying hens. Five experimental diets were formulated on a total amino acid basis with 0, 3, 6, 9, or 12% HP-DDG. The mash diets were fed to fifteen replications of 6 Hy-line W36 laying hens per treatment from 21 to 41 wk of age. The laying hens were housed in a completely enclosed fan-ventilated building with elevated wire cages. Egg production was measured daily and egg weights were measured weekly for mean egg weight and egg mass. In addition yolk color (L*, a*, and b*), Haugh unit, and specific gravity were measured every 4 wk and feed intake and body weight were weighed every 5 wk. The HP-DDG contained 2,883 kcal TME_n/kg with 45.6% protein, 5.4% fat, 9.2% fiber, 0.32% phosphorus, 1.38% lysine, and 1.10% methionine. The addition of 3 and 12% HP-DDG to the diets significantly improved ($P < 0.05$) hen-day egg production as compared to the laying hens fed the control diet. However, hen-day egg production was not different between the birds fed diets with 6 or 9% HP-DDG as compared to birds fed the control diet. The addition of 3% HP-DDG significantly improved ($P < 0.05$) egg mass as compared eggs from the birds fed the control diet. There was no effect of the inclusion of HG-DDG on feed efficiency, egg yolk color or specific gravity. High-protein distillers dried grains (HP-DDG) proved to be an acceptable feed ingredient when used up to 12% in laying hen diets.

Key Words: high-protein distillers dried grains (HP-DDG), laying hens, hen-day egg production

89 Increasing level of nonstarch polysaccharides in diets may not reduce metabolizable energy or nitrogen-corrected metabolizable energy of meat and bone meal. O. A. Olukosi^{*} and O. Adeola, Purdue University, West Lafayette, IN.

Two-hundred eighty-eight 14-day-old male broilers were used to study the possible influence of nonstarch polysaccharides (NSP) on the metabolizable energy (AME) or nitrogen-corrected metabolizable energy (AME_n) of meat and bone meal (MBM). The broilers received corn-soybean meal (SBM) diet for the first 2 weeks. At day 14 of age, the broilers were allocated to 6 treatments in a randomized complete block design with 8 replicates and 6 birds per replicate. The treatments consisted of 3 pairs of basal and test diets as follow: 1) basal corn-SBM diet; 2) test diet similar to diet 1 but in which 80 g/kg MBM replaced corn and SBM; 3) basal corn-SBM diet in which 100 g/kg wheat as a source of NSP replaced corn; 4) test diet similar to diet 3 but with 80 g/kg MBM replacing corn and SBM; 5) basal corn-SBM diet but with 200 g/kg wheat replacing corn; and 6) test diet similar to diet 5 in which 80 g/kg MBM replaced corn and SBM. In the standard-test diet pair, ratio of corn to SBM was kept constant to enable determination of AME and AME_n of MBM by difference. The birds were given 4 days to adjust to the diets, and excreta were collected the last 3 days of week 3. There was no difference in the AME or AME_n of the MBM as the level of NSP in the diet increased, AME ranged from 2,950 to 3,306 kcal/kg and AME_n ranged from 2,805 to 3,178 kcal/kg. On the other hand, both AME and AME_n of the diets increased ($P < 0.05$) with increasing level of wheat and decreased ($P < 0.05$) with increasing level of MBM. In addition, nutrients utilization decreased ($P < 0.05$) with addition of MBM to the standard diets at ileal and total tract levels. The result of the study suggested that the wheat used was low in NSP and that increasing level of NSP may not reduce AME value of MBM. Further studies utilizing greater proportion of high-NSP cereals or total replacement of corn with other cereals may more clearly demonstrate possible influence of NSP on energy value of MBM.

Key Words: nonstarch polysaccharides, meat and bone meal, metabolizable energy

90 Feeding full-fat oilseeds to laying hens: Effect on production parameters, egg quality and yolk fatty acids. Z. Hayat*^{1,2}, T. N. Pasha¹, F. M. Khattak¹, G. Cherian³, and M. A. Jabbar¹, ¹University of Veterinary & Animal Sciences, Lahore, Pakistan, ²University College of Agriculture, University of Sargodha, Sargodha, Pakistan, ³Department of Animal Sciences, Oregon State University, Corvallis.

An experiment was carried out with three hundred, 53-week-old white leghorn hens to examine the effect of dietary full-fat oilseeds (sunflower, canola, flax) at 3 different levels (5, 10, 15%) on egg production, egg weight, feed consumption and yolk fatty acids. The inclusion of oilseeds did not alter the egg production or egg weight when compared with eggs from hens fed the corn- and soy-based control diet ($P > 0.05$). Feeding flax (10, 15%) and canola (5, 10, 15%) led to reduction in the total saturated fatty acids ($P < 0.05$). The deposition of α -linolenic acid (18:3n-3), eicosapentaenoic (20:5n-3) and total long chain n-3 fatty acids was highest with flax 15% ($P < 0.05$). The total n-3 fatty acids was 32, 26, and 15 mg/g yolk in eggs from hens fed flax (15, 10, and 5%) when compared to 6 mg/g yolk in eggs from the control diet ($P < 0.05$). The content of n-6 fatty acids and total polyunsaturates (n-6+n-3) was highest in eggs from hens fed 15% sunflower diet ($P < 0.05$). The feed intake was less for hens fed 10% flax diet when compared to those consuming the control diet ($P < 0.05$). These results suggest that full-fat oilseeds could be incorporated into laying hen diets without affecting production performance and egg quality. In addition, inclusion of oils

seeds could also provide different n-6 and n-3 essential fatty acids to humans upon consumption of these eggs.

Key Words: eggs, full-fat oilseeds, n-3 fatty acids

91 Lipid oxidation products, n-3 fatty acids and egg sensory aspects: Effect of feeding flax and two types of antioxidants. Z. Hayat*^{1,2}, G. Cherian³, T. N. Pasha¹, F. M. Khattak¹, and M. A. Jabbar¹, ¹University of Veterinary & Animal Sciences, Lahore, Pakistan, ²University College of Agriculture, University of Sargodha, Sargodha, Pakistan, ³Department of Animal Sciences, Oregon State University, Corvallis.

The effects of incorporating flax seed and 2 types of antioxidants (α -tocopherols, butylated hydroxy toluene) at 3 levels (50, 100, 150 IU or mg/kg) on egg fatty acids, thiobarbituric acid reactive substances (TBARS) and organoleptic attributes were investigated. Hens (n = 96, 32 weeks old, ISA Brown, 12 birds/treatment) were fed corn-soy diet (Control, no flax, no antioxidant), flax (10% with no antioxidant) or flax 10% +antioxidants for 56 days. Feeding flax increased the α -linolenic (18:3), docosapentaenoic (22:5) and docosaheptaenoic acid (22:6) and total n-3 fatty acids with a concomitant reduction arachidonic acid in the egg ($P < 0.05$). The incorporation of flax did not alter TBARS in fresh eggs ($P > 0.05$). However, upon 60 days of egg storage, TBARS were highest in flax with no antioxidant group ($P < 0.05$) α -tocopherol was better in preventing lipid oxidation in n-3 fatty acid-modified eggs than butylated hydroxy toluene. Among the flax supplemented group, eggs from 10% flax + 150 IU had the lowest TBARS ($P < 0.05$) upon storage. Antioxidant supplementation was not effective in enhancing the sensory attributes of n-3 fatty acid modified eggs. Significant differences were observed for overall difference, flavor and aroma in control vs. flax eggs. The data demonstrate that healthy eggs with increased n-3 fatty acids can be generated by minor diet modifications and α -tocopherol supplementation can reduce lipid oxidation products in n-3 fatty acid modified eggs.

Key Words: eggs, antioxidants, n-3 fatty acids

92 Influence of soybean meal origin on its nutritive value and quality parameters. S. Sueiro¹, M. Hermida¹, D. G. Valencia², M. P. Serrano², and G. G. Mateos*², ¹Laboratorio de Mouriscade, Pontevedra, Spain, ²Universidad Politécnica de Madrid, Spain.

A total of 258 samples of soybean meal (SBM) from 3 different origins (coded A, B, and C) were collected in 2 different years and the nutrient content, protein quality and uniformity were evaluated. The SBM (88, 105, and 65 samples from A, B and C origin, respectively) were analyzed in duplicate. Data are presented on dry matter bases and the amino acid (AA) content as a percentage of crude protein (CP). The experiment was conducted as a completely randomized design with 3 treatments. Additionally, the correlation among the different analyzed parameters was determined. In general, the AA content was higher for origin C than for origin B with origin A being intermediate. For lysine and methionine the contents were 7.00 vs. 6.79 vs. 6.87% and 1.53 vs. 1.45 vs. 1.49% ($P \leq 0.001$) for origin C, B, and A, respectively. Samples from A and C had higher cystine (1.75 and 1.76 vs. 1.68%), threonine (4.45 and 4.48 vs. 4.36%), and tryptophan (1.56 and 1.56 vs.

1.51%) content than samples from B ($P \leq 0.001$). Samples from B had higher NDF content than samples from C with samples from A being intermediate (12.0 vs. 8.4 vs. 9.3%; $P \leq 0.001$). The Ca (0.43 vs. 0.31 and 0.40%) and K (2.52 vs. 2.11 and 2.21%) content were higher in A samples than in B samples, with C samples being intermediate ($P \leq 0.01$). The C samples had higher PDI (22.6 vs. 15.2 vs. 20.1%) and TI content (3.9 vs. 2.8 and 3.4 g/kg) than B samples with A samples being intermediate ($P \leq 0.001$). In addition, C samples had higher KOH (87.6 vs. 83.9 and 84.8%; $P \leq 0.001$) than A and B samples. The TI content was positively correlated with PDI ($r = 0.67$; $P \leq 0.001$) and KOH ($r = 0.75$; $P \leq 0.001$). In addition, PDI was positively correlated with KOH ($r = 0.52$; $P \leq 0.001$). Finally, lysine ($r = 0.31$) and methionine ($r = 0.40$) were lower in those samples with lower KOH ($P \leq 0.001$). In summary, the origin of the soybean meal influences nutrient content and the value of the parameters used to evaluate protein quality.

Key Words: soybean meal, chemical composition, quality control

93 Field observation: Effects of long term feeding of soybean meal high in trypsin inhibitors to broiler breeders. N. Ruiz*¹, E. A. Vargas², and F. de Belalcázar³, ¹Continental Grain Company, New York, NY, ²Avícola de Occidente, Maracaibo, Estado Zulia, Venezuela, ³Nutritional, Bogotá, Colombia.

Nineteen broiler breeder flocks involving a total of 311,904 birds (271,705 hens and 40,199 roosters) of a commercial vertical integrated operation were fed commercial breeder feeds containing soybean meal (SBM) whose trypsin inhibitor (TI) contents fluctuated between 3.04 and 5.02 mg of TI per gram of SBM. Out of these 19 flocks 11 flocks were exposed to high TI intake since one day of age. The general evolutionary observation of the effects of TI antinutritional activity is wet droppings accompanied with feed passage, dirty cloacae, and loss of uniformity. Necropsies of these birds show a consistent nonspecific enteritis and liver damage in every single flock. As the exposure to high TI continues over several weeks feather loss is evident in both males and females during the growing period. Roosters seem severely affected. However, the first exposure of sexually matured flocks to high TI follows basically the same pattern as the growing flocks, but egg production, percent of dirty eggs, fertility, and total hatch were negatively affected. Histopathology of the 19 flocks not only confirmed the nonspecific enteritis, but also consistently underlined the presence of liver toxicity suggesting mycotoxins as one of the several possible etiological agents. However, the routine analysis of white and yellow corn were always below 20 ppb, and the analyses of 15 additional mycotoxins in selected samples were either within normal levels, or not detectable. Only when the TI contents of the feed was reduced in concentration to the "normal" expected levels

contributed by adequately processed SBM (around 2 mg of TI/gram of SBM) the enteritis and feed passage were not observed. Our conclusion is that the TI contents of adequately processed SBM fed to broiler breeders should be at 2 mg/gram of SBM or lower. As the TI contents gets closer to 3 mg/g and higher, feed passage and enteritis are likely to occur at the normal inclusion levels of SBM in corn-soy diets.

Key Words: soybean meal, trypsin inhibitors, broiler breeder

94 Nutritional value of imported corn versus locally produced bronze and white sorghum grain when fed to broiler chicks in Nicaragua. C. Feoli*¹, J. D. Hancock¹, M. G. Viscarra², R. Rodriguez², M. J. Rios², F. J. Baltodano², F. Vargas³, and S. C. Mason⁴, ¹Kansas State University, Manhattan, ²Universidad Nacional Agraria, Managua, Nicaragua, ³Asociación Nacional de Productores de Sorgo, Managua, Nicaragua, ⁴University of Nebraska, Lincoln.

Four hundred sixty-eight 2-d-old broiler chicks (Cobb × Cobb with an avg initial BW of 57 g) were used in a 14-d growth assay to determine the nutritional value of imported corn (US no. 2 with 7.7% CP and 3.6% crude fat) vs. locally produced bronze (CB-8996, a hybrid with 7.9% CP and 2.5% crude fat) and white (Pinolero-1, a variety with 6.7% CP and 2.5% crude fat) sorghum grain. The chicks were allotted to 1.6-m × 2.9-m pens with 26 birds/pen and 6 pens/treatment. Feed and water were consumed on an ad libitum basis. The corn and sorghums were ground through a hammermill (4-mm screen openings) and blended into diets that were formulated to 1.29% Lys, 0.99% Met+Cys, 1.1% Ca, and 0.49% available P. All data were analyzed as a randomized complete block with location within the barn as the blocking term and initial BW as a covariate. Orthogonal contrasts were used to separate treatment means with comparisons of corn vs. the sorghums and bronze sorghum vs. white sorghum. There was no effect ($P > 0.22$) of grain source on average daily gain. However, average daily feed intake was greater ($P < 0.007$) and gain to feed ratio was lower ($P < 0.007$) for chicks fed the corn-based diet compared to those fed the sorghum-based diets. There were no differences in rate of gain or food intake among chicks fed the 2 sorghums ($P > 0.22$), but those fed white sorghum tended to have greater gain-to-feed ratio ($P < 0.09$). For the diets with corn, bronze sorghum, and white sorghum, average daily gain was 24.7, 25.2, and 25.9 g/d, average daily feed intake was 48.5, 45.2, and 43.7 g/d, and gain to feed ratio was 509, 558, and 593 g/kg, respectively. In conclusion, bronze and white sorghums produced in Nicaragua supported equal or greater growth performance compared to imported corn when fed to broiler chicks.

Key Words: broilers, corn, sorghum

Metabolism and Nutrition III: Nutrition

95 Effects of *Echinacea purpurea* fermented juice supplementation through drinking water on performance, serum proteins, and liver enzymes in broilers. Z. Nasir* and M. A. Grashorn, Hohenheim University, Stuttgart, Germany.

Present experiment was conducted to study the effects of *Echinacea purpurea* (EP) fermented juice supplementation through drinking water on broiler performance, serum protein, and liver enzymes. In total, 96

one-day-old broiler (Ross 308) chicks were randomly divided into 8 groups (12 chicks/group). Four randomly selected groups received EP fermented juice at the rate of 0.25 mL/kg^{0.75}/chick/day for 3 days followed by a 9-day interval, while 4 other groups served as control with no supplementation. During the experiment, daily feed intake, weekly weight gain, and daily mortality were recorded. Blood collected on 35th day (at slaughtering) was analyzed to determine the levels of serum total protein, albumin, globulin, ALT, γ -GT, alkaline phosphatase, lactate