

Metabolism and Nutrition II: Ingredients and Protein

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

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

Key Words: broiler, valine, amino acid

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

Two thousand and sixteen Ross x Ross 308 male broilers were fed corn-soybean meal diets supplemented with valine (Val), isoleucine (Ile), glycine (Gly) and glutamic acid (Glu) in a 4 phase feeding program (1 to 7, 7 to 21, 21 to 35 and 35 to 42 d of age). Live performance and post-slaughter responses were evaluated. These amino acids (AA) were supplemented to meet same ratios to lysine (Lys) and/or crude protein (CP, by L-Glu supplementation) levels provided by an industry standard control diet formulated without CP restriction and maintaining recommended Gly+Ser to Lys ratios; Other treatments were constituted by individual or associated synthetic AA supplementations, with consequent less limiting and non-essential AA profile changes, as follow: L-Val; L-Val and L-Gly; L-Val and L-Glu; L-Val, L-Gly and L-Glu; L-Val and L-Ile; L-Val, L-Ile and L-Gly; and L-Val, L-Ile, L-Gly and L-Glu. Therefore, eight treatments with 9 replications of 28 birds were used. An anova and Tukey test at 5% probability was used to determine statistical differences between treatments. No differences on feed intake and mortality were observed, but benefits on body weight gain and feed conversion occurred when Gly and Glu were supplemented. Improvements due to Gly supplementation were mainly observed on early phases of broiler growth, whereas with diets supplemented with Glu occurred

throughout the entire period of study. Carcass, wings and cage yields were similar between treatments. Breast meat yield was higher when broilers were fed with all these AA compared with those fed only Val supplemented diet. Isoleucine supplementation demonstrated importance on breast meat yield. Leg quarters were heavier to the control diet in relation to the other treatments, with exception to the Val and Val plus Gly supplemented treatments. Individual Val and Ile supplementations negatively affected broiler performance and meat yields responses. Advantages in body weight and feed conversion were clearly seen with Gly and Glu supplementation.

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

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

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

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

90 Removed

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

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

Key Words: crude protein, hen performance, economics

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

The objective of this study was to determine amino acid (AA) digestibility of various feedstuffs (corn, soybean meal (SBM) and meat and bone meal (MBM)) using the precision-fed cecectomized rooster assay (PFR), the standardized ileal assay (SID), and a newly developed precision-fed chick assay (PFC). For the PFR, cecectomized roosters were precision-fed approximately 30 g of feed sample and excreta

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

Key Words: amino acid digestibility methods, roosters, chicks

93 Guanidino acetic acid spares arginine in the chick. K. I. Bryant*, R. N. Dilger, C. M. Parsons, and D. H. Baker, University of Illinois, Urbana.

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

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

94 Effect of fermentation on the nutritional value of thevetia peruviana cake. J. A. Olupona*¹ and J. O. Atteh², ¹Federal College of Animal Health & Production Technology, Institute of Agricultural Research & Training, Ibadan, Oyo, Nigeria, ²University of Ilorin, Ilorin, Kwara, Nigeria.

Thevetia peruviana (yellow oleander) grows in temperate climate throughout the world and is abundant in the tropics where it is grown as

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

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

95 Effect of graded inclusion levels of wheat, corn and triticale dried distiller's grains with solubles on growth performance and breast muscle weight in broilers. M. Oryschak^{*1}, D. Korver², A. Pishnamazi², and E. Beltranena^{1,2}, ¹Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ²University of Alberta, Edmonton, AB, Canada.

Ethanol production in Canada is expected to increase dramatically in the near future in response to government mandated 'green' content in gasoline. This is likely to increase local inventories of dried distiller's grains and solubles (DDGS). Replacing more expensive feedstuffs in broiler rations with DDGS might allow feed costs to be reduced while maintaining productivity. The effect of either 5 or 10% inclusion of wheat, corn or triticale DDGS was compared to a wheat-soybean meal control in a 42-d performance study. Diets were formulated to contain similar levels of AME, CP and digestible Lys and met or exceeded recommended concentrations for all other nutrients in the starter (d0-14), grower (d14-28) and finisher (d28-42) periods. Separate test diets were formulated for each period of the study and each was fed to a minimum of 4 pens of male and of female broilers in each of 4 blocks, in a randomized incomplete block design. Birds were weighed as a pen and feed disappearance measured on a weekly basis in order to allow average daily gain (ADG) and average daily feed intake (ADFI) to be calculated. Feed-to-gain (F:G) and gain-to-feed (G:F) ratios were subsequently calculated from weekly ADG and ADFI. Breast muscle

weight (BMW) and percentage yield (BPY) were determined on d 37 by randomly selecting 5 birds from each pen, which were then individually weighed, euthanized and dissected to remove the breast muscles. Expected gender differences in ADG, G:F and weekly weights (WW) were observed between males and females in all 6 weeks of the study ($P < 0.05$). Treatment did not significantly affect WW, ADG, ADFI, F:G or G:F in the overall study ($P > 0.05$). Male BMW was higher (428 vs. 385g) and BPY lower (19.2 vs. 18.8%) compared to females, but treatment had no effect on either BMW or BPY ($P > 0.05$). Our results suggest that wheat, corn and triticale DDGS can be successfully included at levels of up to 10% in practical broiler rations with no detrimental effect on performance, BMW or BPY.

Key Words: DDGS, performance, broiler

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

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

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

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

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

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

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

97 Production performance of two strains of laying hens fed different levels of camelina meal and flaxseed. A. Y. Pekel*, P. H. Patterson, R. M. Hulet, N. Acar, T. L. Cravener, D. B. Dowler, and J. M. Hunter, *The Pennsylvania State University, State College*.

An experiment was conducted to determine the effect of different levels of camelina meal (CM) and flaxseed (FS) on egg production and body weight of two strains of laying hens. Two hundred and ninety four Hy-Line W36 (W36) and two hundred and ninety four Hy-Line Brown (Brown) hens were allocated to a completely randomized block arrangement of seven diets (7 replications per diet) for three consecutive phases (22-26, 26-30 and 30-34 wk). Treatments consisted of increasing levels of FS (1, 2 and 3%) and CM at 3 times more than the FS (3, 6 and 9%) to equal the same dietary omega-3 levels as FS for phase-1. For phase-2 and phase-3, levels of both FS and CM increased 2 and 3 times compared to phase-1 to observe the cumulative diet effects. Body weight, hen-day egg production, feed consumption and feed conversion were measured at 26, 30 and 34 wk. Both W36 and Brown hens consuming the CM (6, 12 and 18%) respectively at 22-34 wk had decreased feed consumption ($P < 0.0001$) while only W36 hens had decreased body weight ($P < 0.0001$). Brown hens fed CM had decreased egg production ($P < 0.0001$) compared to the corn-soybean diet for the entire of the study (22-34 wk). Increased levels of CM (9, 18 and 27% respectively) in phase-3 decreased the feed consumption ($P < 0.0001$), egg production ($P < 0.0001$), and body weight ($P < 0.0001$), regardless of bird strain, whereas decreased egg mass and poorer feed conversion was only observed for W36 hens compared to corn-soybean diet. In conclusion, supplementation of CM up to 9% between 22-34 wk of age did not have any detrimental effect on performance of the hens regardless of the strain. However, more than 12% CM caused significantly reduced performance of the birds both compared with the corn-soybean and FS diets. Flaxseed diets to 9% inclusion level had no negative impacts on hen performance within the time frames of this evaluation.

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

98 Dietary camelina meal vs. flaxseed with and without supplemental copper for broiler chickens: Live performance and processing yield. A. Y. Pekel*, P. H. Patterson, R. M. Hulet, N. Acar, T. L. Cravener, D. B. Dowler, and J. M. Hunter, *The Pennsylvania State University, State College*.

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

Data from the present study demonstrated that either 10% CM or FS can be used throughout the first 3 weeks for broilers with little detrimental effect on growth performance. Furthermore, these results suggest that the addition of Cu sulfate resulted in improved performance of birds fed the corn-soy control and 10% CM diets. Addition of 150 ppm Cu from Cu sulfate to diets containing 10% FS had no beneficial effect on growth performance to 21 d or processing yield.

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

99 Influence of origin on nutritional and quality parameters of soybean meal. G. G. Mateos*¹, S. Sueiro², M. Hermida², P. G. Rebol-lar¹, M. P. Serrano¹, and R. Lázaro¹, ¹*Universidad Politécnica de Madrid, Spain*, ²*Laboratorio de Mouriscade, Pontevedra, Spain*.

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

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

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

Canola meal (CM) is a high quality protein source with an excellent amino acid balance for poultry. However, the level of CM inclusion is often limited in laying hen diets due to evidence of a reduction in feed intake and egg size, and an increase in hen mortality with the use of higher levels. Part or all of these effects may relate to amino acid digestibility and/or the level of glucosinolates in CM. Knowledge and use of amino acid digestibility in feed formulation and much lower levels of glucosinolates in CM suggest that there may be no need for a limit on

the use of CM in laying hen diets. The objective of this research was to determine the effect of graded levels of low glucosinolate CM, up to complete replacement of soybean meal, on the performance of laying hens. Wheat-based diets were formulated on a digestible amino acid basis with 4 levels of CM (0 to 16.7%) and fed to 3 commercial laying hen strains, Lohmann Brown (LOH), ISA Brown (ISA), and Lohmann LSL (LSL). Rations were fed from 19 to 59 wks of age, with egg weight, specific gravity and feed intake measured at 4 wk intervals. Overall, level of CM inclusion had no effect on hen body weight gain, feed intake, feed to egg mass ratio, egg weight or egg specific gravity. Hen-day egg production was also not affected by CM but hens fed all diets including CM laid numerically more eggs than those fed the wheat-soybean meal control diet ($P=0.0512$). Although not statistically significant, hens fed the highest level of CM had the highest mortality ($P=0.0933$). Hen-day production and mortality were similar for all strains, but there were significant differences amongst genotypes for egg shell quality traits. There were no interactions between level of CM inclusion and bird strain. In conclusion, complete replacement of soybean meal in laying hen rations with CM did not affect hen performance but the effect of high levels of CM on mortality requires further investigation.

Key Words: brown-shelled layers, canola meal, egg production

101 Effects of the addition of whole sorghum on the productive and digestive responses of broiler chickens. S. Gómez*, M. L. Angeles, M. A. Islas, and V. Mondragón, *CENIDFyMA - INIFAP, Colón, Querétaro, México.*

An experiment was carried out to evaluate the productivity, breast yield, ileal digestibility of nutrients, organ weights, mucine production and the activity of malatase and sacarase on the mucosa of the small intestine of broiler fed diets in which 20% whole sorghum was included. Birds were allocated individually and were kept on the experiment during 28 days, from 20 to 48 days of age. There were four treatments given by the combination of 2 diets based either on ground sorghum or corn (GS or GC) and the inclusion of 20% ground or whole sorghum (20GS or 20WS). The average daily weight gain, feed intake, feed conversion ratio and breast yield were similar among treatments. However, the ileal digestibility of dry matter ($P < 0.05$) and energy ($P < 0.10$) were lower for 20WS. The weight of the proventriculus and gizzard were greater for 20WS ($P < 0.05$). The amount of total acid mucines (ug of Alcian blue), the acid mucines present per square centimeter per g of the mucosa and the acid mucines per g protein were greater for WS. The total maltase activity was higher for GS-20GS than for GS-20WS

(diet and form interaction, $P < 0.05$). In summary, the results indicate that the ileal digestibility of dry matter and energy were lower and the concentration of acids mucines was greater on the small intestinal mucosa of broiler chickens when 20% whole sorghum was included, however there was not any negative effect on growth performance and breast yield. The results suggest that is feasible to include up to 20% whole sorghum in the ration of finisher broiler chickens as a mean to reduce the cost of feed processing.

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

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

This study was conducted to evaluate the chemical composition and determine the values of apparent metabolizable energy (AME) and apparent metabolizable energy corrected by nitrogen balance (AMEn) of cassava root, leaf of the cassava plant and the branch of the cassava plant. Initially considered was the composition of ingredients and their contents of dry matter (DM), crude protein (CP), mineral matter (MM), ether extract (EE), crude fiber (CF) neutral detergent fiber (NDF) and acid detergent fiber (ADF). After, one metabolism assay was conducted with Japanese quail (*Coturnix japonica*) with twenty days of age, using the method of total excreta collection. 160 birds were allocate in cage system and distributed in a completely randomized design with four replicates and ten birds per experimental unit. The experimental treatments consisted of a reference diet and three other diets composed of 70% of reference diet and 30% of each food test. The assay lasted for 8 days, 4 days of adaptation and 4 days for excreta collection. The chemical composition of the cassava products were: 86.40, 1.82, 2.36, 1.00, 6.99, 4.23 and 3.10% for cassava root; 83.99, 22.48, 3.31, 55.63, 41.63 and 18.39% leaf of the cassava plant and 85.11, 19.52, 5.90; 2.46, 61.81, 42.49 and 24.35% for the hay stems of the cassava plant, for DM, CP, MM, EE, NDF, ADF and FB, respectively. The values of AME and AMEn were: 3,306 and 3,058 kcal/kg for cassava root; 1,626 and 1,373 kcal/kg for leaf of the cassava plant; and 1,524 and 1,448 kcal/kg for branch of the cassava plant, respectively.

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

Processing, Products, and Food Safety I

103 Penetration of *Salmonella enteritidis* through the yolk membrane in eggs from six genetically distinct commercial lines of laying hens. R. K. Gast*¹, D. R. Jones¹, K. E. Anderson², R. Guraya¹, J. Guard-Bouldin¹, and P. S. Holt¹, ¹USDA-ARS, Egg Safety and Quality Research Unit, Athens, GA, ²North Carolina State University, Raleigh.

Infected laying hens can deposit *Salmonella enteritidis* inside developing eggs and thereby transmit disease to humans. Although deposition of *S. enteritidis* inside yolks is less common than deposition in the albumen or on the yolk (vitelline) membrane in naturally contaminated eggs, migration across the membrane to reach the nutrient-rich yolk contents

could lead to extensive bacterial multiplication. Previous studies using *in vitro* egg contamination models determined that penetration into yolks to produce significant growth can occur during storage at warm temperatures, but not when eggs are refrigerated. The present study used an *in vitro* egg contamination model to assess the ability of small numbers of *S. enteritidis* to penetrate the vitelline membrane and multiply inside yolks of eggs laid by six genetically distinct commercial lines of hens during 24 hours of storage at 30° C. Eggs from each line were tested at four different hen ages by inoculation of approximately 100 cfu of *S. enteritidis* onto the outside of the vitelline membranes of intact yolks in plastic centrifuge tubes and then adding back the albumen into each tube