

Metabolism and Nutrition: Nutrition III

219 Influence of main cereal and feed form of the diet on performance and digestive tract traits of brown-egg laying pullets from hatching to 17 weeks of age. R. Harzalli¹, B. Saldaña¹, P. Guzmán¹, A. Pérez-Bonilla², J. García², and G. G. Mateos^{*1}, ¹Universidad Politécnica de Madrid, Madrid, Spain, ²Camar Agroalimentaria S.L., Toledo, Spain.

The influence of the main cereal and feed form of the diet on performance and gastrointestinal tract (GIT) traits was studied in brown-egg laying pullets from hatching to 17 wk of age. There were 8 dietary treatments arranged as a 2 × 4 factorial with 2 main cereals (corn vs. wheat with enzymes) and 4 feeding programs that consisted in changing feed form (mash vs. crumble) according to feeding period. Two of the groups were fed the diets as mash or crumble continuously (1 to 17 wk of age) and the other 2 groups were fed crumbles from 1 to 5 wk or from 1 to 10 wk followed by mash to 17 wk of age. Each treatment was replicated 9 times (40 pullets per replicate). No interactions between main cereal of the diet and feed form program were detected at any age and therefore, only main effects are presented. From 1 to 5 wk of age, pullets fed wheat had higher BW gain ($P < 0.001$) and better FCR ($P < 0.001$) than pullet fed corn but the differences disappeared with age. Also at this age, pullets fed crumbles ate less feed ($P < 0.001$) but had better FCR ($P < 0.001$) than pullets fed mash. From 1 to 17 wk, pullets fed crumbles continuously had the highest BW gain of all groups ($P < 0.001$). Also, pullets fed crumbles continuously had better FCR ($P < 0.001$) than pullets fed mash continuously, with pullets from the other 2 treatments being intermediate. At 17 wk of age, pullets fed corn had heavier ($P < 0.001$) GIT and gizzards than pullets fed wheat, but body and small intestine length were not affected. Also, pullets fed crumbles continuously had lower ($P < 0.001$) gizzard and GIT weight but higher ($P < 0.001$) gizzard pH than pullets fed mash continuously. It is concluded that wheat supplemented with enzymes can be used in substitution of corn diets for pullets from 1 to 17 wk of age. Feeding crumbles improved growth performance of the pullets at all ages.

Key Words: corn, digestive organ, feed form, pullet performance, wheat

220 Influence of feed form of the pullet diet and energy concentration of the laying diet on productive performance and digestive tract traits of brown-egg laying hens. B. Saldaña¹, P. Guzmán¹, A. Pérez-Bonilla², J. García², C. E. Gewehr³, and G. G. Mateos^{*1}, ¹Universidad Politécnica de Madrid, Madrid, Spain, ²Camar Agroalimentaria, S.L., Toledo, Spain, ³Universidade do Estado de Santa Catarina, Lages, Brazil.

The influence of feed form of the pullet diet and energy concentration of the laying diet on productive performance and gastrointestinal tract (GIT) traits were studied in brown-egg laying hens from 17 to 48 wk of age. The experiment was completely randomized with 4 treatments arranged as a 2 × 2 factorial with 2 forms (mash vs. crumble) of the feeds fed during the rearing period (1 to 17 wk of age) and 2 levels of energy during the laying period (2,650 vs. 2,750 kcal AMEn/kg). Each treatment was replicated 15 times (an enriched cage with 10 hens). All diets within each rearing and laying phase had similar nutrient content per kcal of AMEn. No interactions between feed form of the rearing diets and energy concentration of the laying diets were detected for any of the variables studied and therefore, only main effects are presented. At the end of the experiment, hens that were fed mash during the rearing phase had higher BWG ($P < 0.001$) than hens that were fed crumbles. An increase in the energy content of the laying diet reduced ADFI ($P <$

0.001) and improved FCR ($P < 0.001$) but egg weight and egg production were not affected. At 48 wk of age, the relative weight (%BW) of the GIT and of the full and empty gizzard was higher ($P < 0.05$) for hens that were fed mash than for hens that were fed crumbles during rearing. However, GIT traits were not affected by energy content of the laying diet. It is concluded that the feed form during rearing did not affect subsequent laying hen performance of the hens. Also, an increase in the energy content of the diet from 2,650 to 2,750 kcal/kg reduced ADFI and improved FCR but had no effects on the other productive variables studied.

Key Words: crumbles, energy concentration, gastrointestinal tract trait, laying hen performance, mash

221 Changes in yolk sac membrane absorptive area and fat digestion during broiler embryonic development. L. Yadgary* and Z. Uni, Faculty of Agriculture, Food and Environment, The Hebrew University, Rehovot, Israel.

The capacity of yolk sac (YS) utilization by the chick embryo may be affected by structural changes in the YS membrane (YSM) and by the mechanisms within its cells for digestion and absorption. To achieve an optimal YS utilization by the embryo, a good understanding of the digestive, absorptive and secretive processes that take place in the YS is needed. We examined 2 aspects of YS utilization- the absorptive area of the YSM tissue and the digestion of lipids by lipase and bile acids. Accordingly, weights of embryo, YS and YSM as well as the total area of the YSM, and the absorptive area of the YSM, were measured in Cobb Broiler embryos between E5 (d 5 of embryonic development) and E21 (day of hatch). In addition, fat content, lipase activity and bile acids concentration in the YSM and YS contents (YSC) were measured between E11 and E21. Results showed that YSM weight increased by 34 fold from E5 to E15, and decreased by 2 fold between E17 and E21. The absorptive area in the YSM increased from 536 mm² on E5 (51% of total YSM area) to 6370 mm² (86% of total area) on E17, and decreased to 4439 mm² on E21 (85% of total area). Lipase activity was detected in the YSM with increasing levels from E15 to E21. In addition, our results confirmed for the first time, that bile acids are present in the YS from E11, with levels that ranged from 0.61 to 1.06 μmole/g in the YSM, and therefore suggest that bile is synthesized in the YSM of the chick embryo. The smaller YSM area between E17 and E21 did not decrease the rate of YS fat utilization which could suggest that YSM mechanisms for fat absorption, digestion and secretion increased during that period. Results of the current study contribute to our understanding of the developmental changes and nutritional needs that affect YS functionality. Further research is needed to elucidate the coordination between the embryo's demands and the morphological, absorptive, digestive and secretive changes in the YSM, to achieve an efficient transfer of nutrients and an optimal development of the broiler embryo.

Key Words: yolk sac membrane, absorptive area, lipase, bile acid, nutrient utilization

222 Prenatal nutritional supplementation by in ovo feeding influences bone structure, composition and mechanical properties of Cobb broilers. R. Yair^{*1,2}, R. Shahar², and Z. Uni¹, ¹Department of Animal Science, Robert H. Smith Faculty of Agriculture, Food and Environment, Hebrew University of Jerusalem, Rehovot, Israel, ²The Koret School of Veterinary Medicine, Robert H. Smith Faculty of

The skeletal system is dependent upon minerals such as P, Cu, Mn and Zn for its proper development. Research in our lab showed that on 19E (embryonic d 19) the yolk, which is the major reserve of minerals, contains low reserves of those minerals and respectively their uptake by the embryo between 19E and hatch is low. The purpose of this study was to examine the effect of prenatal nutritional supplementation by in ovo feeding (IOF) on bone mechanical, compositional and structural properties. For that purpose, 300 eggs were incubated and divided to 2 groups: Enriched (on 17E with a solution containing organic minerals, vitamins and carbohydrates by IOF) and control. Eight eggs per group were randomly selected on 19E and 21E, their yolks were taken for mineral content analysis using ICP-AES and the tibia of each embryo was taken for analysis. Hatchlings were raised and the tibia of 8 chicks per group was taken on 7d, 14d, 28d and 54d for biomechanical testing using a micromechanical testing device. Additionally, structural analysis of the cortical and cancellous parts of the bones was done using a high-resolution μ CT and compositional analysis (for the mineral content of the bone) was done by quantifying the cortical bone ash content. The results show that the IOF enriched group had higher yolk P, Cu, Mn and Zn and exhibited higher uptake between 19E and 21E than the control. Bone analysis showed that on day of hatch and d 14, the enriched group tibia had higher load-to-fracture and ultimate-load than the control. On 7d the tibiae trabecular bone of the enriched group had higher trabecular thickness and bone percent than the control. On d 28 and d 54 the IOF enriched group showed increased bone mineralization. This study demonstrates that IOF with organic minerals, vitamins and carbohydrates elevated yolk mineral content and the mineral uptake by embryos, affected and improved bone properties at least until d 14. Additionally, the elevated mineral content of the enriched group on d 28 and d 54 leads to a potential long lasting improvement in bone properties as a result of the IOF.

Key Words: embryo, bone, tibia, mineral, in ovo feeding

223 Effect of in ovo feeding and programmed nutrition strategy on the growth performance and meat yield of Ross 708 broilers. P. Ferket^{*1}, T. Ao², R. Samuel², R. Malhios¹, M. Ford², A. Pescatore², and A. Cantor², ¹North Carolina State University, Raleigh, ²Alltech-University of Kentucky Nutrition Alliance, Lexington.

Programmed nutrition (PN) relies on conditioning during the first few days post-hatch to improve subsequent nutrient utilization. In ovo feeding (IOF), which advances early development, may benefit PN. Male Ross 708 broilers were assigned to a 2 × 3 factorial arrangement of 2 hatchery treatments (IOF versus control) and 3 dietary treatments (control, 72 h conditioning diet (PN Post Hatch Broiler Chick Starter, Alltech Inc.) followed by PN diets, or only PN diets). Each treatment was replicated by 8 pens of 22 birds. Embryos were injected into the amnion at E18 with either 600 μ l of IOF solution with Marek's vaccine (IOF) or with 100 μ l Marek's vaccine using the Inovoject IOM (Pfizer, Durham, NC). Eighteen hours after hatch, each hatchery group was placed in floor pens assigned 1 of the 3 dietary treatments. The PN diets contained lower levels of ME, minerals, and vitamin E than the control diets. In ovo feeding increased body weight (BW) by ~1.5% at hatch, and reduced BW shrinkage after 12 h of transport by ~10% ($P < 0.005$). There were no significant hatchery × diet interaction effects observed. Relative to controls, IOF increased 42 d BW (2,725 g vs. 2,636 g, $P < 0.005$), reduced BW CV (8.0 vs. 10.1%), and improved 1–42 d FCR (1.58 vs. 1.63, $P < 0.005$), but without effect on % carcass meat yield. Relative to controls, the 72hr conditioning diet improved

10 d BW (220 g vs. 187 g) and 1–10 d FCR (1.28 vs. 1.59), but the PN diets resulted in inferior 42 d BW (2,646 g vs. 2,738 g, $P < 0.005$) and 1–42 d FCR (1.63 vs. 1.58, $P < 0.005$); although the conditioning diet reduced this treatment difference. Breast meat yield was increased most by PN with conditioning in comparison to controls (28.0 vs. 26.9%, $P < 0.005$). The additive benefit of IOF and PN with conditioning resulted in superior growth performance and meat yield in comparison to controls.

Key Words: in ovo feeding, programmed nutrition, growth performance, meat yield, broiler

224 Comparison of the true check in vitro screening method for normal and reformulated diets containing increasing levels of Allzyme SSF versus measured AME. R. S. Samuel^{*1}, P. B. Becker², M. J. Ford¹, A. H. Cantor¹, A. J. Pescatore¹, and T. Ao¹, ¹Alltech-University of Kentucky Nutrition Research Alliance, Lexington, ²Alltech Inc., Nicholasville, KY.

The True Check in vitro screening method (Alltech Inc.) has been developed to simulate the digestion of feeds by poultry by replicating major areas of digestion. True Check measures reducing sugar and phosphate released due to the addition of Allzyme SSF. The objective of this project was to compare the results obtained from True Check versus animal performance results measured from the same diets fed to broilers. To evaluate additions of Allzyme SSF to normal and reformulated wheat-based diets, 8 dietary treatments representing a 2 × 4 factorial arrangement of 2 nutrient levels and 4 enzyme levels (0, 200, 400 or 600 g/T) were designed. The normal ME diet was formulated to provide all nutrients equal or greater than the recommendations of NRC for broilers. The low ME diet was reformulated to contain 0.1% less available phosphorus and total calcium and 75 kcal/kg less ME than the normal ME diets. Day old male broiler chicks (n = 384) were randomly assigned as 8 replicates/treatment of 6 chicks per cage raised for 21 d. An internal marker was included for the measurement of AME. True Check samples were analyzed in triplicate and the results were averaged. Animal performance data were analyzed as a factorial arrangement for the main effects of Allzyme SSF inclusion and nutrient level and the interaction. Free phosphate and reducing sugars increased when Allzyme SSF was added to the normal diet, except at 600 g/T. For reformulated diets, a numerical increase in reducing sugar release from 200 and 400 g/T inclusion rates compared with the control and a significant increase in reducing sugar release from 600 g/T inclusion of Allzyme SSF was observed. A significant ($P < 0.01$) interaction indicated greater energy uplift due to Allzyme SSF in the reformulated diets compared with the normal diets. Reducing sugar content predicted ($P = 0.01$) the measured AME of normal ($R^2 = 0.20$) and reformulated ($R^2 = 0.20$) diets. In conclusion, both methods demonstrated a curvilinear response to additions of Allzyme SSF where maximum benefit was observed at 400 g/T in reformulated wheat-based diets.

Key Words: enzyme, AME

225 Effect of inclusion levels of different plant proteins sources on preference and palatability in broiler chickens. R. B. Agivale^{*}, E. Y. Opoku, and T. A. Scott, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

Negative preference and palatability for plant protein (PC) based diets has been observed; although this was reduced with age, it was still evident in 21 d old broilers. The present study was designed to measure the influence of 3 inclusion levels of 4 PC based diets on preference and palatability. A total of 360 Ross 308, male broilers (0–14 d) were

randomly distributed into 12 treatments (6 broilers for each of 5 cages per treatment). The experiment was a completely random block design (4×3) that compared 4 sources of plant protein (PC) [canola protein concentrate (CPC); pea1 (PPC1); pea2 (PPC2); and canola meal (CM)] fed at 3 levels (low, medium and high) in a separate feeder than a diet containing 5% fish meal (FM). Diets were formulated to be nutrient equal and fed ad libitum. When birds were choice fed with 12 (4×3) PC diets against FM diet, there were significant ($P < 0.05$) difference in growth ($CPC \geq PPC1 > PPC2 > CM$). The preference for FM diets was higher when choice fed with PC diets ($PPC1 = PPC2 > CM = CPC$); indicating maximum aversion for the diet containing pea proteins from 0 to 14 d. With increased inclusion level of PC, significantly ($P < 0.05$) higher aversion ($lowCPC = CM = PPC2 > PPC1 = PPC1+PPC2$) and feed intake ($FM \geq CPC \geq CM > PPC2 > PPC1 = PPC1+PPC2$) was observed. When both pea diets were offered simultaneously, preference for PPC1 over PPC2 was observed. Based on this result, further studies will be done to evaluate different processing and/or additive treatments to identify methods to improve palatability of PC-based diets.

Key Words: canola protein concentrate, pea protein concentrate, canola meal, fish meal, preference

226 Influence of replacing different levels of corn with sweet potato root meal on the performance and meat quality of broilers. R. C. Beckford*, J. R. Bartlett, E. G. Rhoden, V. A. Khan, M. A. McHugh, and K. M. Liles, *Tuskegee University, Tuskegee, AL*.

The amount of corn available for animal and poultry feed has been reduced in recent years. As a consequence, there has been an increase in the price of feed, chicken, and chicken by-products. Researchers are exploring alternative feed sources that could be substituted for corn in the diet of poultry. This study evaluated the performance and nutrient content of broilers fed diets containing sweet potato root meal (SPRM). After a complete nutrient analysis of the SPRM, diets were formulated where 0, 10, 20, and 30% of corn was substituted for SPRM. The study utilized 360 1-d-old Cornish Rock male broilers randomly assigned to one of 4 treatments (diets A = 0%; B = 10%; C = 20%; and D = 30% SPRM). Body weights and feed intake were monitored weekly for 7 wk. Birds were slaughtered on d 50 and feed intake (FI), BW gain, average daily gain (ADG), average daily intake (ADI), abdominal fat, dressing percentage, and internal organ weights were measured. White (breast) and dark (leg and thigh) meat were evaluated for nutrient content (protein, moisture, fat, and ash). Results showed no significant differences among treatments for FI, ADG, and FE. Birds fed diet D had higher ($P < 0.05$) BW gain (2,938.60 g) and ADG (59.97 g) than diet C with 2617.14 g and 53.39 g, for BW gain and ADG, respectively. There were no differences in dressing percentage among treatments. Abdominal fat was highest ($P < 0.05$) in birds fed diet D. Organ weights were similar across treatments. Moisture, protein, and ash content of white meat were not different among treatments. However, fat content was lower ($P < 0.05$) in birds fed diet A (2.16%). For dark meat, protein and ash content were similar among treatments, while moisture and fat were different ($P < 0.05$). Birds fed the SPRM diets compared well with those fed the control for both performance and nutrient content of meat.

Key Words: sweet potato root meal, broiler, performance, alternative ingredient, nutrient content

227 Evaluation of *Camelina sativa* meal as a feedstuff for layers: Effects of increasing dietary inclusion and copper supplementation on egg production and physical egg quality. M. Oryschak*¹ and E. Beltranena^{1,2}, ¹*Alberta Agriculture and Rural Development,*

Edmonton, AB, Canada, ²*University of Alberta, Edmonton, AB, Canada.*

The effect of increasing dietary inclusion of expeller-pressed camelina meal (CAM; 32.6% CP, 11.5% fat, 35.6 $\mu\text{mol/g}$ total glucosinolates) was studied in Brown Nick hens ($n = 288$; H&N International) housed 4 per test cage in an egg layer battery (668 cm^2/hen). Treatments consisted of diets containing 0, 5, 10, 15, 20 or 25% CAM, either with or without supplemental copper (125 ppm Cu) in a 2×5 factorial arrangement, which were fed to 6 replicate cages in a RCB design. Phase 1 diets (22–46 wk of age) were formulated to contain 2.8 Mcal AME/kg, 2.4 g AID Lys:Mcal AME, 3.70% Ca, 0.43% available P and other AID AA in recommended ratios to Lys. Egg production was measured daily, average egg wt weekly, and BW and ADFI every 4 wks. Yield of egg components (shell, yolk, albumen) and objective egg quality (e.g., specific gravity, albumen height) were determined from eggs sampled midway through the 24-wk study period. All data were analyzed using the MIXED procedure of SAS. Models included the fixed effects of CAM inclusion, copper supplementation and the 2-way interaction, with block as the random term. For the overall 24-wk study, increasing dietary CAM inclusion linearly reduced ADFI, feed efficiency and laying percentage ($P < 0.01$). Increasing CAM inclusion also linearly reduced average egg weight and daily egg mass production ($P < 0.01$), which was attributable to a linear decrease in albumen wt ($P < 0.05$). Supplemental Cu increased ADFI ($P < 0.01$), average egg wt ($P < 0.01$) and daily egg mass production ($P < 0.01$), but slightly reduced lay percentage ($P < 0.05$) over the 24-wk study period. These results indicate a reduction in AME and digestible AA with increasing CAM inclusion in the diets.

Key Words: camelina meal, laying hen, performance, egg quality, copper

228 Solvent-extracted vs. expeller-pressed *B. napus* and *B. juncea* fed to layers: effects on feed intake, egg production and physical egg quality. M. Oryschak*¹ and E. Beltranena^{1,2}, ¹*Alberta Agriculture and Rural Development, Edmonton, AB, Canada,* ²*University of Alberta, Edmonton, AB, Canada.*

The effect of dietary inclusion of solvent-extracted (SE) or expeller-pressed (EP) *B. napus* (BN) or *B. juncea* (BJ) meal was studied in Brown Nick hens ($n = 96$; H&N International) housed 4 per cage in a conventional battery (668 cm^2/hen). Diets containing 20% of either SE or SP BN or BJ in a 2×2 factorial arrangement were fed to 6 replicate cages in a RCB design. Phase 1 diets (22–46 wk of age) were formulated to contain 2.8 Mcal AME/kg, 2.4 g AID Lys:Mcal AME, 3.70% Ca, 0.43% available P, and other AID AA in recommended ratios to Lys. Egg production was measured daily, average egg wt weekly, and BW and ADFI every 4 weeks. Yield of egg components (shell, yolk, albumen) and physical egg quality (specific gravity, albumen height, etc.) were determined on eggs sampled midway through the 24-wk study period. All data were analyzed using the MIXED procedure of SAS. Models included the fixed effects of extraction method (SE vs. EP), canola species (BN vs. BJ) and the 2-way interaction, with block as the random term. There was no effect of extraction method or canola species on ADFI ($P > 0.10$) for the study period, however feed efficiency was higher for SE compared with EP ($P < 0.05$). Laying percentage tended ($P < 0.10$) to be higher for BJ compared with BN, but was unaffected by extraction method ($P > 0.10$). Average egg wt was higher for SE BN compared with the other 3 regimens ($P < 0.01$). Daily egg mass production was not different between SE and EP for BJ ($P > 0.10$), but was lower for EP compared with SE for BN ($P < 0.05$). Specific gravity, albumen height and pH of yolk and albumen were unaffected by treatment ($P > 0.10$). These results indicate that all 4 canola products are

well tolerated by laying hens at high (20%) dietary inclusions. Further research into sources of variability affecting nutrient digestibility in EP canola meal is required to optimize use of this ingredient for poultry.

Key Words: canola meal, laying hen, performance, egg quality

229 Effect of fat and oil source on performance, carcass fatty acid composition, ileal lipid and dry digestibility and energy metabolism in broilers. R. A. Swick^{*1}, M. L. Pauvert¹, S. B. Wu¹, and B. Vanselow², ¹University of New England, Armidale, NSW, Australia, ²Dept Primary Industries, Armidale, NSW, Australia.

A study was conducted to evaluate the impact of feeding diets containing different sources of fat/oil on bird performance, fat digestibility, carcass fatty acid composition and energy metabolism. Two hundred 40 Ross 308 d-old male chicks were allocated to 4 dietary treatments in a completely randomized design. There were 24 floor pens of 10 birds each with 6 replicates per treatment. Data were analyzed by one-way ANOVA using Proc GLM of SAS with means separated using Duncan's Multiple Range test where appropriate. Diets contained canola oil (C), linseed oil (L), marine fish oil (M) or tallow (T), at 70 g/mt from 0 to 14d and 75 g/mt from 14 to 35d. On d22, body weights of birds (BW, g) for C, L, M and T were 1286^{ab}; L: 1322^b; 1236^a; 1285^{ab} respectively ($P < 0.05$). No differences in (BW) were observed on d14 or d35 or FCR on d14, d22 or d35 ($P > 0.05$). Levels of DHA (C22:6 n-3) mg/100g tissue for C, L, M and T were breast: 34^a, 52^b, 370^c and 49^b ($P < 0.05$); thigh: 33^a, 54^a, 423^b and 57^a ($P < 0.05$). Ileal digestibility coefficients on d35 for C, L, M and T were fat: 0.89^a, 0.93^a, 0.92^a and 0.67^b ($P < 0.05$) and dry matter: 0.79^b, 0.84^a, 0.83^a and 0.79^b ($P < 0.05$). Grower diet apparent metabolizable energy AME and heat production was measured by total excreta collection and gas exchange on d 25 and 26 in 12 chambers (2 birds each) by removing 1 bird from each floor pen above. AME values (kcal/kg as is basis) for C, L, M and T were 3104, 3048, 3129 and 3049 with no treatment differences detected ($P > 0.05$). Heat production values (kcal/kg bw^{0.7}/d) for C, L, M and T (as measured by gas exchange using the Brower equation) were 190^b, 198^{ab}, 203^{ab} and 210^a. In conclusion, the results show major differences in body composition between birds fed different sources of fat/oil and while no differences in dietary AME were detected between treatments, birds fed tallow produced more heat than those fed canola oil.

Key Words: fat/oil, DHA, AME, heat production, Brower equation

230 Impact of applying energy equations on diet costs for broilers. A. Helmbrecht^{*}, Evonik Industries AG, Health and Nutrition, Hanau, Germany.

Energy is the main cost driver in animal diets. Optimization according to the requirement for metabolizable energy (ME) is established in poultry. ME is in poultry calculated as the difference of gross energy contained in feed and excreta. Data can be regressed to the crude or digestible nutrient content of individual raw materials. Various regression equations have been published either for poultry in general (WPSA, 1989; Beyer et al., 2003) or separately for broilers and laying hens (CVB, 2004; Rostagno et al., 2011). All equations are based on digestible nutrients. Digestible CP was considered by all authors, digestible ether extract and N free extract is contained in all equations except Beyer et al. (2003), who used digestible starch, sugar and N free residue instead. Table 1 shows ME values for corn, soybean meal (48% CP) and meat-and-bone meal (48% CP) either calculated accordingly to the mentioned formulas, based on the same nutrient contents (INRA, 2002) and digestibility coefficients (WPSA, 1989), or measured in vivo (INRA, 2002). Differences mainly

results from differences in formula constituents; another source are conversion factors in cases joule had to be calculated to calorie (INRA, 2002; Beyer et al., 2003; CVB, 2004). Feed optimization for male broilers from 23 to 35 d [nutrient recommendations according to Aviagen (2007) and AminoChick (2012)] containing 3,100 kcal ME/kg show the effect of even small differences in ME content on diet costs (raw material costs from February 2013), which sum up to about 20 USD/ton. Variance in proximate analysis and inaccuracy in conversion N to CP (16% in general) affected the development of all regression equations. The conversion from MJ to kcal additionally affects the ME content of raw materials. The aforementioned factors should be considered when comparing different equations and their effect on diet costs.

Table 1.

	WPSA (1989)	INRA (2002)	Beyer et al. (2003)	CVB (2004)	Rostagno et al. (2011)
Corn	3322	3189*	3407	3322	3323
Soybean meal, 48% CP	2212	2228*	2173	2212	2212
Meat-and-bone meal, 48% CP	2376	2530*	2478	2375	2377
Diet cost, US\$/ton	319.40	341.70	310.37	319.40	319.01

*Measured in growing broilers.

Key Words: energy, ME, broiler, feed formulation

231 Hematology, growth indices and performance traits of Guinea fowl (*Numida spp.*) fed rations supplemented with Mexican sunflower leaf (MSL). A. H. Ekeocha^{*1} and P. O. Fakolade², ¹Ondo State University of Science and Technology, Okitipupa, Ondo, Nigeria, ²Osun State University, Osogbo, Osun, Nigeria.

Wheat bran (WB) in Nigeria about 15 years ago had little or no value but presently, due to high cost of conventional energy sources, population explosion, WB presently is a major source of energy for animals. To reduce the high cost of poultry products, there is the need for replacement of some percentages of WB with Mexican sunflower leaves (MSL) which is readily available. An 84-d feeding trial was conducted to evaluate MSL (*Tithonia diversifolia*) as dietary fiber source in keat diets. Five straight diets were formulated to contain the MSL at dietary levels of 0, 1.5, 3.0, 4.5, and 6.0% as a replacement for wheat bran. Ninety (90) day-old keats were randomly allotted to the 5 diets containing 3 replicates per treatment with 6 keats per replicate in a completely randomized design (CRD). Feed and water were provided ad-libitum and routine medications and vaccinations administered. Data were analyzed using descriptive statistics and ANOVA. The study investigated the performance and hematological responses of the birds to the diets. The results shows a significant ($P < 0.05$) decrease in all the parameters measured for performance characteristics. The final body weight, daily weight, daily feed intake and daily protein intake were generally higher in the birds fed control diet (0%MSL). There were significant ($P < 0.05$) differences in daily feed intake and daily protein intake between the control diet and the other groups, while daily weight gain, feed conversion ratio and protein efficiency ratio were not statistically different ($P > 0.05$) across board except at 6% level where there was a fall in weight gain. Digestible crude fiber values significantly ($P < 0.05$) decreased with increasing levels of MSL in the diets while the other digestibility percentages were comparable ($P > 0.05$) in all dietary treatments. Values for the hematological parameters and blood serum chemistry did not deviate ($P > 0.05$) statistically from established normal values for Guinea fowl. The results suggest that MSL could replace wheat bran in

guinea fowl diet up to 4.5% as a dietary fiber source before envisaging significant weight losses.

Key Words: Mexican sunflower, hematology, performance

232 Effect of feeding single cell protein diet, produced from date waste, on the performance of laying hens. H. Najib*¹, S. Aleid², F. Al-Jasass³, and S. Hamad¹, ¹College of Agricultural and Food Sciences, King Faisal University, Al-Hofuf, Saudi Arabia, ²Date Palm Research Center of Excellence, King Faisal University, Al-Hofuf, Saudi Arabia, ³King Abdulaziz City for Science and Technology, General Directorate of Research Grants, Riyadh, Saudi Arabia.

The main objective of this research was to feed microbial protein, produced from date waste to poultry. An experiment was conducted using different levels; 0, 5, 10 and 15% of single cell protein yeast in the diets of laying hens. An intensive chemical analysis and true metabolizable energy determination were performed on the yeast. Based on these analyses an iso-nitrogenous, iso-caloric layer diets were formulated to

feed 60, 35 week old layers. The layers were distributed in 12 cages each containing 5 birds. The treatments were then distributed among the cages. A completely randomized design was adopted. Data of the study were analyzed by the GLM procedure of SAS. Differences among means were tested by Duncan Multiple Range Test. The experiment continued for 24 weeks. The results of the energy determination and chemical analysis of the yeast showed that the True Metabolizable Energy was about 3380 kcal/kg, while the protein content was 48%. This protein was found to be rich in Lysine (1.02%). Level of fat in the yeast was only 6.41%, however, Oleic acid was 43.2% of total fat. Performance of the hens in terms of hen-day egg production, egg mass, egg weight and feed conversion was significantly ($P < 0.05$) better when 5% yeast was included in the ration. However there was a clear indication that addition of 15% single cell protein may be harmful to the birds. It was concluded that adding 5% single cell protein, produced from date waste to the poultry diet, produced no adverse effect to the performance of the birds and may be included in their diet.

Key Words: date waste, single cell protein