Nonruminant Nutrition: Mineral

W224 Bioavailability of copper sources to broiler chicks when fed below the copper requirement. K. C. Klasing* and A. Naziripour, *University of California*, *Davis*.

Tribasic copper chloride (TBCC) has been shown to have better bioavailability than copper sulfate pentahydrate (CS) when fed at levels in excess of the requirement. Our objective was to determine if this relationship holds at levels below the Cu requirement. After depleting Cu levels for 7 d, 3 pens of 4 chicks/pen were fed a purified diet or a sorghum-soy diet supplemented with either 0, 1, 3, 4.5 or 6 ppm Cu. LPS was injected in order to initiate an acute phase response and bioavailability was calculated by common-intercept multiple linear regression. Prior to LPS, TBCC resulted in greater ($P < 0.05$) bioavailability as indicated by weight gain and tendon Cu levels with both diet types. Following LPS injection, TBCC resulted in greater bioavailability based on the plasma acute phase protein, ceruloplasmin ($P = 0.01$; slope ratio = 1.26). Bioavailabilities of the Cu sources did not differ for hematocrit or liver Cu. In general, these results indicate higher bioavailability of TBCC when dietary Cu is deficient in both healthy and inflammatory-stressed chicks.

Key Words: copper, bioavailability, poultry

W225 Effects of tribasic copper chloride on intestinal absorption ability and mucosal immunity of broiler chickens. Y. Ding[1], R. She*[1], H. Bao[1], D. Han[1], Z. Yue[1], J. Tian[1], P. Yu[1], R. Li[1], J. Yin[1], and C. Liang[2], [1]*China Agricultural University, Beijing, China,* [2]*Micronutrients, Indianapolis, IN.*

In recent years there has been increasing interest in the growth-promoting effect and immune-enhancing role of the copper. The objective of this study was to determine the effect of tribasic copper chloride (TBCC) on intestinal absorption ability and mucosal immune responses in chickens. One hundred and eighty 1-day-old broiler chickens were randomly divided into 4 groups, and were fed the following diets respectively: a basal diet with no supplemental copper (negative control), a basal diet + 188 mg of Cu/kg of diet from TBCC (TBCC group), a basal diet + subtherapeutic antibiotics (positive control), and a basal diet + TBCC+ subtherapeutic antibiotics(mixed addition group). Fifteen chickens of each group were randomly selected and killed on day 7, 21, 35, and samples of the duodenum were immediately collected and fixed. The height and width of the villus and the crypt depth were measured and the number of goblet cells, which determined the absorptive capacity of intestine, was counted. The results showed that the TBCC group had significantly increased villus height and crypt depth at the age of 7 day compared with the control group ($P < 0.05$). The number of goblet cells of duodenum was higher ($P < 0.05$) in the TBCC group than in the negative control group at the age of 7 day. The number of intestine intraepithelial lymphocyte (iIEL) cells and the IgA-secreting cells were counted to reflect the mucosal immunity level. The results showed that the numbers of iIEL in duodenum of TBCC group were increased significantly than the control groups ($P < 0.05$) on day 7. In the duodenum, the IgA-secreting cells of TBCC group were increased significantly compared with the other three groups ($P < 0.01$) on day 35. In conclusion, the results of the experiment indicated that TBCC could effectively enhance the small intestine to absorb nutrients and improve the mucosal immunity of the chickens, especially for the young chicks. These findings demonstrated that TBCC could be considered to replace antibiotics in modulation of the immune response for animal health.

Key Words: copper, broiler chicken, absorption ability and mucosal immunity

W226 Productive performance and egg quality of laying hens as a response to dietary copper supplementation. M. J. González*[1], J. J. Bañuelos[1], M. Huerta[1], S. Carrillo[2], and J. M. Cuca[3], [1]*Universidad Autónoma Chapingo*, *Texcoco, México, México*, [2]*INCMNSZ*, *México, DF, México*, [3]*Colegio de Posgraduados*, *Texcoco, México, México*.

This study was carried out to: 1) Evaluate the productive performance and egg quality as a response to dietary copper (Cu) supplementation, and to 2) Calculate the dietary optimal Cu levels to minimize feed conversion (DOLFC) and to maximize egg mass (DOLEM) or profits (DOLP). Methodology: 250 Hy-Line W36 hens, from 23 to 34 weeks of age, were allocated in five treatments with five replicates each. Treatments consisted of five supplemented Cu levels (0, 75, 150, 225 and 300 mg Cu/kg diet) from copper sulfate as a source of Cu. A sorghum-soybean basal diet was calculated to fulfill the Hy Line W36 nutrient requirements. A completely randomized design, with an orthogonal contrast analyses, was used to detect linear and quadratic tendencies of the experimental variables as a response to Cu levels. Econometric and regression models were applied to calculate DOLFC, DOLEM and DOLP. Results of contrast analyses showed ($P \leq 0.05$) linear and quadratic effects on feed intake (FI), egg mass (EM), feed conversion (FC) and laying percentage (LP). The dietary Cu optimal levels were calculated at 129.5 mg Cu/kg diet for DOLFC; 117.1 mg Cu/kg diet for DOLEM, and 120.6 mg Cu/kg diet for DOLP. The DOLP was sensible to egg price variation. A comparison of the dietary Cu optimal levels with the control values for FC (2.07), EM (44.2 g), and LP (79.6%) showed a performance improvement of 13.5%, 13.1% and 11.3%, respectively. Egg quality showed no effect ($P > 0.05$) for egg weight. Nevertheless, height of albumin and Haugh units diminished ($P \leq 0.05$) with increasing dietary Cu levels. Shell thickness improved ($P \leq 0.05$) with Cu supplementation. Conclusions: 1) Dietary Cu supplementation improves productive performance and shell thickness; 2) Dietary Cu optimal levels are specific for each biological or economic goal.

Key Words: hens, copper, performance

W227 Effect of organic trace mineral sources on production and egg quality of white egg laying hens. L. M. Macalintal*, A. H. Cantor, T. Ao, J. L. Pierce, A. J. Pescatore, K. A. Dawson, M. J. Ford, W. D. King, and H. D. Gillespie, *Alltech-University of Kentucky Nutrition Research Alliance*, *Lexington*.

The effects of supplementing white laying hens with graded levels of organic and inorganic sources of Cu, Mn, Fe, Zn and Se on egg production and quality were studied. The organic sources used were proteinates of Cu, Mn, Fe and Zn (Bioplex, Alltech, Inc.) and selenium yeast (SelPlex, Alltech, Inc.). Seven treatments consisted of feeding corn-soybean meal diets alone (basal) or supplemented with Cu, Mn, Fe and Zn at 25, 50, or 100% of the NRC (1994) requirements provided by either inorganic salts or organic sources. Selenium was provided at 0.075, 0.15 and 0.3 mg/kg as either sodium selenite or selenium yeast in the diet containing 25, 50 and 100% of the NRC requirements, respectively. At each stage of growth or production, other nutrient levels were adjusted to meet the dietary requirements. Eight replicate groups of 16 chicks at day 1 of age were randomly assigned to each treatment. At 17 weeks of age, pullets were transferred to laying cages using 12 pullets per replicate and the mineral treatments were continued for 28 weeks of production. Egg quality parameters were assayed monthly on samples of six eggs per replicate group. During the 28 weeks of production, overall body weight gain (465 g/hen), feed intake (93.0 g/hen/d) and hen-day egg

production rate (85.0%) were not affected by treatments. During Weeks 17-20, hens fed organic minerals at 50% of the NRC requirement had higher egg production (94.2%) than those fed the basal diet (90.3%) or inorganic minerals at the 25% level (90.4%). Average egg weight at 26 wk of production was significantly higher for hens fed organic minerals at the 100% rate compared with all other treatments. Compared with the basal treatment, no improvements in shell breaking strength, % shell and specific gravity were observed due to mineral supplementation.

Key Words: trace minerals, mineral proteinates, egg production

W228 Layer excreta mineral content: Organic versus inorganic dietary trace mineral sources. S. Leeson[1], A. E. Sefton*[2], and K. A. Jacques[2], [1]*University of Guelph*, *Guelph, ON, Canada*, [2]*Alltech Inc.*, *Nicholasville, KY*.

Regular inorganic mineral premixes used in layer diets can result in levels of mineral in manure that are of environmental concern. Previous trials have shown that reduced levels of more available organic mineral forms do not harm performance or well being and can substantially reduce manure minerals. This experiment evaluated performance, egg quality and mineral excreta content of Lohmann layers fed inorganic or reduced amounts of organic copper (Cu), manganese (Mn) and zinc (Zn) sources over a laying cycle. Hens (720) at 18 wks of age were randomly allocated to cages of 5 birds assigned to diets containing either inorganic (sulfate) or organic (Bioplex, Alltech Inc.) sources of Cu, Mn and Zn. Mineral concentrations from supplemental sources in the inorganic control and organic mineral diet, respectively, were Cu, 5 and 0.6; Mn, 100 and 12.6; Zn, 60 and 14 ppm. The experiment consisted of 13, 28 day periods. Response variables were egg production, total egg number, egg weight, shell deformation, albumen height, feed intake, body weight, feather scoring and excreta mineral content. The data were subjected to ANOVA with means separated using Tukey's test. In general, diet treatment did not affect bird performance. Body weights, feed intake and feather scores were similar for both treatments ($P > 0.05$). There were marked reductions in the levels of Zn, Mn and Cu in excreta ($P < 0.01$) when birds were fed Bioplex vs. inorganic minerals (Zn, 149 vs. 354; Mn, 116 vs. 407; Cu, 18 vs. 38 ppm). It was concluded that layers performed equally well throughout a laying cycle when fed a diet containing either inorganic or Bioplex mineral sources. There was a very significant decrease in Zn, Mn and Cu in excreta when hens were fed a diet containing Bioplexes during the laying cycle.

Key Words: layers, trace minerals, excreta

W229 The effect of selenium source and supplementation level on vitelline membrane strength and glutathione peroxidase activity in the liver and shell gland of laying hens. A. A. Aljamal*[1], C. A. Fassbinder-Orth[2], and S. E. Scheideler[1], [1]*University of Nebraska-Lincoln*, *Lincoln,* [2]*Creighton University*, *Omaha, NE*.

The objective of this study was to investigate the effects of selenium source and level on production parameters of laying hens, effects on vitelline membrane strength, and effects on GSH-Px activity in the liver and shell gland of hens. A total of 120 White Bovan hens were fed the experimental diets for 8 weeks from 35 to 42 wks of age. A total of 30 cages were used in the trial with 6 cages/ treatment. Cages were blocked by side, north and south, each side with a total of 15 cages. Hens were fed a corn-soybean meal basal diet supplemented with: (0, 0.2 ppm Sel-Plex, 0.2 ppm sodium selenite, 0.4 ppm Sel-Plex, or 0.4 ppm sodium selenite) for a total of 5 dietary treatments, with the basal level of Se in the diet being 0.2 ppm. Feed intake and egg production were measured daily. Egg weights, specific gravity, and Haugh units were taken weekly. Aged and fresh albumen and yolk pH were measured biweekly. The experimental design of the trial was a randomized completely blocked design. Vitelline membrane strength was measured at weeks 5, 6, 7, and 8 of the trial. At the end of the study, 2 hens/ cage were euthanized to measure GSH-Px activity of the liver and shell gland tissues. Feed intake and egg production increased as dietary Sel-Plex supplementation increased in the diet ($P < 0.05$). Dietary treatments had no significant effect on egg weight, specific gravity, Haugh unit, or hen weight. Using Selenite at 0.2 ppm or Sel-Plex at 0.4 had the same effect to improve the VMS ($P = 0.0592$). Using 0.4 ppm Sel-Plex had a significant effect in decreasing the aged albumen pH but this was only significantly different from the treatment supplemented with 0.4 ppm selenite ($P = 0.0577$). Neither Sel-Plex nor selenite had any effect on GSH-Px activity in the liver and shell gland of the hens. Our research indicates that 0.4 ppm Se from Sel-Plex significantly improved egg quality in aged albumen pH and VMS measurements.

Key Words: laying hens, Sel-Plex, egg production

W230 Effects of altered calcium and phosphorus intake on growth performance and bone characteristics in growing pigs. L. A. Pettey*, K. M. Martorana, T. D. Moore, and J. M. Krumheuer, *California Polytechnic State University*, *San Luis Obispo*.

A two stage growth study was conducted to quantify the effects of altered calcium (Ca) and phosphorus (P) levels on growth performance and bone characteristics in growing pigs and to compare the sensitivity of various bones to changes in Ca and P intake. Pigs (n=112; 21.4 kg BW) were randomly allotted by weight to one of two dietary treatment groups: 1) NRC levels of Ca and P as control; and 2) as 1 with Ca and P increased to 120% of NRC. Pigs were fed diets for 2 weeks before six pigs from each group were harvested for collection of all skeletal bones. Increased Ca and P intake had no effect ($P > 0.10$) for ADG or Ca and P content of leg bones. Following the feeding of high and low Ca and P diets, 96 of those pigs were randomly allotted in a RCB design to one of three diets: 1) a corn-SBM based diet as control (0.62% Ca, 0.54% P), 2) as 1 with 0.74% Ca and 0.63% P, 3) as 1 with 10% added soybean hulls to decrease ME by 100 kcal/kg. Prior level of Ca and P intake was used as a blocking factor. Pigs were fed diets for 4-wk prior to collection of all skeletal bones. As expected, soy hull addition increased ($P < 0.05$) ADFI, thus increasing Ca and P intake ($P < 0.05$) compared with pigs fed the control, but similar ($P > 0.10$) to pigs fed a high Ca and P diet. Pigs with increased Ca and P intake (Diets 1 and 2) had greater ($P < 0.05$) ADG compared with pigs fed the control diet. Prior level of Ca and P intake had no effect ($P > 0.10$) on growth or bone traits. Increasing Ca and P intakes tended to increase ($P < 0.08$) the weight of ribs, metacarpal, metatarsal, humerus and femur. On a concentration basis (g/kg) all bones from pigs with increased Ca and P intakes were higher ($P < 0.05$) in ash, Ca, and P compared with pigs fed the control diet. The percentage increase in bone ash most closely correlated to Ca and P intake for rib bones ($R^2 = 0.92$), yet positive correlations were observed for femurs ($R^2 = 0.82$), humerus ($R^2 = 0.78$) and metacarpal/metatarsal bones ($R^2 = 0.74$). Overall, mineral content of specific bones increase differently to increasing levels of Ca and P intake in growing pigs.

Key Words: calcium, phosphorus, bone

W231 Effect of mineral source and mannan-oligosaccharide supplementation on mineral metabolism on young growing pigs. A. Lebel*[1], F. Guay[1], and P. Groenewegen[2], [1]*Universite Laval*, *Quebec, Qc, Canada*, [2]*Alltech Canada*, *Guelph, On, Canada*.

The objective of this study was to evaluate the effect of mineral source and mannan-oligosaccharide supplementation on the digestibility and net utilization of zinc and copper in young growing pigs. Twenty eight barrows (25.7 kg, SEM 1.2) were assigned to one of 4 diets in a randomized complete block design. Corn soybean diets were supplemented with 10 ppm of copper and 100 ppm zinc from organic (Bioplex) or inorganic (Sulfate) sources, and with (0.1%) or without mannan-oligosaccharide (Bio-Mos, MOS) according to a 2 x 2 factorial design. Animals were maintained in individual metabolic crates for an adaptation period of 3 days following by a collection period of 5 days for the total collection of urine and feces. Pigs fed organic mineral supplemented diets had higher feed intake (2,247 vs. 2,068 g/d, SEM 86, $P < 0.05$), copper intake (56.5 vs. 50.7 mg/d, SEM 2.2, $P < 0.07$) and zinc intake (325 vs. 293 mg/d, SEM 10, $P < 0.04$) than those fed diets supplemented with the inorganic minerals. The higher zinc and copper intakes in the organic treatment led to higher copper retention (32.0 vs. 22.4 mg/d, SEM 2.5, $P < 0.01$) and a trend for higher zinc retention (170 vs. 142 mg/d, SEM 10, $P < 0.07$). There was also a trend for a reduction in fecal copper excretion (23.8 vs. 27.7 mg/d, SEM 1.5, $P < 0.09$). These results explain the increased digestibility (45 vs. 56%, SEM 2, $P < 0.01$) and net utilization (44 vs. 55%, SEM 2, $P < 0.01$) of copper when fed in the organic form. However, these effects tended to be more pronounced when the diet did not contain MOS (interaction, mineral form × MOS, $P < 0.09$, without MOS 41 vs. 59% and with MOS 48 vs. 54%, SEM 3 for digestibility; without MOS 40 vs. 57% and with MOS 48 vs. 54% for net utilization). Mineral form and MOS supplementation had no significant effect on zinc digestibility or net utilization. These results suggest that organic mineral supplementation is an effective method to improve the digestibility and net utilization of copper, and reduce its total excretion but these effects would be less pronounced when the diet is supplemented with MOS.

Key Words: copper, zinc, mannan-oligosaccharide

W232 Enrichment of Japanese quail eggs with organic selenium. R. A. Gravena, R. H. Marques, J. D. T. Silva, F. H. Hada, J. Picarelli, J. Roccon, S. A. Queiroz, and V. M. B. Moraes*, *São Paulo State University*, *SP - Brazil*.

The aim of this study was to evaluate the effect of diets supplemented with organic selenium (Se) on the deposition of this mineral in the yolk and albumen of Japanese quail eggs. One hundred 92 quail were randomly distributed into 4 treatment groups with 6 replicates of 8 birds in each pen. The birds were placed on 1 of 4 dietary treatments (0, 0.35, 0.70 and 1.05 mg organic Se/kg feed) for 4 lay cycles. Three eggs were collected per treatment at 56 d. The Se content of egg yolks and albumen were determined using microwave digestion followed by AAS. The Se concentration in egg yolk was not affected by supplementing diets with organic Se ($P > 0.05$). The Se levels in albumen increased linearly ($y = 3.09308 + 9{,}63459x$; $r^2 = 0.52$) with the increase of supplemented Se in diets ($P < 0.0001$), which can be explained by the interaction of organic Se deposition with the proteins in albumen. These results suggest that supplementing the diets of Japanese quail with organic Se can improve the nutritional value of their eggs.

Table 1. Se concentration in the yolk and albumen in quails eggs supplemented with organic Se

	Se concentration		
Se levels (mg/kg diet)	Yolk (µg/kg yolk)	Albumen (µg/kg albumen)	Se concentration in albumen (%)
0	68.60	3.07	–
0.35	89.27	6.47	110.75
0.70	67.25	9.90	222.47
1.05	72.41	13.16	328.66
CV (%)	25.68	46.73	–
P value	0.76^{ns}	0.0001*	–

Key Words: albumen, organic selenium, quail

W233 Improved piglet birth weight by feeding sows an organic trace mineral blend. J. Zhao*[1], L. Greiner[2], M. Vazquez-Anon[1], C. D. Knight[1], and R. J. Harrell[1], [1]*Novus International Inc.*, [2]*Innovative Swine Solutions*.

The objective of this study was to examine the benefits of feeding sows an organic trace mineral blend (OTM, Mintrex, Novus International Inc.) on piglet birth weight and uniformity. Two sister farms with a common grandparent farm were fed either an inorganic control (ITM) or an OTM blend (Zn, Mn, and Cu), which replaced 50% of the ITM, with the target levels of Zn, 165ppm, Cu, 16.5ppm, and Mn, 38.5ppm in final diets. Treatment was initiated at weaning and continued through growing and entry into the breeding herd. After 2.5 years, about 30 litters were selected for each parity (P1, P2, P3+4, P5 and above). Individual piglet weight (within 24 hours after birth and before cross-fostering) was collected in a two-week period in August and December, 2009. The number of total born was not different on selected litters (12.9 vs. 13.0 ± 0.27, $P = 0.84$). The mean piglet weight was greater for sows fed OTM (1.36 vs. 1.25 vs. ± 0.02 kg, $P < 0.001$). Piglet uniformity was not different between treatments ($P = 0.45$). Benefits of OTM on piglet weight were more profound from P2 to P4 with average piglet weight of 1.13 vs. 1.22 kg for P1 ($P = 0.15$), 1.27 vs. 1.38 kg for P2 ($P = 0.04$), 1.23 vs. 1.38 kg for P3+4 ($P = 0.002$), and 1.19 vs. 1.25 kg for P5 and above ($P = 0.50$) for sows fed the control and OTM, respectively. In summary, sows fed OTM had heavier piglets compared to sows fed ITM and there is no difference on piglet uniformity between treatments.

Key Words: birth weights, sow, organic trace mineral,

W234 Dietary calcium affects neonatal bone development and mesenchymal stem cell activity. A. Mahajan[1], L. S. Alexander[1], B. S. Seabolt*[1], D. E. Catrambone[2], J. P. McClung[2], J. Odle[1], T. W. Pfeiler[3], E. G. Loboa[3], and C. H. Stahl[1], [1]*Laboratory of Developmental Nutrition, North Carolina State University*, *Raleigh,* [2]*Military Nutrition Division, US Army Research Institute of Environmental Medicine*, *Natick, MA,* [3]*Joint Department of Biomedical Engineering at University of North Carolina-Chapel Hill and North Carolina State University*, *Raleigh*.

Effects of dietary calcium (Ca) deficiency on skeletal integrity and endocrine parameters are well characterized in growing and mature pigs; however, little work has examined Ca nutrition during the neonatal period. We examined the effects of neonatal Ca nutrition on bone integrity, endocrine parameters, and mesenchymal stem cell (MSC) activity. Neonatal pigs (24 ± 6h post-partum) were pair-fed either a Ca adequate (Ca+) or a 30% Ca deficient (Ca-) liquid formula diet for 18 d. There were no differences in growth rate or feed efficiency based on dietary Ca level and all pigs grew at a rate similar to sow-reared pigs.

As anticipated, Ca deficiency reduced (P < 0.05) both BMD and bone flexural strength. The anticipated increase ($P < 0.05$) in plasma PTH levels was not evident until the end of the study. Surprisingly, dietary Ca level did not affect plasma Ca or 1,25(OH){2} vitamin D concentrations throughout the study. Calcium deficiency reduced ($P < 0.05$) the in vivo proliferation of MSC isolated from bone marrow by approximately 50%. To further assess the impact of Ca nutrition on MSC activity, cells isolated from these pigs were cultured in homologous sera, under both proliferative and adipogenic conditions for 6d. Under proliferative culture conditions, Ca- sera reduced MSC proliferation and Ca+ MSC had greater expression of osteocalcin and Runx2 mRNA. Under adipogenic culture conditions, MSC cultured in Ca- sera had greater Oil Red O staining and Ca+ MSC also had greater Oil Red O staining than did there Ca- counterparts. Ca- MSC cultured with Ca- sera under adipogenic conditions had 2-fold greater expression of PPARG2 mRNA than any other treatment group. Concentrations of calcitropic hormones were not different between Ca+ and Ca- sera, but we identified 22 differentially expressed proteins in these sera. The results indicate that neonatal Ca restriction may have long-term effects on bone integrity via programming of MSC. The results indicate that neonatal Ca nutrition is crucial for bone integrity and suggest that early life Ca restriction may have long-term effects on bone integrity via its effects on MSC activity.

Key Words: calcium, mesenchymal stem cells, pig

W235 Serum from pigs fed a high-Se diet inhibits growth of human lung cancer cells. J. G. Li[1], J. Shi[1], K. N. Wang[1], G. Gao[2], X. J. Xia[1], and X. G. Lei*[1,3], [1]*Int. Ctr. of Future Agriculture for Human Health, Sichuan Agri. Univ.*, *Chengdu, China*, [2]*Chengdu Municipal Ctr for Disease Control and Prevention*, *Chengdu, China*, [3]*Cornell University*, *Ithaca, NY*.

Supranutritional levels of Se may decrease risks of human lung cancer, but may increase risks of diabetes. Pigs are an excellent model for humans. The objective of this study was to determine if serum from pigs fed a high-Se diet inhibited growth of human lung cancer cells. A total of 16 weanling pigs were fed a Se-deficient (0.03 mg Se/kg) corn-soy basal diet and the basal diet plus 3 mg Se/kg (as sodium selenite) for 16 wk. At the end, serum collected from individual pigs was pooled by the treatment groups and filtered through a 0.22-μm membrane for cell culture. While serum insulin and insulin-like growth factor 1 concentrations were similar between the two groups of pigs, serum Se concentration and serum lactate dehydrogenase (LDH) activity was lower ($P < 0.05$) and higher ($P < 0.05$), respectively, in the Se-deficient pigs than those fed 3 mg Se/kg. Based on cell viability, the optimal serum level for the cell growth was 17 and 15%, respectively, for serum from pigs fed the basal diet and the diet plus 3 mg Se/kg. Compared with the Se-deficient serum (16%), the high-Se serum (16%) from pigs fed 3 mg Se/kg decreased ($P < 0.05$) cell viability, promoted ($P < 0.05$) apoptosis, and increased medium LDH activity. In conclusion, serum from pigs fed a high-Se diet may have anti-cancer potential.
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Key Words: selenium, lung cancer, pig, serum, cell culture

W236 Effect of sodium selenite and turmeric powder on Gompertz nonlinear function in broilers reared under heat stress. A. Zeinali*[1], H. Kermanshahi[1], H. Ziaie[2], H. Farhangfar[3], and A. Riasi[3], [1]*Ferdowsi University*, *Mashhad, Khorasan, Iran*, [2]*Agriculture and Natural Resources Research Center*, *Birjand, South Khorasan, Iran*, [3]*Birjand University*, *Birjand, Khorasan, Iran*.

An experiment was conducted to study the effect of organic and inorganic antioxidant on Gompertz nonlinear function in broilers reared under heat stress. So, 180 one-day old chickens (male and female) were used in a completely randomized block design with 6 treatments and 3 replicates. The experimental diets were (T1) control diet ; (T2) control diet + 5 g/kg turmeric powder; (T3) control diet + 10 g/kg turmeric powder; (T4) control diet + 0.3 mg/kg sodium selenite; (T5) control diet + 0.3 mg/kg sodium selenite + 5 g/kg turmeric powder; and (T6) control diet + 0.3 mg/kg sodium selenite + 10 g/kg turmeric powder. Broilers were subjected to heat stress (35°C) during the fifth and sixth weeks. The results showed that diets including 10 g/kg turmeric powder significantly increased final weight (Wf), weight at inflection time (Wt) and time at inflection time (t) ($P < 0.05$). However, the difference between 10 and 5 g/kg turmeric powder levels was not significant. The interaction between selenium and sex was significant on Wf in such a way that male chickens fed with selenium had higher Wf.

Key Words: selenium, turmeric powder, nonlinear model

W237 Modelling the fate of dietary phosphorus in the digestive tract of growing pigs: a way to optimize phytase efficacy in releasing dietary P. M. P. Letourneau-Montminy*[1], A. Narcy[2], M. Magnin[3], and C. Pomar[1], [1]*Agriculture and Agri-Food Canada*, *Sherbrooke, Qc, Canada*, [2]*INRA UR83*, *Nouzilly, France*, [3]*BNA Nutrition Animale*, *Chateau-Gontier, France*.

A mathematical model simulating the fate of all forms of dietary phosphorus (P) in the digestive tract of the growing pig was developed to provide ways to improve dietary P utilization. It was developed using in vitro and in vivo information. Three compartments are distinguished into the model: 1) the stomach in which dietary forms of P can be solubilised and phytic P (PP) hydrolyzed by phytases, 2) the proximal small intestine in which intense absorption occurs and 3) the distal small intestine in which P may form insoluble complexes with calcium that reduces its absorption. Flows between compartments of all forms of P are assumed to follow mass action laws parameterized with experimental data. The prediction capabilities of the model were assessed by comparing actual and simulated apparent total tract digestibility of P (ATTD), considering experiment effect, based on pig published data not used for model development. It revealed adequate prediction of P digestibility in diets supplemented or not with plant or microbial (Aspergillus niger) phytase (ATTDobserved = 5.53 + 0.87 x ATTDpredicted, n=281, nexp=66 R2=0.85, RSD=4.2% relMSPE=9.4%). Model sensitivity and behavior analysis showed that the hydrolysis of PP by phytases is largely dependent on PP solubility. Phytic P enters into the model in non-solubilised forms (PPns) and is then solubilised (PPs) according to the stomach pH. The equilibrium between PPns and PPs is also represented allowing PPns to solubilise after PPs has been hydrolysed by phytase. The simulation of a corn-soybean meal control diet supplemented with 1000 FTU/kg of A. niger phytase resulted in a 60% PP hydrolysis. This diet was used as control to study the effectiveness of phytase in releasing P from phytate. PPs hydrolysis is improved by increasing stomach mean retention time (74%) and by lowering its pH (66%). Based on the present simulation study, PP hydrolysis is mainly limited by the solubilisation of PPns. Further studies are needed to highlight and to quantify the impact of other factors that may interfere with PP solubility in the digestive tract of pigs.

Key Words: modelling, phytase, pigs

W238 Expression of borate transporter (NaBC1) mRNA by growing pigs is sensitive to dietary boron levels. S. F. Liao*, J. S. Monegue, M. D. Lindemann, G. L. Cromwell, and J. C. Matthews, *Department of Animal and Food Sciences, University of Kentucky*, *Lexington*.

Metabolic studies indicate that homeostatic control of elemental B in animals primarily involves the absorption and excretion of borate through gastrointestinal and renal epithelia, respectively. Recently a borate transporter, NaBC1 (SLC4A11), has been identified in the basolateral membranes of mammalian epithelial cells. A nutrient balance study was conducted to determine the effect of B supplementation on DM, N, Ca, and P digestibilities of growing barrows (initial BW=74.0±9.8 kg) commonly fed a corn-soybean meal diet without P supplementation for 12 d and then supplemented with either (n=8) 0 (Basal), 50, or 100 ppm B (prilled sodium borate pentahydrate) for 12 d (7-d adaptation, 5-d collection). Supplementation of B did not affect nutrient digestibilities. To determine (1) if pig jejunal (J) and ileal (I) epithelia, and kidney (K) express NaBC1 mRNA and (2) if expression is sensitive to dietary B concentration, total RNA was extracted from individual tissue homogenates prepared from all the pigs killed at the end of the balance study. The cDNA sequences of the RT-PCR products (130 base pairs each) generated from each tissue shared 100% identity to each other and to the putative pig NaBC1 sequence (GenBank no. XM_001924562). Subsequent real-time RT-PCR analysis quantified the relative amount of NaBC1 mRNA (NaBCl:18S) expressed. Compared to the Basal level, 50 ppm supplemental B tended ($P = 0.11$) to increase (248%) J, did not affect ($P = 0.83$) I, and decreased ($P = 0.02$) K NaBC1 mRNA contents, whereas 100 ppm supplemental B did not affect ($0.23 \leq P \leq 0.42$) the expression by any tissue. The tissue NaBC1 mRNA content did not differ ($P \geq 0.19$) between pigs fed B at 50 vs. 100 ppm. The finding that pig J, I, and K express NaBC1 mRNA is novel. Despite no effect on measured digestibilities, that 50 ppm supplemental B differentially altered NaBC1 mRNA content suggests that NaBC1 expression may be responsive to borate levels in digesta, blood, or both.

Key Words: borate transporter (NaBC1, SLC4A11), nutrient-gene interaction, pig

W239 Evaluating trace mineral level and form in diets fed gilts: effects on ovulation rate, embryonic survival and mineral composition of conceptus products. W. L. Pope[1], B. J. Middendorf[1], H. S. Cárdenas[1,2], D. C. Mahan[1], and K. A. Jacques*[3], [1]*OARDC, Department of Animal Sciences, The Ohio State University*, *Columbus,* [2]*College of Medicine, The Ohio State University*, *Columbus,* [3]*Alltech Inc.*, *Nicholasville, KY*.

Crossbred gilts (n=210) (Large White × Landrace) × PIC boar (line 280) were utilized to examine whether the previously observed increase in litter size after replacing inorganic trace elements with an organic source was due to improved ovulation rate, embryonic survival and/or fetal survival. At 45-kg body weight, gilts were randomly assigned to one of four dietary treatments; 1) industry levels of inorganic trace elements (Cu, 15; Fe, 120; Mn, 40; Zn, 120; Se, 0.3 ppm), 2) NRC levels of organic Cu, Fe, Mn, Zn (Bioplex) and Se (Sel-Plex) (Alltech Inc.), 3) industry levels of organic and 4) 1.5 times industry levels of organic trace elements. Due to space limitations of the barn, the design of this experiment was accomplished in 9 reps over a 2-year period. Within each replicate, the treatments were rotated so that differences due to pens or locations were randomized throughout the experiment. Gilts were individually penned and at about 130 kg were naturally mated at 12 and 24 h after onset of estrus. Boars had at least 3 days rest between matings. Gilts were slaughtered at day 30 of gestation. Resulting conception rate, ovulation rate, total embryos, total live embryos and embryonic survival were unaffected by treatment with overall means of 88.8, 16.9 (corpora lutea), 13.8, 13.6 and 80.3%, respectively. Macro and microelement content of embryonic and endometrial tissues collected at slaughter and of allantoic and amnionic fluids were analyzed in a subset (n=12) of gilts from each treatment group. Amounts of macro and microelements were altered ($P<0.05$) in numerous comparisons of endometrial or embryonic tissues and in allantoic or amniotic fluids of gilts fed organic versus inorganic trace elements. As the form or amount of trace minerals in the diet had no effect on ovulation rate, number of live embryos and embryonic survival, any improvement in litter size must be attributable to events occurring after 30 days of gestation.

Key Words: trace minerals, ovulation rate, fetal survival

W240 Cloning of porcine pancreatic α-amylase gene and characterization of the enzyme over-expressed in *Pichia pastoris*. T. Qin[1], H. Zhao[1], X. Xia[1], and X. G. Lei*[1,2], [1]*Int. Ctr. of Future Agriculture for Human Health, Sichuan Agri. Univ.*, *Chengdu, China*, [2]*Cornell University*, *Ithaca, NY*.

α-Amylase (α-1,4-glucan-4-glucanohydrolase, EC.3.2.1.1) catalyzes the hydrolysis of α-(1,4) glycosidic linkages in starch and various malto-oligosaccharides, and may be used to improve feed carbohydrate utilization by animals. The objective of this study was to develop an efficient expression system to produce porcine pancreatic α-amylase (PPA). The full-length cDNA encoding the PPA was isolated from porcine pancreas by RT-PCR and cloned into the pPICZαA (Invitrogen, Shanghai, China) expression vector. The pPICZαA-PPA plasmid was transformed into *Pichia pastoris* (X33) cells, and transformants were screened by SYBR-green quantitative real-time Q-PCR (ABI 7900HT, Applied Biosystems, Foster City, CA). After the transformants were induced by 0.5% methanol for 3 d, the extracellular PPA protein containing a his-tag appended to the C terminus was purified using Ni Sepharose High Performance affinity column (GE Healthcare, Piscataway, NJ). The purified recombinant PPA showed a molecular mass of approximately 58 kDa, an optimal temperature of 50°C, an optimal pH of 7.5, K_m of 65 mg/ml (soluble starch), and V_{max} of 1.7 mg/min, respectively. After an exposure to 50° for 30 min, the recombinant PPA lost nearly 50% activity. The recombinant enzyme was more sensitive to the inhibition by Cu^{2+} than Fe^{3+}, Ca^{2+}, or Zn^{2+}. In conclusion, we have cloned the PPA gene and produced a relative high level of the functional enzyme in *P. pastoris*.

Key Words: porcine, pancreatic, α-amylase, *Pichia pastoris*, gene expression

W241 Heterologous expression of a truncated bovine lactoferrin gene in *E. coli* to produce a novel antimicrobial peptide. L. H. Sun[1], Y. Liu*1,2, H. Zhao[1], M. Y. Xie[1], J. Xing[1], X. J. Xia[1], and X. G. Lei[1,2], [1]*Int. Ctr. of Future Agriculture for Human Health, Sichuan Agri. Univ.*, *Chengdu, China*, [2]*Cornell University*, *Ithaca, NY*.

Antibiotic resistance has become a major concern for the animal feed industry and human medicine worldwide. As a promising alternative of antibiotics, LfcinB is a peptide of 25 amino acids that originates from the N-terminus (Phe17 to Phe41) of bovine lactoferrin. Because LfcinB has a broad spectrum of potent antimicrobial activity, it is highly toxic to heterologous expression hosts like *E. coli* cells. The objective of this experiment was to develop an efficient expression system to produce an inactive or non-toxic precursor of LfcinB in *E. coli*. A DNA fragment encoding the N-terminal 121 amino acids of bovine lactoferrin that contained the LfcinB peptide was synthesized and inserted into an expression vector pET-30a(+) (Merck, Shanghai, China). The construct

was transformed into *E. coli* strain Rosetta (DE3) cells. As shown by the SDS-PAGE, a truncated bovine lactoferrin with a molecular mass of approximately 19.2 kDa was produced by the transformants, and the yield accounted for 30% of the total cell protein. We are currently investigating if LfcinB can be released from the overly-produced truncated bovine lactoferrin by pepsin at the acid pH in the stomach of animals. In summary, our approach in producing the LfcinB precursor may offer advantages of convenience and cost over other expression systems.
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Key Words: lactoferrin, lactoferricin, gene expression, antimicrobial peptide

W242 Cloning and expression of palustrin-OG1 in *E. coli*. Y. G. Xie*, Y. F. Liu, C. Luan, F. F. Han, and Y. Z. Wang, *Institute of Feed Science, Zhejiang University*, *Hangzhou, Zhejiang, China*.

Palustrin-OG1 is a novel antimicrobial peptide (AMP) isolated from the skin of the frog *Odorrana grahami*. It is a 31 amino acid peptide with antibacterial activities against a broad spectrum of microorganisms, especially against *S. aureus* ATCC 25923. With increasing resistance to existing antibiotics, it is imperative to develop new therapeutics such as AMPs. So far there have been no reports about its structure and antibacterial mechanism. In order to obtain enough amount of palustrin-OG1 for biological and structural studies, the gene encoding mature peptide of palustrin-OG1 was deduced from its amino acid sequence according to the codon bias of *E. coli* and synthesized with the method of gene splicing by overlapping extension PCR(SOE–PCR). Palustrin-OG1 gene was recombined to the expression vector pET32a(+) homologously to construct the recombinant expression plasmid pET32a(+)–OG1. The recombinant plasmid was then transferred into *E. coli* BL21 (DE3) and induced for 3h by IPTG with the final concentration of 1 m*M*. The soluble form fusion protein expressed in *E. coli* was up to 57.97mg/L. After ultrasonic disruption of cells, the soluble protein was purified by nickel column chromatography and desalted through Sephadex G25 column chromatography. Palustrin-OG1 was released from purified fusion protein after cleavage by enterokinase for 16h. The agar diffusion test showed the released palustrin-OG1 exerted activity against *S. aureus* ATCC25923. The integration strategy such as codon bias, homologous recombination and protease cleavage would provide an effective platform for biological and structural studies or production of AMPs as therapeutics.

Key Words: palustrin-OG1, fusion expression, *E. coli*

W243 Activated carbon does not reduce or prevent the effects of zearalenone in gilts. D. Srichana*[1], T. Srichana[2], W. Suttitham[1], P. Panja[1], A. Sumrit[3], and D. R. Ledoux[4], [1]*Department of Agricultural Technology, Faculty of Science & Technology, Thammasat University*, *Pathumtani, Thailand*, [2]*Faculty of Pharmaceutical Sciences, Prince of Songkla University*, *Songkla, Thailand*, [3]*Plant Pathology Research Group, Office of Plant Protection Research and Development, Department of Agriculture*, *Bangkok, Thailand*, [4]*Division of Animal Science, University of Missouri*.

The objective of this research was to produce activated carbon (AC) and evaluate its efficacy as an absorbent for zearalenone (ZEA) in swine diets. Three experiments (Exp.) were conducted to achieve this objective. In Exp. 1, 5 methods (M1 to M5) for producing AC were evaluated and included; M1), coconut shells (CS) treated with KOH (2:1) then heated at 400°C for 1 h and 800°C for 3 h; M2), CS treated with K_2CO_3 (1:1) then heated at 110oC over night and 800oC for 3 h; M3), CS treated with K_2CO_3 (2:1) then heated at 110°C over night and 800°C for 3 h; M4), CS heated at 400°C for 1 h then heated at 800°C for 3 h; and M5), CS heated at 110°C over night and then heated at 800°C for 3 h. Nitrogen gas was let in at 5 l/h during both heat treatments. Methylene blue indexes were not different among the 5 methods ($P > 0.05$), however ash content was different ($P < 0.05$) and ranged from 1.5% for M4 to 3.9% for M1. In Exp. 2, an in vitro procedure was used to evaluate the efficacy of the 5 ACs, from Exp. 1, to adsorb ZEA. The ZEA was analyzed using HPLC-fluorescence. ZEA adsorption by ACs produced by M3, M4 and M5 were not different ($P > 0.05$) and averaged 97%, whereas ZEA adsorption by ACs produced by M1 and M2 averaged 87 and 54%, respectively. Based on these results and production costs, the AC produced by M4 was chosen for evaluation in Exp. 3 which was conducted to evaluate the ability of M4 AC to ameliorate or prevent the effects of ZEA in 19 wk old gilts fed a diet contaminated with ZEA for 4 wks. The treatments were arranged as a 2 × 2 factorial in a CRD (4 replicates). The main factors were levels of AC (0 or 1% in diet) and concentrations of ZEA (0 or 1.165 ppm) in diets. Feed intake and FCR of the gilts were significantly higher ($P < 0.05$) in pigs fed diets containing 1% AC. Diets containing ZEA did not affect production performances, uterus weight and liver weight. The gilts fed diets containing ZEA had red swollen vulvas throughout the experimental period. However, no residues of ZEA or α-zearalenol were found in muscle, uterus or liver tissues of pigs fed ZEA. The data indicated that 1% AC, produced by M4, did not alleviate the effects of ZEA in gilts.

Key Words: zearalenone, activated carbon, gilt

W244 Gender effect on nutrient digestibility and reproductive organ sizes by zearalenone feeding with different levels of Calibrin-Z enterosorbent in young pigs. Z. B. Yang*[1], S. Z. Jiang[1], and F. Chi[2], [1]*Shandong Agricultural University*, *Tai-an, Shandong, PRC*, [2]*Amlan International*, *Chicago, IL*.

We previously reported addition of 1 ppm zearalenone (ZEA) reduced dietary protein (CP) and energy (GE) utilization in gilts and the reduced CP and GE were improved by addition of clay enterosorbent (CE). In present study, a total of 36 pigs (L × Y × D; 18 M, 18 F; 8.84 ± 0.21 kg) were used to study the genders' response to ZEA feeding. Pigs were divided into 6 treatments and fed diets contained 0 or 1 ppm ZEA with addition of different levels of CE (Calibrin-Z). Pigs were fed treatment diets (Table 1) individually in metabolic cages for 21 d. Vulva and testicle sizes were measured at 3-d intervals, and total feces were collected and pooled on 3-d bases for CP, GE, Ca, and P digestibility determination. Vulva sizes increased ($P < 0.01$) with ZEA feeding and the increased vulva sizes were reduced linearly as dietary CE increased. No treatment differences were observed with testicle size in male pigs. No treatment effect was obtained on ADG, ADFI and FE; however, the female pigs showed a poorer FE ($P = 0.01$) than the male pigs. There were differences ($P < 0.01$) on GE, Ca, and P digestibility between treatments but not on CP digestibility. Pigs fed Diet 3 showed lower Ca and P digestibility ($P < 0.01$) as compared with the pigs fed Diet 1. Additions of CE to ZEA contaminated diet improved ($P < 0.01$) GE, Ca, and P digestibility compared with the pigs fed ZEA alone (Diet 3). And the increased nutrient digestibility was improved as the dietary CE levels increased. A gender effect on CP, GE, Ca, and P digestibility ($P < 0.05$) was observed in the study with no interactions between treatments and sexes. For nutrient digestibility, a gender effect was observed with ZEA feeding (Diet 1 vs. Diet 3) where female pigs showed a decrease ($P < 0.01$) of CP digestibility, and male pigs showed decreases ($P < 0.01$) of Ca and P digestibility. The study showed that the reduced nutrient

digestibility by ZEA feeding maybe gender dependent in young pigs. Also, the increased vulva sizes and the reduced nutrient digestibility resulting from ZEA feeding can be ameliorated by Calibrin-Z.

Table 1. Treatments and Results

Treatment	ZEA, ppm	Calibrin-Z, %	Vulva Size, mm^2	DCP, %	DGE, %	DCa, %	DP, %
Diet 1	0	0	52^{c}	88.4	88.4^{c}	67.3^{a}	57.7^{a}
Diet 2	0	0.1	51^{c}	88.6	88.7^{c}	66.8^{ab}	55.8^{cd}
Diet 3	1	0	190^{a}	87.5	88.3^{c}	65.5^{c}	55.0^{d}
Diet 4	1	0.1	142^{ab}	88.2	88.9^{bc}	66.2^{bc}	55.4^{d}
Diet 5	1	0.2	124^{b}	88.3	89.3^{ab}	67.1^{ab}	56.4^{bc}
Diet 6	1	0.4	110^{b}	88.8	89.4^{a}	67.0^{ab}	56.9^{ab}

DCP - digestible CP; DGE - digestible energy; DCa - digestible Ca; DP - digestible P.

Key Words: gender, zearalenone, clay enterosorbent, digestibility, pigs

W245 Effects of dietary *Fusarium* mycotoxins on intestinal lymphocyte subset populations, cell proliferation and histological changes in avian lymphoid organs. C. K. Girish*, T. K. Smith, H. J. Boermans, P. Anil Kumar, and G. N. Girgis, *University of Guelph, Guelph, Ontario, Canada*.

An experiment was conducted to investigate the effects of dietary *Fusarium* mycotoxins on gut immunity, cell proliferation, and histology of avian lymphoid organs. The efficacy of a polymeric glucomannan mycotoxin adsorbent (GMA) was also determined. Seventy-two 1-d-old male turkey poults were fed corn, wheat, and soybean meal-based diets for 21 d. Diets included control grains, contaminated grains and contaminated grains + 0.2% GMA. The major contaminant was deoxynivalenol (DON, vomitoxin; 3.9 µg/g) with lesser amounts of zearalenone (0.67 to 0.75 µg/g) 15-acetyl-deoxynivalenol (0.34 µg/g) and HT-2 toxin (0.078 to 0.085 µg/g). The T and B-lymphocyte populations and crypt cellular proliferation in duodenum, jejunum, ileum and cecal tonsils were measured immunohistochemically on d 14 and 21. Histological changes were recorded after 14 and 21 d of feeding. Feeding contaminated grains significantly ($P = 0.004$) increased the percentage of B-lymphocytes in ileum on day 14, and reduced ($P = 0.04$) the percentages of $CD8^{+}$-lymphocytes in cecal tonsil on d 21. GMA supplementation prevented these effects. The feeding of contaminated diets also caused a reduction ($P = 0.03$) in ileal crypt proliferating cells and a significant (P=0.003) increase in spleen secondary follicle on d 21. In conclusion, feeding grains naturally contaminated with *Fusarium* mycotoxins results in adverse effects on gut immunity and mucosal cell proliferation. The feeding of GMA can prevent some of these effects.

Key Words: *Fusarium* mycotoxin, intestinal lymphocyte, immunohistochemistry, lymphoid organ, turkey

W246 Effects of purified zearalenone on serum metabolites and antioxidant status in young gilts. S. Z. Jiang[1], Z. B. Yang*[1], and F. Chi[2], [1]*Shandong Agricultural University, Tai-an, Shandong, PRC*, [2]*Amlan International, Chicago, IL*.

The study was designed to investigate the adverse effects of dietary zearalenone (ZEA) on oxidative stress and organ damage in young female pigs. A total of 20 gilts (L × Y × D; 10.36 ± 1.21 kg BW) were fed a commercial diet for 7 d adaptation and then divided into 4 groups. Diets were a corn-soy-fishmeal based with an addition of 0, 1, 2, or 3 ppm ZEA to the basal diet. Pigs were fed the test diets ad libitum for 18 d. All measurements and analyses were based on individual pig. Vulva length, width, and height were measured at 4-d intervals. Serum samples were collected for enzyme activities and antioxidant status analyses. Genital organs, liver, kidney and spleen were isolated, weighed, and the relative organ weights were calculated. Results showed that gilts fed different levels of ZEA had no effect on weight gain and feed intake. The vulva length, width and height were increased linearly as dietary ZEA concentrations increased ($P < 0.01$). Relative organ weights including genital organs, liver, and kidney weights were increased linearly as dietary ZEA increased ($P < 0.01$). Serum aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, γ-glutamate transferase, urea, and creatinine in the serum were all linearly increased as dietary ZEA increased in test diets ($P < 0.05$). Malondialdehyde concentrations in both serum and liver were also increased linearly by increased dietary ZEA ($P < 0.001$). Unlike the liver and kidney, relative spleen weight was decreased linearly as dietary ZEA concentrations increased ($P < 0.01$). Activities of total superoxide dismutase and glutathione peroxidase in the serum and liver ($P < 0.05$) were also reduced linearly as dietary ZEA increased. Results suggested that besides genital organs, the liver, kidney and spleen may also be target tissues in young gilts fed diets containing 1 to 3 ppm ZEA for 18 d. The reduced relative spleen weights suggested potential detrimental effect on pig immunity by feeding ZEA. Elevated key liver enzymes in the serum suggested a progressive liver damage by feeding ZEA, and the damage was probably mediated by the lower antioxidant enzymes in the liver and serum.

Table 1. Serum markers and relative organs weights of gilts fed diets with various levels of ZEA

	0 ppm-ZEA	1 ppm-ZEA	2 ppm-ZEA	3 ppm-ZEA
Aspartate AT, U/L	40.1^{b}	44.6^{b}	53.5^{ab}	66.9^{a}
Alanine AT, U/L	49.5^{c}	55.0^{bc}	62.5^{ab}	66.0^{a}
Alkaline phosphatase, U/L	221.0^{c}	245.6^{b}	264.7^{b}	298.4^{a}
γ-glutamate transferase, U/L	32.2^{c}	35.8^{bc}	38.0^{b}	48.7^{a}
Urea, mmol/L	2.8^{c}	3.8^{bc}	4.2^{b}	5.3^{a}
Creatinine, µmol/L	71.2^{c}	86.1^{bc}	89.7^{ab}	96.3^{a}
Genital organ, g/kg BW	$.33^{d}$	$.53^{c}$	$.74^{b}$	1.16^{a}
Liver, g/kg BW	30.2^{b}	33.4^{b}	36.7^{ab}	44.3^{a}
Spleen, g/kg BW	2.20^{a}	2.10^{ab}	1.90^{bc}	1.83^{c}

AT - aminotransferase.

Key Words: zearalenone, serum enzymes, oxidative stress

W247 A survey of free and conjugated deoxynivalenol in the 2008 Ontario corn crop. S.-T. Tran*[1], G. Stewart[2], and T. K. Smith[1], [1]*University of Guelph, Guelph, ON, Canada*, [2]*Ontario Ministry of Agriculture, Food and Rural Affaires, Guelph, ON, Canada*.

Deoxynivalenol (DON, vomitoxin), one of the most important mycotoxins produced by many *Fusarium* species, is found as a common contaminant of crops worldwide. DON can reduce production efficiency and cause serious economic losses to livestock and poultry producers. Recent studies have described the presence of conjugated forms of DON (glycosides and fatty acid). The aim of the current study was, therefore, to investigate the natural occurrence of free and conjugated DON in Canadian corn. Free and conjugated DON were determined by HPLC and ELISA kits (AgraQuant DON kit) in 86 corn samples collected from the 2008 Ontario crop. Free DON was found in all samples and concentrations determined by ELISA were similar to values determined

in most samples using HPLC. Conjugated DON, however, was not detected in 15 samples. Levels of DON ranged from 0.01 to 14.00 μg/g. Samples highly contaminated with DON did not necessarily show a high concentration of conjugated DON. The highest levels of free DON were found in corn samples from the south and south-west regions of Ontario while samples from eastern region were less contaminated with 8 of 13 samples found to contain 0.01 μg/g. Conjugated DON was found mainly in corn from the east-central region with 5 of 6 samples showing high levels of conjugated DON. Low levels of conjugated DON (<10%) were detected in the majority of corn samples from the south-west region (13 of 19 samples) and from the central region (23 of 36 samples). The reasons for the differences between regions could be due to climatic conditions or plant genetics. The current survey of free and conjugated DON in the 2008 Ontario corn crop emphasizes the potential challenges in understanding the hazard posed by DON contaminated feedstuffs. Although much research has been carried out since the original discovery of free and conjugated DON, the significance of these mycotoxins for animal health remains to be determined.

Key Words: deoxynivalenol, conjugated, corn

W248 Impact of ochratoxin A (OTA) and zearalenone (ZEA) on growth performance and pig physiology. U. Hofsteter* and I. Rodrigues, *Biomin Holding GmbH*, *Herzogenburg, Austria*.

The objective of this study was to evaluate the negative impact of OTA and ZEA on piglets and to investigate the effects of a mycotoxin deactivator. A total of 48 female crossbred weaning piglets were divided into 6 groups: negative control; positive control (2kg/mt); toxin group (500μg/kg OTA, 250μg/kg ZEA); trial group 1 (500μg/kg OTA, 250μg/kg ZEA, 0.5kg/mt); trial group 2 (500μg/kg OTA, 250μg/kg ZEA, 1kg/mt); trial group 3 (500μg/kg OTA, 250μg/kg ZEA, 2kg/mt). Data was analyzed using the General Linear Model Procedure of SAS in a completely randomized design. Comparison of the group averages was done using Duncan's Multiple Range Test. Uterus, ovaries, kidneys and liver were evaluated for histopathological changes. Significantly heavier ($P<0.05$) pigs compared to the toxin group resulted from the addition of the mycotoxin deactivator in the OTA and ZEA contaminated diets. The relative weight of the different organs tended to be lower (uterus and liver showed $P<0.1$, ovaries and kidneys were not significant) in pigs fed contaminated diets, but no incidence of vulvovaginitis was observed within the groups. Pigs fed the control and diets with 0.10% and 0.20% of the feed additive had normal uterine body and horn, which are characterized by thick endometrium and enlarged glands. The ovaries from pigs fed the contaminated diets exhibited only one young tertiary follicle with several atretic follicles, an indication of degeneration. Although relative kidney weights did not vary within the groups, renal lesions were microscopically observed in pigs fed OTA and ZEA. Respectively one pig from group 3 to 6 exhibited nephrotoxicosis, the primary toxic response to OTA, which is characterized by degenerative changes such as swollen, pale, vacuolated cells in the renal tubular epithelium. Livers from pigs fed the control diets had normal cells whereas those fed OTA and ZEA contaminated diets showed liver sinusoids with red blood cells, a sign of congestion. The combination of OTA and ZEA showed a negative impact on performance and physiological parameters which were overcome by the addition of the mycotoxin deactivator.

Key Words: ochratoxin A, zearalenone, physiology

W249 Adverse effects of feed-borne *Fusarium* mycotoxins on performance and serum chemistry of rabbits. M. A. Hewitt*, G. N. Girgis, C. K. Girish, and T. K. Smith, *University of Guelph*, *Guelph, Ontario, Canada*.

The effects of *Fusarium* mycotoxins on performance and metabolism of livestock and poultry have been described in the literature. There is a lack of information, however, regarding the effects of *Fusarium* mycotoxins on rabbits. An experiment was conducted to investigate the impact of feed-borne *Fusarium* mycotoxins on performance, hematology and serum chemistry of male New Zealand White rabbits. Rabbits were fed either a control diet or a diet containing corn and wheat naturally contaminated with *Fusarium* mycotoxins. The contaminated diet contained 5.0 μg/g deoxynivalenol (DON) and 0.24 μg/g 15-acetyl-DON. At the end of the 12 days experimental period, there were trends towards reduced body weight gain and feed efficiency in rabbits fed the contaminated diet. Serum urea concentrations were significantly higher ($P = 0.02$) in rabbits fed the contaminated diet compared to controls. Increased serum concentrations of urea in cattle and uric acid in poultry have been described to be a result of altered protein metabolism following ingestion of *Fusarium* mycotoxin-contaminated diets.

Key Words: rabbit, *Fusarium* mycotoxins, urea

W250 Enrichment of eggs of Japanese quail with α-tocopherol. R. H. Marques, R. A. Gravena, J. D. T. Silva, F. H. Hada, J. Roccon, J. Picarelli, S. A. Queiroz, and V. M. B. Moraes*, *São Paulo State University*, *SP - Brazil*.

The objective of this study was to evaluate the effect of diets supplemented with vitamin E on the concentration of α-tocopherol in egg yolks of Japanese quail. One hundred 92 70-d-old quail were randomly distributed into 4 treatment groups with 6 replicates of 8 birds in each pen. The birds were placed on 1 of 4 dietary treatments (0, 200, 400 and 600 IU vitamin E/kg feed) for 4 lay cycles. Three eggs were collected per treatment at 56 d. Levels of α-tocopherol in yolk determined by high performance liquid chromatography showed a linear relationship ($y = 0.223 + 0.0015x$, $R^2 = 0.9256$), with dietary vitamin E supplementation levels ($P < 0.05$). In treatments using diets supplemented with 600 IU vitamin E/kg feed, α-tocopherol reached a value of 479.05% above control values, suggesting that the nutritional value of eggs can be enhanced by the addition of vitamin E to diets.

Table 1. Effect of vitamin E in quail diet on concentration of α-tocopherol in egg yolk

Vitamin E	α-tocopherol concentration in yolk (mg/g)	% increase
Control	0.191	-
200 IU	0.579	203.14
400 IU	0.789	313.08
600 IU	1.106	479.05
Probability	0.001*	-
F values	273.52	-
CV[1] (%)	14.68	-

[1]Coefficient of variation, * significant ($P < 0.001$).

Key Words: egg yolk, quail, α-tocopherol

W251 Expression of kyphosis in young pigs is altered by carryover effects of sow vitamin D status. L. A. Rortvedt*, L. A. Zappitelli, J. L. Reichert, J. R. Booth, and T. D. Crenshaw, *University of Wisconsin*, *Madison*.

Kyphosis, or 'hump-backs', is an idiopathic disease that may affect 30% of pigs. The UW Swine Center had a flare-up and subsidence of kyphosis over 4 mo that affected ~20% of pigs. The incidence was consistent with unintentional omission of vitamin D (D) from all diets. This experiment was designed to determine if kyphosis was expressed in pigs produced by sows fed no supplemental D. Crossbred (LR × LW), multiparious sows (n = 8) were fed corn-SBM diets supplemented with either 280 (+D) or 0 (-D) IU vitamin D_3/kg diet from breeding through lactation. At weaning (4 wk), 6 pigs (3, +D; 3, -D) were scanned using DXA (GE Lunar Prodigy) to determine whole body bone mineral content (BMC, g/pig) then killed to assess femur properties. The other 75 pigs were weaned and randomly assigned by weight within sow groups to diets that supplied either 120% (HCaP) or 80% (LCaP) of required Ca and P. Pig diets had no added D. At 9 wk all pigs were fed HCaP diets until termination at 13 wk. Serum Ca and P were assessed at 4 and 9 wk. A subset of pigs were scanned and killed at 9 (n = 12) and 13 (n = 25) wk. Kyphosis was evident at 9 wk in 4 of 19 pigs from –D litters fed LCaP, but not in other groups. At 13 wk, 5 of 15 pigs in –D litters fed LCaP and 5 of 17 pigs from +D litters fed LCaP showed kyphosis. No pigs fed HCaP showed kyphosis regardless of sow D diets. Growth, BMC, and serum P were reduced ($P < 0.05$) in pigs fed LCaP compared with HCaP, but reductions were greater (interaction, $P < 0.05$) in pigs from sows fed -D diets. Evidence of sow diet effects were detected in BMC of pigs at 13 wk. In conclusion, kyphosis was induced in pigs fed diets without supplemental D and marginal Ca P. Evidence of kyphosis occurred at a younger age if pigs were produced by sows fed -D diets.

Table 1.

Vitamin D, IU/kg	280	280	0	0	
Ca P, % of required	120	80	120	80	SEM
ADG, kg/d [a, b]	0.649	0.480	0.547	0.428	0.034
9 wk serum Ca, mg/dL[a]	12.81	13.13	11.49	12.44	0.25
9 wk serum P, mg/dL [a, b, c]	11.02	5.39	9.31	5.37	0.19
DXA BMC, g [b, c]	1070	796	1128	642	49

a. +D vs -D, $P < 0.05$; b. HCaP vs. LCaP, $P < 0.05$; c. D × CaP, $P < 0.05$.

Key Words: skeletal, maternal imprint, DXA

W252 Incorporating whole grain sorghum in broiler rations. C. Marr*, C. M. Rude, M. A. Barrios, R. Rierson, and R. S. Beyer, *Kansas State University*, *Manhattan*.

Commercial poultry producers streamline feed production and lower costs by utilizing fewer ingredients in feed rations. This reduces opportunities to utilize nontraditional grains or by products when prices decline since storage bins and specialized handling equipment may require investment that is not used at full capacity. It may be possible to incorporate some ingredients into formulations to realize savings without changing the manufacturing process if the ingredients could be used without excessive processing. Because grain sorghum is sometimes priced competitively with corn, work was conducted to determine methods of incorporating whole sorghum directly into feed rations. A typical corn-soy broiler starter formula was adjusted to incorporate 15% grain sorghum, substituting mostly for the corn fraction. The cereal grains were ground and mixed into a mash control ration. The treatments included 0, 5, 10 and 15% whole sorghum, substituted on a 1:1 basis for the ground sorghum. Cobb 500 broiler chicks were placed in Petersime battery units, 6 per pen, 8 reps per treatment, with feed and water provided ad libitum. All feed was overlaid with a screen of 1-inch mesh to prevent the chicks from segregating the feed. The trial was conducted for 21 d, during which BW and FI were determined for day 7, 14, and 21. At each week, the data indicate that adding whole grain sorghum decreased BWG and FC compared to ground sorghum. At 5% added whole grain sorghum, the effects were smaller and were not significant at each period. The data suggest that whole sorghum particles could be difficult for new chicks to process since the digestive system is not fully functional compared to adult birds which possess a mature gizzard capable of grinding large feed particles. It was observed that the chicks were attracted to the dark sorghum berries which were consumed immediately if the feed was stirred. Because the birds appeared to consume all of the diet, it was assumed that selective feeding did not affect performance. Additional studies are required to determine if adding whole sorghum to pelleted rations during the grower phase will decrease selection and affect broiler performance.

Key Words: sorghum, whole grain, broiler

W253 Water consumption and performance of broilers receiving Mate (*Ilex paraguariensis*) infusions. A. M. C. Racanicci*[1], J. F. M. Menten[2], and J. Rabello[1], [1]*University of Brasília (UnB)*, *Brasília, DF, Brazil*, [2]*University of São Paulo (ESALQ)*, *Piracicaba, SP, Brazil*.

Aqueous extracts of mate are known to be an important source of phenolic compounds with a strong antioxidant capacity in chicken meat products. The objective of this study was to offer infusions of mate in substitution of water to broilers and evaluate performance and oxidative stability of cooked meat balls. One hundred male Cobb broilers were allotted in cages and distributed randomly to 4 treatments with 5 repetitions of 5 birds. From 11 to 21 d of age, birds were fed conventional corn-soybean meal diets ad libitum and received water (CON) or infusions prepared with hot water (90 °C) and 3 concentrations of mate 0.1, 0.5 or 1.0% as experimental treatments (MA0.1, MA0.5 and MA1.0). Birds received liquids in trough drinkers and the consumption was measured every two days. At 21 d of age, body weight (BW) and feed consumption were recorded to calculate individual weight gain (WG), feed intake (FI) and feed conversion ratio (FCR). Breast meat from 8 birds per treatment was used to prepare meat balls (30 g ± 0.5 g), cooked in boiling water for 8 m and stored in the dark in a cold room (4 °C) for 3 d. Progression of lipid oxidation in meat balls was evaluated by analyzing TBARS (thiobarbituric acid reactive substances; expressed in µmol of malondialdehyde (MDA) per kg of meat). Averages of BW and WG obtained from CON, MA0.1 and MA1.0 (966.8, 966.4, 984. g and 63.6, 63.2 and 61.6 g/d, respectively) were similar ($P > 0.05$), however, MA0.5 showed reduced values (907.2 g and 57.9 g/d, respectively) compared to CON and MA0.1. Averages of FI were not affected ($P > 0.05$) by treatments (86.2, 88.2, 83.6 and 84.4 g/d, respectively) but FCR was affected negatively ($P < 0.05$) by MA0.5, which showed the higher average (1.45) compared to CON and MA1.0 (1.36 and 1.37). The substitution of water by mate infusions did not affect ($P > 0.05$) liquid consumption, however, was effective to protect meat balls from lipid oxidation during storage. This effect can be demonstrated by lower TBARS ($P < 0.05$) in meat balls from MA0.1, MA0.5 and MA1.0 (36.63, 34.35 and 34.23 µmol MDA/kg of meat, respectively) compared to CON (48.88 µmol MDA/kg of meat).

Key Words: natural antioxidants, mate, liquid consumption

W254 Effect of fiber separation from ground corn flour on nutritional value of poultry diets. R. Srinivasan* and A. Corzo, *Mississippi State University*, *Mississippi State*.

In a previous demonstrational study, the Elusieve process, a combination of sieving and elutriation (air classification), was found to be effective in fiber separation from ground corn flour. Corn flour was sieved into

four size fractions and the three biggest size fractions were air classified (aspirated) individually to separate fiber from each of the three size fractions. The material remaining after fiber removal is called enhanced corn flour. Ground corn flour is a major ingredient in diets for swine and poultry, which do not digest fiber very well because they are non-ruminant animals. Fiber separation could increase the nutritional value of corn flour for broilers and could decrease the usage of expensive dietary ingredients such as oil/fat and enzymes. The objective of this study was to determine the effect of fiber separation on nutritional value of poultry diets by carrying out broiler feeding trials. Fiber separation increased starch content in corn flour by 3.0% points. The grow-out study encompassed the period between 0 to 21 d of age using Ross × Ross 308 males obtained from a commercial hatchery. Day-old chicks were randomly placed in each of 24 floor pens (15 birds/pen; 360 birds total). There were 2 different dietary treatments (regular corn diet and enhanced corn diet) with each treatment being replicated 12 times. Diets were formulated to be isocaloric, isonitrogenous, and similar in calcium, phosphorus and all limiting amino acids. Data were analyzed by the GLM procedure of SAS (2004) and treatment effects were separated using Tukey's multiple comparisons test option of SAS (2004) using an α of 0.05. The body weight gain of chicks was significantly higher (by 4.3%) and feed conversion ratio was significantly lower (by 3 points) when fed with enhanced corn diet compared with the regular corn diet. Thus, fiber separation from corn flour increases nutritional value of broiler diets.

Key Words: fiber, separation, elusieve

W255 The effect of using different levels of corn gluten meal in free range chickens diet. C. B.-V. Rabello*, A. F. da Silva, S. B. P. de Lima, H. Pandorfi, M. B. dos Santos, C. da Costa Lopes, and M. d. C. M. M. Ludke, *Universidade Federal Rural de Pernambuco*, *Recife, Pernambuco, Brasil*.

The objective of this work was evaluated the effect of inclusion of the corn gluten meal (CGM21) on performance and carcass yield of free range chickens. A total 240 free range chickens, females with 32 days-old, were distributed according with completely randomized design, five levels of inclusion of the CGM21 and 4 replicates. One reference diet based on corn and soybean meal was formulated and three test diets containing 7, 14 and 21% CGM21 (21% crude protein). The birds were housed in breeding system semi-intensive with access to the piquete containing pasture. Feed intake, weight gain and feed conversion were evaluated weekly. The Carcasses were evaluated (weight and yield) at 84 d, when eviscerated carcass (with head and feet), eviscerated carcass (without head + feet), thighs, drumsticks, wings, back, edible offal (liver, heart and gizzard), and abdominal fat were measured. The assay had two periods: grower phases (32 to 63 d of age) and finish phase (64 to 84 d of age). Data underwent regression analysis. In the growth phase the weight gain (WG), feed intake (FI) and feed conversion (FC) were not affected by increasing CGM21 inclusion in diets, but in the final (64 to 84 d of age) and total period (32 to 84 d of age) showed effect about the CA with better results when we included 10.0 and 9.8% of CGM21, respectively; the WG in the total period had quadratic effect with the better level of inclusion of CGM21 of 9.0%;. In the evaluation of carcass weights of carcass, breast, thigh, wing, back, neck, heart, gizzard and abdominal fat did not show significant effects. The liver and drumstick of birds had similar response, with higher weights when they were included: 11.65 and 9.63% of GM21, respectively. The yield of breast, wing, back, thigh, heart and gizzard were not affected, but the drumstick, liver and abdominal fat showed a quadratic effect with the highest level 13.7%, 8.5% and 10.8% of the inclusion of CGM21, respectively. The inclusion of gluten meal for free-range chickens can not exceed the level of 10% from at growth phase (63 days old), but can use around 21% in the initial phase (28 days old).

Key Words: growth performance, free-range chicken, carcass yield

W256 Effects of feeding low-density diets to Hy-Line W-36 laying hens on production performance. S. A. dePersio*[1], K. W. Koelkebeck[1], C. M. Parsons[1], P. L. Utterback[1], C. W. Utterback[1], N. O'Sullivan[2], K. Bregendahl[2], and J. Arango[2], [1]*University of Illinois*, *Urbana*, [2]*Hy-Line International*, *Dallas Center, IA*.

An experiment was conducted using 480 Hy-Line W-36 hens (18 wk of age) to determine whether feeding diets of different nutrient densities would affect egg production performance. At 18 wk of age hens were moved from a floor grow out facility to a caged layer building, weighed, and allotted to 6 replicate groups of 16 hens each (2 adjacent cages containing 8 hens per cage, 60.9 x 58.4 cm) per treatment diet in a completely randomized design so that mean body weight was similar for each treatment. Treatments consisted of 5 diets formulated to contain 85 (Diet 1), 90 (Diet 2), 95 (Diet 3), 100 (Diet 4), and 105 (Diet 5) % of the energy and nutrient recommendations stated in the 2009 Hy-Line W-36 management guide. Egg production performance was measured for 22 wk from 18 to 40 wk of age. At Week 14, egg production of hens fed Diet 1 (85% of control) dropped greatly to 57.6%. It was decided to switch these hens to the control diet (Diet 4). After this, egg production of Diet 1 hens began recovering and was stable by Week 17. Hens fed the control diet (Diet 4) came into production sooner than the other treatments, but by Week 5 all treatments had similar egg production. Overall average hen-day egg production for Diets 1 through 5 was 76.1, 80.6, 81.3, 84.2, and 82.1%, respectively. Hens fed Diets 1, 2, and 3 had lower ($P<0.05$) egg production than those fed the control diet. Hens fed Diets 2 and 4 consumed more ($P<0.05$) feed than those fed Diets 1 and 5. Feed efficiency was the greatest ($P<0.05$) for hens fed Diets 4 and 5. Egg weight was heavier for hens fed Diet 5 vs. Diets 1 and 2, while egg mass was greater for hens fed Diets 4 and 5 vs. Diets 1 and 2. The results of this study show that feeding Hy-Line W-36 hens diets formulated to contain lower nutrient density specifications (85% of control) than recommended may compromise early production performance.

Key Words: laying hens, low density diets, egg production

W257 Effect of prebiotic on performance and some blood parameters of partridge. H. Hashemipour, V. Khaksar, H. Kermanshahi, and A. Golian*, *Ferdowsi University of Mashhad*, *Khorasan Razavi, Iran*.

In modern poultry production, newly hatched chicks have no contact with maternal feces and so no maternal spectrum of antigens is present. In this situation, chicks can be affected by a number of pathogenic intestinal microorganisms, and fortifying diets with prebiotics can alleviate this problem. This experiment evaluates the effect on the performance, carcass characteristics and some blood parameters of the chukar partridge (*Alectoris chukar chukar*) of dietary supplementation with a prebiotic (Fermacto). Eighty day-old mixed sex chicks in a completely randomized design with two treatments (with or without 0.18% Fermacto) and four replicates of 10 birds each was used. The experimental period lasted 16 weeks in two phases of starter (0-8 weeks) and grower (9-16 weeks). Performance data recorded biweekly and carcass characteristics and some blood parameters were measured at the end of the experiment. Data revealed that the supplementation of Fermacto significantly ($P<0.05$) increased breast and gastrointestinal tract percentages, decreased the back-neck percentage, lowered blood triglyceride and total cholesterol and increased blood calcium levels in

the Fermacto-treated group. Under the conditions of this study, it was concluded that the dietary supplementation of 0.18% Fermacto might offer some beneficial effects in chukar partridges to improve their carcass quality and some blood parameters.

Key Words: prebiotics, performance, partridge

W258 Influence of diet quality on nutrient digestibility and productive performance of weanling pigs. J. D. Berrocoso*, C. H. Zúñiga, M. P. Serrano, L. Cámara, and G. G. Mateos, *Universidad Politécnica de Madrid*, *Madrid, Spain*.

The effect of ingredient composition of the diet on nutrient digestibility and growth performance was studied in piglets. There were 6 experimental prestarter diets (27-47 d of age) with similar NE and AA content. The positive control diet contained 40% cooked corn (HPC), 14% lactose (LAC), and 10% fish meal (FM). Two other experimental diets had the same composition than the control diet but the HPC was substituted by either raw corn (RC) or cooked rice (HPR). Two extra diets were similar to the positive control diet but contained only 7% LAC or 4% FM. Finally, there was a control negative diet with 40% RC, 7% LAC, and 4% FM. From 47 to 68 days age, half of the pens received a standard SBM-raw corn-lard diet and the other half a diet with similar nutrient profile that included 1.3% LAC, 5% FM, 20% HPC, 2% soy protein concentrate, and 1% soybean oil. Each treatment was replicated 6 times (6 pigs per box). Type of diet did not affect growth performance of pigs at any stage. Piglets fed the rice diet had lower incidence of diarrhea (DI) from 27 to 47 d of age than those fed the raw corn control diet ($P < 0.1$), with DI of pigs from the other treatments being intermediate. At 36 days of age, CP digestibility was not affected by dietary treatment but the CTTAD of GE, DM, and OM was lower ($P < 0.05$) for piglets fed raw corn than for piglets fed HPR with piglets fed HPC being intermediate. Also, an increase in the LAC content of the diet improved ($P < 0.05$) digestibility of these dietary components. Feeding program diet did not affect digestibility of any of the nutrients at 57 d of age. It is concluded that piglets weaned at 27 d of age performed similarly when fed diets containing raw corn and low levels of LAC an FM than when fed more complex diets but DI was reduced with the inclusion of cooked rice. Also, 47 d-old pigs (>11 kg BW) do not need to include any sophisticated ingredients in the diet, for optimal performance.

Key Words: cooked cereal, piglet nutrient digestibility, incidence of diarrhea

W259 Effects of different level of fish meal on growth performance, intestinal microbiology, and blood parameters of weaned pigs. H. F. Ji*, J. Wang, D. C. Shan, S. X. Wang, D. Y. Zhang, F. M. Wang, L. Hou, and Y. M. Wang, *Institute of Animal Husbandry and Veterinary Medicine, Beijing Academy of Agriculture and Forestry Sciences*, *Beijing, China*.

This study was undertaken to determine the effect of one commercial fish meal (CP, 65.5% DM) as protein sources on growth performance and blood parameters of weaned pigs. Sixty piglets (Large White × Landrace) weaned at 28 d of age (7.32 ± 0.86 kg BW), were assigned randomly to 4 treatments (n=15) in a completely randomized design. The 4 treatments included 1 basal diet (control) and 3 diets with different level of fish meal (2%, 5%, and 8% of diet). The experiment lasted thirty three days. Body weight and feed consumption of animals were determined on d 0 and 33 of the study to calculate ADG and G:F. The incidence of diarrhea in piglets was observed and recorded 3 times per day during the study. Fresh fecal samples were collected to evaluate shedding of *E. coli* and *Lactobacillus* and blood samples were collected from jugular vein to measure ω-3 fatty acid and C-reactive protein (CRP) at the end of the experiment. Utilization of fish meal improved ($P < 0.05$) overall ADG and G:F in comparison with the control. Along with the increase of fish meal in the diets, ADG and G:F were all increased significantly ($P < 0.05$). The incidence of diarrhea was significantly decreased ($P < 0.05$) by dietary fish meal inclusion during 0-10 d postweaning, while the diarrhea incidence was 0% when fish meal was included in the diet during 11-33 d postweaning. Fecal samples from pigs receiving diets containing fish meal had greater ($P < 0.05$) *Lactobacillus* counts than those from control pigs, and no difference existed in *E. coli* counts. The eicosapentaenoic acid (EPA, C20:5) and docosahexaenoic acid (DHA, C22:6) content of the blood increased ($P < 0.05$) with increasing fish meal in the diet. Piglets fed the diet containing 8% fish meal had the lowest ($P < 0.05$) CRP production. The current results indicated that fish meal as a protein sources in diets of young pigs enhanced growth performance by increasing ADG and G:F and decreasing the incidence of diarrhea, and improved intestinal microbes, ω-3 fatty acid level and physiological status.

Key Words: fish meal, weaned pig

W260 Energy value of cassava products and their use in weaning-growing pigs. E. Salcedo[1], L. Mestra[1], T. Rivero*[1], Y. Avellaneda[1], G. Afanador[1,2], and C. Ariza-Nieto[1], [1]*CORPOICA*, *Bogota, Colombia*, [2]*Universidad Nacional de Colombia*, *Bogota, Colombia*.

This study evaluated the digestible energy (DE) value of cassava meal, cassava meal extruded, and cassava foliage from 6 varieties of cassava harvested in 3 microregions of Colombia and evaluated their use in wean to finishing pigs. The DE was determined using the mobile nylon bag technique (MNBT). Samples, 1 g, ground through a 0.5-mm mesh, were enclosed in nylon bags (25 × 40 mm; 48 µm). Following pre-digestion (0.1 N HCl; pepsin 754.8 IU/1;4 h), eight bags of each feedstuff were inserted via a T-cannula placed in the duodenum. The material, remaining in the bags after passing through the digestive tract, was pooled within pig and feedstuff and used to estimate DE. The effect of cassava meal was evaluated in diets for weaning to growing pigs and its economic implication was estimated. Twenty (20) pigs with an average body weight of 15 kg were randomly assigned to one of the two treatments groups (with cassava, without cassava) in a phase feeding system approach; pre-starter (15-20 kg), starter (20-50 kg) and growth (50-70 kg). Pigs were individually weighed every other week until slaughter. Feed intake and feed conversion were record at the end of each phase. Data were analyzed as a completely randomized design using the GLM procedure of SAS. The digestible energy coefficient of cassava foliage was low (18.2%) compared to cassava meal (87.8%). The extrusion process increased the energy coefficient of the cassava meal (93.3%); therefore, the DE in pigs of cassava meal extruded was greater (3519 kcal/kg) compared to cassava meal (3309 kcal/kg). Cassava meal grown in Valley of Sinu river, Cordoba, Colombia showed the greatest energy value (3634 Kcal/Kg) and its inclusion at a rate of 25% in wean to growth pig diets showed that body weight gain, feed intake, and feed conversion were not significantly affected (P>0.05), The economic analysis showed that the inclusion of cassava meal significantly (P<0.05) reduced the cost of feed per kilogram of diet, because cassava meal price was 55% less than corn. Additionally, the cost per kilogram of pigs fed cassava meal was reduced (-$0.25) compared to pigs on the control group.

Key Words: cassava meal, digestible energy, pigs

W261 Effect of three feeding programs on body reserves gain of gestating sows. A. García-Rendón[1], J. López[2], A. G. Borbolla*[2], and E. Toledo[2], [1]*Granjas Covadonga*, *Estado de México, México*, [2]*Departamento de Producción Animal: Cerdos. Facultad de Medicina Veterinaria y Zootecnia. Universidad Nacional Autónoma de México*, *Coyoacán, D.F. México*.

An elevated number of pigs weaned/sow/year is essential to maintain pig farm productivity and efficiency. This is related to the amount and type of body reserves in the sow. During lactation, body reserves of sows are intensively mobilized for milk production, due to an insufficient feed consumption. Feeding programs during gestation therefore, must be designed to optimize protein deposition and avoid excessive fat accumulation. The objective of this study was to evaluate 3 different feeding programs on protein and fat gain of pregnant sows over 2 gestation cycles. Three hundred and 40 sows were assigned randomly to 3 treatments: Tr. 1: feed allowance based on visual body condition at mating. Tr. 2: Feed allowance based on body condition evaluated by weight and back fat using an ultrasound device. Tr. 3: Feed allowance according to the expected net maternal gain established by NRC (1998). Body condition was determined using Noblet (1990) formulas. Variables were analyzed with ANOVA, using a significance level of ($P < 0.05$). Initial and final weights ± SE in both gestation cycles were not different ($P > 0.05$) for the 3 feeding programs (Cycle 1. Tr.1:193.7 ± 3.05 and 253.8 ± 4.9 Kg, Tr.2:197.5 ± 3.6 and 257.4 ± 4.7 Kg, Tr. 3:198.0 ± 3.5 and 260.2 ± 4.8 Kg, respectively; Cycle 2. Tr.1: 211.4 ± 2.80 and 268.60 ± 2.7 Kg, Tr.2: 218.3 ± 3.6 and 271.1 ± 3.1 kg, Tr.3: 219.7 ± 2.9 and 275.6 ± 3.1 Kg, respectively). Accordingly, total weight gain during gestation was similar ($P > 0.05$) for all treatments in both cycles (Cycle 1. 60 ± 2.5 Kg; Cycle 2. 57.5 ± 1.5 Kg). As well on net maternal gain no differences ($P > 0.05$) were observed in any cycle (Cycle 1. 32.6 ± 2.0 Kg; Cycle 2. 30.4 ± 1.5 Kg). Differences ($P < 0.05$) over feed consumption and total body fat gain during the 2 gestation cycles are shown in Table 1. As for protein gain no differences ($P > 0.05$) were observed in both cycles (Cycle 1. 6.08 ± 0.5 Kg; Cycle 2. 5.1 ± 0.2 Kg). The use of a suitable feeding program during gestation, besides optimizing body reserves gain (fat and muscle), can improve sow output, and therefore increase its productivity, and longevity in the farm.

Table 1. Effect of feeding program on feed consumption and body composition of gestating sows.

	Gestation 1			Gestation 2		
	Treatment 1	Treatment 2	Treatment 3	Treatment 1	Treatment 2	Treatment 3
Total feed consumption, Kg	263.7 ± 1.3[a]	269.1 ± 3.4[b]	287.8 ± 1.2[c]	271.5 ± 0.3[d]	292.7 ± 3.1[e]	293.6 ± 1.4[e]
Body fat gain, Kg	6.4 ± 0.7[a]	9.1 ± 0.8[b]	8.5±0.9[a,b]	9.4 ± 0.5	9.9 ± 0.5	10.1 ± 0.5

[a,b,c,d,e]Means with different superscript letter differ (P < 0.05) for the same gestation.

Key Words: body reserves, feeding programs, gestating sows

W262 Effect of triticale on blood chemistry and performance of commercial growing turkeys. H. Zarghi, A. Golian*, and H. Aghel, *Ferdowsi University of Mashhad*, *Mashhad, Khorasan Razavi, Iran*.

A trial was conducted to study the performance of male broiler turkeys fed diets with triticale replaced for corn at the levels of 0, 25, 50, 75 and 100%. Each diet was fed to five groups of twelve male birds each. The diets were provided isocaloric and isonitrogenous for each period of 30- 53, 54-83, 84-94 and 95-116 d of age. Feed and water were fed ad-libitum. Similar weight gain, feed intake and feed conversion observed in birds fed control or diets contained up to 75% triticale replaced for corn. However, the average daily weight gain decreased, feed intake and feed conversion increased when 100% of corn was replaced with triticale during all periods (P<0.05). Although, carcass yield decreased in birds fed triticale contained diets, small intestine and large intestine weight and blood serum TG increased, whereas serum HDL and LDL decreased when measured at 116 d of age ($P < 0.05$). This study revealed that the turkey producers may substitute up to 75% of the corn with triticale in grower and finisher diets without adverse effect on performance.

Key Words: turkey performance, triticale, blood chemistry

W263 Influence of origin on in vitro protein and dry matter digestibility of soybean meal. S. Santos-Rosell, P. García-Rebollar, N. Núñez-Romero, M. P. Serrano, and G. G. Mateos*, *Universidad Politécnica de Madrid*, *Madrid, Spain*.

Previous works have demonstrated that the origin of the beans might affect the nutrient content and availability of soybean meals (SBM). In vitro procedures can be used to predict the *in vivo* ileal digestibility of SBM in broilers. The present research was conducted to determine the influence of origin (USA; Brazil, BRA; Argentine, ARG) on in vitro digestibility of N and DM of SBM. An adaptation of the Boisen and Fernandez (1995) method consisting on a two-step enzymatic hydrolysis simulating digestion in the stomach and small intestine followed by measurement of the remaining residues for the two digestion steps was used. The one-step method (stomach digestion) was an incubation of the SBM samples with pepsin at pH 2. The two-step method consisted in including a second multi-enzyme hydrolysis process (pancreatin at pH 7) to the pepsine digestion to simulate ileal digestibility. On DM bases, the BRA meals (n = 7) had higher CP content (55.9 vs. 54.3 and 53.1%; P < 0.001) than the USA (n = 8) and ARG (n = 7) meals. After the one-step enzymatic digestion (stomach), N digestibility was higher (67.7 vs. 65.8 and 64.9%, $P < 0.01$) for BRA meals than for USA and ARG meals. Also, DM digestibility (57.6 vs. 56.1 vs. 55.1; $P < 0.05$) was higher for BRA than for USA meals with the ARG meals being intermediate. When the two-step hydrolysis process (stomach and small intestine) was used, USA SBM had higher N digestibility (88.2 vs. 87.5 vs. 86.4; $P < 0.05$) than BRA meals and ARG meals were intermediate. Also, DM digestibility was higher (71.0 and 71.5 vs. 69.2; $P < 0.05$) for USA and ARG than for BRA meals. In conclusion, the in vitro hydrolysis methodology showed that the contribution of the small intestine to total digestion of N and DM is lower for BRA SBM than for USA and ARG meals and that those differences might be associated to different nutritional values for poultry of commercial available SBM differing in origin.

Key Words: soybean meal origin, in vitro digestibility, nutritional value