Effect of expanded cottonseed meal on laying performance, egg quality, concentrations of free gossypol in tissue, serum and egg of laying hens. C. Yuan*, H. H. Song, Q. He, and X. T. Zou, Feed Science Institute, Zhejiang University, Hangzhou, China.

Three hundred sixty Hy-Line brown hens at 40 wk of age were randomly allocated to 5 treatments, each of which included 4 replicates of 18 hens. After an expanded process of cottonseed meal (CSM), free gossypol (FG) content in CSM was decreased from 1.24 to 0.40 g/kg. The dietary treatments were corn-soybean meal based diets supplemented with 6% CSM and 6, 8, and 10% expanded cottonseed meal (ECSM). The experiment lasted 9 wk. Results were analyzed by general linear models using SPSS. Hens fed 8% ECSM had higher \((P < 0.05)\) laying rate and average egg weight than those fed 6% CSM. ADFI increased as the levels of ECSM increased, and hens fed 10% ECSM had highest \((P < 0.05)\) ADFI. Birds fed 6% CSM and 10% ECSM had lower \((P < 0.05)\) albumen height and Haugh unit than those in other groups. Hens fed 6% CSM diets produced egg yolks with severe \((P < 0.05)\) discoloration. Concentrations of FG in yolk \((0.200 \text{ mg/kg})\) and albumen \((0.103 \text{ mg/kg})\) and tissues \((0.442 \text{ mg/kg}, 0.385 \text{ mg/kg} \text{ and 0.250 mg/kg in the liver, kidney, and muscle, respectively})\) of the 6% CSM group were greater \((P < 0.05)\) than those in any ECSM treatments \((0.068 \text{ mg/kg}, 0.033 \text{ mg/kg}, 0.182 \text{ mg/kg}, 0.160 \text{ mg/kg} \text{ and 0.039 mg/kg in yolk, albumen, liver, kidney, and muscle of 6% ECSM group, respectively}, 0.093 \text{ mg/kg}, 0.055 \text{ mg/kg}, 0.258 \text{ mg/kg}, 0.195 \text{ mg/kg} \text{ and 0.089 mg/kg in yolk, albumen, liver, kidney, and muscle of 8% ECSM group, respectively}, 0.155 \text{ mg/kg}, 0.075 \text{ mg/kg}, 0.350 \text{ mg/kg}, 0.297 \text{ mg/kg and 0.142 mg/kg in yolk, albumen, liver, kidney, and muscle of 10% ECSM group, respectively}).\) Hens fed 6% CSM and 10% ECSM had the highest \((P < 0.05)\) FG concentrations in the liver compared with those in the kidney and muscle, and higher \((P < 0.05)\) FG residues in yolks than those in albumen. There was significant \((P < 0.05)\) interaction between dietary levels of ECSM and different samples in concentrations of FG. In conclusion, FG in CSM can be reduced by 68% through an expanded process and ECSM can be available in laying hens at up to 10% of the total diet and an appropriate replacement of soybean meal with ECSM may improve performance in laying hens.

Key Words: egg quality, expanded cottonseed meal, gossypol, laying hen, laying performance

Effect of main cereal and mean particle size of the diet on the pattern of voluntary feed intake in brown egg laying hens. A. Pérez-Bonilla1, M. de Vega-Téllez2, B. Saldaña1, P. Guzmán2, and G. G. Mateos*1, 1Camar Agroalimentaria, S. L., Toledo, Spain, 2Departamento de Producción Animal, Universidad Politécnica de Madrid, Madrid, Spain.

An experiment was conducted to study the effect of main cereal and mean particle size (MPS) of the diet on particle size preference of 48-wk-old hens. The experiment was completely randomized with 10 treatments organized as a \(2 \times 5\) factorial with 2 main cereals (barley vs. corn) and 5 particle sizes that resulted from grinding the cereal with a hammer-mill provided with a 4-, 6-, 8-, 10-, or 12-mm screen. Each treatment was replicated 5 times and the experimental unit was an enriched cage with 10 birds. Diets were fed to the hens from 0600 h (lights turned on) to 1400 h. Feed intake and MPS of the feed remaining in the feeder were measured per replicate at 2-h intervals. At the start of the experiment (0600 h), the MPS was higher for the barley than for the corn diets (1,369 vs. 1,168 um; \(P < 0.001\)). As expected, the MPS increased as the screen size of the mill increased from 4 to 12 mm \((P < 0.001)\). The MPS of the diets decreased significantly with time \((P < 0.001)\), indicating that hens chose coarse particles when allowed to do so. The reduction in MPS observed was more pronounced for the first periods of the test than for the last periods controlled \((P < 0.001\) for the interaction). Also, the reduction in MPS with time was more pronounced in hens fed barley than in hens fed corn \((P < 0.001\) for the interaction). The uniformity of the feed particles, as measured by the geometric standard deviation (GSD) was lower in the feed formulated with barley in the feed formulated with corn \((P < 0.001)\). However, the differences in feed uniformity between both types of diets were reduced with time \((P < 0.001\) for the interaction). We conclude that laying hens have a preference for large particle components of the diets. Consequently, when no extra feed is added to the feeder, feed texture change with time.

Key Words: barley, corn, hen performance, mean particle size, pattern intake

Influence of glycerolin and lecithin inclusion in the diet on productive performance of brown-egg laying hens from 23 to 47 weeks of age. H. A. Mandalaw1, A. Pérez-Bonilla2, J. García2, D. Menoyo1, and G. G. Mateos*1, 1Departamento de Producción Animal, Universidad Politécnica Madrid, Madrid, Spain, 2Camar Agroalimentaria S. L., Toledo, Spain.

In total, 480 Lohmann brown-egg laying hens were used to study the inclusion of raw glycerolin (Gly), a by-product of the ethanol industry, and lecithin, a by-product of the biodiesel industry, on productive performance and egg quality. There were 6 diets based on corn, soybean meal with 4% supplemental fat that contained 2,750 kcal AME/kg, 16.5% CP, and 0.73% digestible Lys. The diets were arranged as a \(2 \times 3\) factorial with 2 levels of glycerol (0 and 7%) and 3 levels of lecithin (0, 2, and 4%). In these diets lecithin substituted same amount of animal fat. Each treatment was replicated 8 times and the experimental unit was a cage with 10 hens. Productive performance was recorded by replicate every 28-d and cumulatively from 23 to 47 wk of age. Egg quality was measured in 12 eggs per replicate, chosen at random from eggs produced the last 2 d \((n = 6)\) of each of the 6 periods. The data were analyzed as a completely randomized design and main effects (glycerolin and lecithin level) and the interactions were determined. Productive performance and egg quality traits were not affected by the inclusion of Gly in the diet except for FCR per kilogram of eggs and BW gain that were reduced when hens were fed the diets containing 7% Gly \((P < 0.01)\). The substitution of animal fat by lecithin increased egg weight \((59.6 \text{ vs. 61.3 g})\) and egg mass production \((56.6 \text{ vs. 58.8 g})\) and improved FCR per kilogram of eggs \((2.076 \text{ vs. 2.024})\) \((P < 0.01)\). However, feed intake, egg production, and BW gain were not affected. Also, yolk color was increased when lecithin was included in the diet. It is concluded that the inclusion in the diet of up to 4% lecithins as a replacement of animal fat improved egg production and egg quality whereas the inclusion glycerolin at a level of 7% reduced feed efficiency and BW gain.

Key Words: glycerolin, lecithin, productive performance
142 Lysine requirement of Jing-Hong laying hen pullets from hatch to 8 weeks of age. S. G. Wu, J. Wang*, H. J. Zhang, H. Y. Yue, and G. H. Qi, Feed Research Institute of Chinese Academy of Agricultural Sciences, Beijing, China.

Pullet nutrition can affect laying hen health and performance to a great extent, in which, lysine (Lys) is important for pullets in earlier phase. A study was conducted to evaluate Lys requirement of Jing-Hong pullets during 0 to 4 wk and 5 to 8 wk on aspects of growth performance. Over 1,200 day-old pullets were prepared for the trial, and the trial pullet selection was based on flock uniformity (FU, = 90%). Three hundred birds were randomly allotted to 1 of the 5 treatments, and each treatment consisted of 5 replicates with 5 pens each and 12 birds per pen. The Lys levels are 1.0, 1.1, 1.2, 1.3, and 1.4%. The experiment lasted 28 d (phase I). During this period, the other birds were fed a diet with 1.0% Lys, and from d 29, 300 birds were selected from the unused flock and arranged using the same method, with Lys levels of 0.8, 0.9, 1.1, 1.2, and 1.3%. The second experiment lasted 28 d (phase II). During phase I, the 1.2% Lys group showed higher ADG and final BW than the 1.0, 1.3, and 1.4% Lys groups (P < 0.05), whereas the 1.0 and 1.4% groups showed better FU than the other 3 groups (P > 0.05). No differences were observed on ADFI and feed/gain ratio. The final BW was quadratically correlated with Lys level with the equation: y = −371.929x2 + 906.479x − 287.153 (R2 = 0.727). During phase II, the 0.9% Lys group showed higher ADG than 1.3% Lys group (P < 0.05) and the highest final BW than all the other groups (P > 0.05). The 0.8% Lys had higher ADFI than the 1.1 and 1.2% Lys groups (P > 0.05). The 1.3% Lys group lowered the FU compared with the 0.9 to 1.2% Lys groups (P > 0.05), in which the 0.9 and 1.1% Lys groups had the highest values. After hatch, we expect the pullets to grow strong soon in the early phase, and after that, a fine FU is important for the controlling of the age at first egg. Based on these considerations, the present results suggest that Lys levels at 1.2% and 0.9% are optimum for pullets at the age of 0 to 4 wk and 5 to 8 wk, respectively.

Key Words: Jing-Hong laying hen, pullet, lysine requirement, body weight, flock uniformity

143 Effect of nutrient density on performance, egg quality and profits in laying hens during 24 to 32 weeks of age. M. Afrouziyeh* and A. Pourali, Department of Animal Science, Tabriz Branch, Islamic Azad University, Tabriz, Iran.

The concept of feeding economically optimal concentrations of nutrients based on diminishing returns functions is not new but has rarely been used in nutrition. The objective of this experiment was to determine the effect of increasing both dietary energy and other nutrients on performance, egg quality, and profits in Hy-line W-36 laying hens during 24 to 32 wk of age. Hy-line W-36 laying hens were randomly assigned into 6 treatments (4 replicates of 8 birds/replicate). Experimental diets with different energy levels (including 2.515, 2.615, 2.715, 2.815, 2.915, and 3.015 Mcal/kg) were fed to hens. Nutrient levels were kept in a constant ratio to energy level. The influence of dietary nutrient density on performance and egg quality were investigated. Data were fitted to quadratic equations by using Excel polynomial regression to express egg mass and feed consumption in terms of energy density. The optimization model and conventional linear programming was solved using the solver of Excel. Dietary energy concentration had a significant effect on feed conversion ratio and egg mass. Increases in energy and nutrient density improved egg mass and feed conversion ratio (P < 0.05). However, egg quality characteristics were not affected by energy concentration (P > 0.05). In the equation of laying hens’ feed consumption and egg mass response to energy density during 24 to 32 wk of age, the R2 were 0.9971 and 0.9773, respectively. The sensitivity analysis for nonlinear programming showed that if the protein level of the diet was changed from 14.96 to 13.96%, the cost of the diet would decrease by $0.0272/kg from $0.3547 to $0.3275/kg. Because egg prices and ingredient prices often change, there can be no fixed optimal nutrient density for optimal profits.

Key Words: egg, laying hen, nutrient, profit

144 Effects of graded levels of dietary gossypol on growth performance, serum biochemical parameters and gossypol residue of 15- to 35-day-old duck. Q. Zeng*, M. Afrouzi, J. Wang1, X. Ding1, Y. Luo1, S. Bai1, X. Wu1, L. Zhao2, S. Lin2, and K. Zhang1, 1Institute of Animal Nutrition, Sichuan Agricultural University, ChengDu, Sichuan, China, and 2ChengDu Feed Measure Center, ChengDu, Sichuan, China.

The objective of this study was to determine the effects of dietary gossypol from cottonseed meal (CSM) on growth performance, serum biochemical profiles and gossypol residue in grower ducks. Fourteen-day-old ducks were randomly allocated to 5 dietary treatments (10 replicate pens; 18 ducks/replicate). The 5 experimental diets were formulated to produce diets in which 0, 25, 50, 75, and 100% of proteins from soybean meal were replaced with that from CSM, and the corresponding analyzed free gossypol concentration in 5 diets were 0, 36.4, 75.2, 100.7, and 152.9 mg/kg, respectively. Daily BW gain and feed to gain ratio linearly decreased (P < 0.01) with the increase of dietary free gossypol during the whole experimental period. Serum alanine aminotransferase (ALT) activity and creatine content linearly increased (P < 0.05), and the ratio of aspartate aminotransferase to ALT linearly decreased (P < 0.05) with increasing level of dietary gossypol at 28 d of age. Serum total protein, albumin and globulin were decreased (P < 0.05) and the ratio of albumin to globulin was increased (P < 0.01) in a linear manner by increasing level of CSM in the diets at 35 d of age. As gossypol concentrations of the diets increased, the concentrations of gossypol in liver, kidney, heart, leg and breast muscle increased linearly (P > 0.001), with the liver having the highest residue of gossypol followed by kidney, breast muscle, heart, and leg muscle. These results suggested that duck at the age of 14 to 35 d should be fed diets with free gossypol concentration below 36.4 mg/kg.

Key Words: duck, growth performance, gossypol, gossypol residue, serum biochemical profile


Soybean meal (SBM) is the main source of indispensable amino acids in poultry diets. Factors such as growing conditions of the beans, crushing plant, and length of storage of beans and meals affect nutrient content, amino acid profile, and protein quality variables. This research studied the differences in nutritive value of SBM from the 3 main countries that supply meals to the EU-28. Chemical composition of 497 batches of SBM and the correlations between analytical values and protein quality of 3 different origins: USA, (n = 186), Brazil (BRA; n = 152), and Argentina (ARG; n = 159) were studied. Samples were collected during a 7 yr period directly in the country of origin (66%) or at arrival of the vessel at European ports. On DM basis, meals from USA had more CP (53.5, 53.2, and 51.7%), sucrose (8.22, 6.44, and 7.61%) and stachyose (6.44, 5.23, and 5.61%) and less NDF (53.5, 53.2, and 51.7%), sucrose (8.22, 6.44, and 7.61%) and stachyose (6.44, 5.23, and 5.61%) and less NDF (53.5, 53.2, and 51.7%) than SBM from other countries.
from ARG and BRA ($P < 0.001$). Crude protein content was negatively related with sucrose (-0.70, $P < 0.001$) for USA meals and with NDF (-0.64 and -0.43, $P < 0.001$) for ARG and BRA meals. Phosphorus content was higher for USA than for ARG and BRA (0.78, 0.75, and 0.70% $P < 0.001$) and was positively related (0.60, 0.27, and 0.31, $P < 0.01$) with CP content of the meals. Trypsin inhibitor activity (TIA, 3.49, 2.81, and 2.93 mg/g), PDI (19.5, 16.3, and 5.3%), and KOH solubility (86.4, 81.5, and 82.6%) were higher ($P < 0.001$) for USA than for ARG or BRA meals. PDI and KOH were positively related (0.66 and 0.61, $P < 0.001$) with TIA. In addition, USA meals had more Lys (3.30, 3.22, 3.15%), Met+Cys (1.54, 1.49, 1.49%), Thr (2.10, 2.06, 2.03%), and Trp (0.73, 0.71, 0.71%) than BRA and ARG meals ($P < 0.001$). Lys content (% CP) was negatively (0.49, $P < 0.001$), positively (0.30, $P < 0.001$), or not related with CP content for USA, BRA, and ARG meals, respectively. It is concluded that the nutritive value of SBM varied widely among origins and that country of origin of the beans should be specified in feed tables for accurate nutritive evaluation and use in formulation of poultry diets.

Key Words: chemical composition, origin, protein quality, soybean meal

146 New low-fiber canola. Part 1: Chemical and nutritive composition of meals from yellow-seeded Brassica napus canola and canola-type Brassica juncea mustard. A. Rogiewicz1, M. Radfar1, J. Jankowski2, D. Hickling3, and B. A. Slominski1, 1University of Manitoba, Winnipeg, MB, Canada, 2University of Warmia and Mazury, Olsztyn, Poland, 3Canola Council of Canada, Winnipeg, MB, Canada.

Brassica napus is the most commonly grown canola species in Canada. Selection for yellow seed coat color has been a priority in canola breeding in an attempt to increase the oil content in the seed and to reduce the fiber content in the meal. The objective of the current study was to evaluate the chemical and nutritive composition of pre-press solvent extracted meals derived from newly developed low-fiber, yellow-seeded B. napus canola and canola-quality, yellow-seeded Brassica juncea mustard. The meal derived from conventional black-seeded B. napus canola served as a control. In comparison with the conventional meal, yellow-seeded B. napus and B. juncea meals contained (DM basis) more crude protein (43.4 and 47.2 vs. 41.1%), more sucrose (10.1 and 8.0 vs. 6.6%), less neutral detergent fiber (19.0 and 18.5 vs. 25.2%), less acid detergent fiber (9.3 and 9.9 vs. 20.1%), and more total dietary fiber (29.8 and 28.9 vs. 35.0%), respectively. Lower fiber content was reflected in a lower content of lignin with associated polyphenols (3.1 and 5.3 vs. 10.1%). B. napus yellow and B. juncea contained less fat (3.5 and 4.0 vs. 5.1% DM) and ash (7.3 and 8.0 vs. 8.5% DM) than the B. napus black, respectively. The highest content of all essential amino acids (except cysteine) was observed in B. juncea meal which was due to its higher protein content. The level of glucosinolates of all 3 canola meals was relatively low. The meals from yellow-seeded B. napus and B. juncea canola, however, still contained more glucosinolates that the conventional meal (14.6 and 12.5 vs. 7.9 μmol/g). In comparison to the conventional meal, superior quality characteristics (i.e., lower dietary fiber and increased CP and sucrose contents) of the meals derived from yellow-seeded canola would contribute to the improved nutritive value of canola meal.

Key Words: B. napus canola, B. juncea canola, chemical composition, dietary fiber

147 New low-fiber canola. Part 2: Nutritive value of Brassica napus and Brassica juncea meals for broiler chickens and turkeys. M. Radfar1, A. Rogiewicz2, D. Mikulski2, K. Kozłowski2, J. Jankowski2, Z. Zdunczyk1, R. Patterson4, and B. A. Slominski1, 1University of Manitoba, Winnipeg, MB, Canada, 2University of Warmia and Mazury, Olsztyn, Poland, 3Institute of Animal Reproduction and Food Research, Olsztyn, Poland, 4Canadian Bio-Systems Inc., Calgary, AB, Canada.

Earlier research from this laboratory, as documented in the accompanying Part 1 of this series, has demonstrated superior quality characteristics (i.e., increased protein and sucrose and reduced dietary fiber contents) of newly developed yellow-seeded Brassica napus canola and canola-quality, yellow-seeded Brassica juncea mustard. As opposed to our earlier research, this is the first time that the respective meals were obtained from a large-scale, pre-press solvent extraction process. The objectives of this research were to determine amino acid digestibility and available energy contents to be further used in the validation growth performance studies with broiler chickens and turkeys. Standardized ileal total amino acid digestibility of B. napus yellow, B. juncea, and the conventional B. napus black canola as determined with broiler chickens (21 d of age) and turkeys (28 d of age) were, respectively, 82.5, 83.2, and 81.8% for broilers and 76.2, 76.4 and 78.0% for turkeys. Apparent metabolizable energy (AME) values for yellow B. napus, B. juncea, and the conventional black B. napus canola meal as determined with broiler chickens (14 to 19 d of age) and turkeys (35 to 40 d of age) were, respectively, 1,865, 2,092, and 1,902 kcal/kg of DM for broilers and 2,170, 2,276, and 2,088 kcal/kg of DM for turkeys, respectively. Enzyme (multicarbohydrase) supplementation resulted in AME values of 2,131, 2,264, and 1,851 kcal/kg of DM for broilers and 2,264, 2,267, and 2,196 kcal/kg of DM for turkeys, respectively. The nutritive value of canola meals was further validated in a growth performance study with turkeys from 1 to 56 d of age fed wheat/soybean meal-based diets containing 20% of canola meals. All diets were balanced for digestible amino acids and available energy contents. No significant differences ($P > 0.05$) in BWG and FCR were observed indicating that all types of canola meal could effectively replace SBM in turkey rations providing that the diets are formulated based on digestible amino acids and available energy contents.

Key Words: canola meal, nutritive value, broiler chicken, turkey, enzyme supplementation

148 Algae biomass increases apparent amino acid digestibility using a Cobb 500 broiler model. A. M. Evans1, A. M. Evans1, 1West Virginia University, Morgantown, WV, 2Eastern New Mexico University, Portales, NM.

Crude oil prices have dramatically increased in recent years, influencing the development of next generation alternative fuel sources. Algae biomass, a co-product from oil extraction for fuel, has potential as a feed ingredient. The objective of the current study was to determine apparent amino acid digestibility (AAAD) of 6 diet formulations containing incrementally increasing levels of algae biomass using 21d Cobb 500 broilers. A preliminary study was conducted to determine true metabolizable energy and true amino acid digestibility values of algae biomass using intact and cecectomized roosters. These values were used to formulate a practical broiler starter diet containing 21% algae biomass. A diet containing 0% algae biomass was also formulated. Both diets were pelleted at 82°C, ground, and mixed at different ratios to create diets containing 6, 11, 16% algae biomass, as well as a diet containing 0% algae biomass with a green food coloring. Diets were randomly assigned to pens containing 10 broiler chicks and were
fed from d 1 to 21. On d 21, birds were euthanized and contents of the lower ileum were collected and analyzed for amino acid and titanium content. The 16% algae biomass diet demonstrated the highest level of digestible cysteine, whereas all other diets had lower values ($P = 0.0254$). The 16% algae biomass diet demonstrated the highest level of digestible methionine and lysine, whereas diets containing 0 and 0% algae biomass with food coloring demonstrated the lowest levels, with all other diets being intermediate ($P < 0.0001$). The 16% algae biomass diet also demonstrated the highest digestible threonine level, whereas the 21% algae biomass diet demonstrated the lowest level, and all other diets were intermediate ($P = 0.0085$). Ileal digestibility supported true amino acid digestibility data and demonstrated value in practical diet formulations up to 16% inclusion.

**Key Words:*** algae biomass, broiler, apparent amino acid digestibility, titanium oxide, diet formulation

149 Field observation: The trypsin inhibitor content in imported commercial shipments of yellow corn contaminated with raw soybeans may be a contributing factor in outbreaks of rapid feed passage in broiler chickens. N. Ruiz*, J. Castillo², J. F. Suárez³, L. Naranjo¹, and F. de Belalcázar⁴, ¹ Nelson Ruiz Nutrition LLC, Suwanee, GA, ² Jorge B Castillo Consulting Inc., Cambridge, ON, Canada, ³ Albateg, S.A., Funza, Cundinamarca, Colombia, ⁴ Nutriánalisis, Bogotá, Colombia.

The objective of this presentation is to illustrate with quantitative data the levels of trypsin inhibitors (TI) present in shipments of commercial yellow corn contaminated with whole and/or fractions of raw soybeans. A total of 134 samples collected from 134 trucks containing yellow corn from 44 shipments from Argentina, Brazil, Colombia, and the United States between September 2012 and February 2014 were analyzed for trypsin inhibitors. A 5-kg sample was collected per truck from multiple sampling points, ground, and homogenized using a Romer Series II Mill following a sampling protocol for analytes of uneven distribution (Whitaker et al., 2005); a subsample of 1 g was extracted for TI in an alkaline medium at 4°C following the ISO 14902 method. Forty-five percent of the samples tested below the detection limit of 0.20 mg of TI/g of corn, 20% had TI levels between 0.20 and 0.35 mg/g of corn, and 35% showed levels higher than 0.35 mg of TI/g of corn. The difference between the groups was subjected to ANOVA and the differences were statistically significant ($P < 0.001$) using Tukey-Kramer. Given the fact that a correlation between TI in SBM and the occurrence of rapid feed passage outbreaks in broiler flocks fed commercial corn-soy diets has been reported [Poult. Sci. 2005; 84(Suppl. 1):70], we concluded that the contamination of yellow corn shipments with whole and/or fractions of raw soybeans is a factor to consider when investigating a rapid feed passage outbreak in the field.

**Key Words:** trypsin inhibitor, yellow corn, rapid feed passage, broiler

150 Effect of high-temperature ethanol fuel processing on the digestibility of wheat protein derived from various stages of ethanol production in broiler chickens. H. L. Classen*, D. Abbott, and M. Nickerson, University of Saskatchewan, Saskatoon, SK, Canada.

Research was completed to investigate the effect of phases of wheat ethanol production that apply high temperature on amino acid (AA) digestibility in broiler chickens. Wheat feedstock (WF) as well as samples collected post-liquefaction/cooking (PL), post-distillation (PDI); whole stillage) and post-drying (PDR; DDGS, distillers dried grains with solubles) were collected from a commercial ethanol production plant on 3 separate occasions. Liquid samples were freeze-dried and then samples were analyzed for key nutritional characteristics. Samples were also used in an AA digestibility experiment using 18- to 21-d-old broilers (6 reps/trt; 6 birds/rep). Data were analyzed as a 4 (stage of processing) x 3 (date of sample collection) factorial arrangement using the Proc MIXED of SAS version 9.2 (SAS Institute, 2001). Differences were considered significant when $P \leq 0.05$. Nonstarch components of the grain increased after fermentation; therefore, PDI and PDR samples were higher relative to those from WF and PL. The content of individual AA as a proportion of total AA varied in response to processing with some increasing with further processing, others remaining essentially unchanged, and some decreasing. Of relevance, the content of Arg, Lys, and Met decreased by approximately 20% in the DDGS sample compared with the original wheat. Extensive interactions were found between stage of processing and sampling date for AA digestibility, indicating variation in WF and/or processing conditions. In general, liquefaction/cooking negatively affected the digestibility of Asp, Glu, Iso, Leu, Met, and Pro, increased digestibility of His and Phe, and had no effect on the remaining AA. Distillation reduced digestibility of all AA except Ala, Arg, and Iso compared with PL samples. Drying decreased digestibility with only Asp, Glu, and His not being affected compared with the PDI samples. All stages of heat application tested affected the content and digestibility of AA in a negative fashion, indicating the need to consider the level and control of heat application in wheat ethanol production.

**Key Words:** distillers grains with solubles, heat processing, amino acid

151 Use of a broiler chick preference model to evaluate processing and nonessential amino acids to improve the palatability of vegetable proteins to replace fish meal. R. B. Agivale and T. A. Scott*, Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.

A broiler chick preference model has determined significant aversion of diets with vegetable protein [VP; i.e., pea protein concentrate (PPC), canola meal (CM), or canola protein concentrate (CPC)]-based diets as compared with a fish meal (FM)-based diet. In 2 separate experiments, Ross 308 male broiler chicks were given a VP- and a FM-based diet from 0 to 14d. Feed intake was determined weekly and expressed as the ratio of FM to individual VP diets. Diets were isonitrogenous and isocaloric and contained either FM (5%), PPC (15%), CM (10%) or CPC (10%), replacing soybean meal and/or wheat. In experiment 1, each VP-based diet was fed without or with 1 of 3 nonessential amino acids (NEAA) at 0.5%; these were proline (Pro), hydroxyproline (Hyp), and taurine (Taur). Each diet combination was fed to 6 cages of 5 birds. Analysis was a completely randomized design of 3 VP (PPC, CM, and CPC) with (0% NEAA, 0.5% Pro, 0.5% Hyp, or 0.5% Taur); significance was $P < 0.05$ for both studies. When PPC was supplemented with Pro and Taur, there was a significant reduction in aversion to PPC, there was no effect of Hyp. Diets with CM or CPC were more preferred than PPC, and no response to NEAA was observed. In experiment 2, the VP sources (PPC and CPC, no CM) were either nonextruded (NE) or extruded (EX; 30 kg/h, 100°C, with 43 bar pressure, and dried at 100°C for 2.5 min). The completely randomized design included 2 VP sources (PPC and CPC) with or without extrusion for a total of 4 treatments, each fed to 4 cages of 12 birds. There was a tendency for an interaction ($P = 0.10$) between VP source and processing. This indicated that for PPC the preference for FM decreased from 14.9 when PPC was NE to 1.4 with EX ($P < 0.05$); whereas for CPC the ratios were 1.6 NE and 1.3 EX ($P > 0.05$). The aversion decreased during the second week, but
there was still a trend for improvements in palatability of VP with EX. The preference model for assessing palatability and preference for VP indicates it can be a useful tool for assessment of how processing and/or additives may be improved.

**Key Words:** broiler, vegetable protein, preference, nonessential amino acid, extrusion


An experiment was conducted to study the effect of diet (commercial broiler starter vs. commercial pullet starter) and inclusion (wt:wt) of insoluble fiber (0 and 3% sunflower hulls) in the diet on growth performance and energy efficiency (g of BW/1,000 kcal of AMEn) of broilers and pullets from 1 to 21 d of age. In total, 280 one-day-old female broilers (Cobb 500) and 280 pullets (Lohmann Brown) were used. There were 8 treatments arranged factorially (2 fiber levels × 2 type of diets × 2 type of birds) with 7 replicates per treatment. The broiler diet contained 3,000 kcal of AMEn/kg and 9.2% NDF, and the pullet diet 2,900 kcal of AMEn/kg and 11.0% NDF. As expected, growth performance at 7 and 21 d of age was better for broilers than for pullets, and better for birds fed the broiler diet than for birds fed the pullet diet (P < 0.01). Fiber inclusion increased ADFI (P < 0.01) in broilers from 0 to 7 d of age but did not affect growth performance or energy efficiency at any age. The relative weight (RW, % of BW) of the full and empty gizzard were lower in broilers than in pullets at both ages (P < 0.001). At 7 and 21 d of age the RW of the full and empty gizzard increased when fiber was included in the broiler diet but no differences were detected when fed the pullet diet (P < 0.01). Also, at 7 d of age the RW of the GIT, liver, and pancreas was higher in broilers than in pullets but opposite effects were observed at 21 d of age (P < 0.01). The relative length (cm/kg empty BW) of the small intestine was lower at both ages in broilers than in pullets and lower in birds fed the broiler diet than in birds fed the pullet diet (P < 0.001). Feeding the broiler diet to pullets for the first 21 d of life increased growth performance. Fiber inclusion increased ADFI and the RW of gizzard without showing any significant effect on ADG, FCR, or energy efficiency.

**Key Words:** broiler, digestive tract, fiber, growth performance, pullet