NONRUMINANT NUTRITION: EVALUATION OF FEED INGREDIENTS FOR MONOGASTRIC DIETS

1347 (W165) Nutritional value of macauba pulp presscake (*Acrocomia aculeata*) for growing pigs. *J*. H. B. Pereira[1], S. L. S. Cabral Filho[1], C. G. D. Q. Roriz[1], C. B. Bernardes[1], T. M. Barbosa[1], L. R. Roos[1], A. P. Santana[1], J. B. Lopes[2], and L. S. Murata[*1], *[1]University of Brasilia, Brazil, [2]Federal University of Teresina, Brazil.*

The aim of this study was to determine the apparent digestibility coefficients of the dry matter (DCDM), crude protein (DCCP) and fiber (DCFB). Also, we aimed at determining the apparent digestible (DE) and metabolizable energy (ME) in macauba pulp presscake (*Acrocomia aculeata*) for pig feeding. The apparent digestibility of dry matter (DM), crude protein (CP), fiber (NDF), DE and ME of treatments was also assessed for growing pigs. The study was conducted using a randomized block design with three treatments distributed in two blocks of four replications/block. Twenty-four commercial barrows with an initial weight of 28+0.13 kg were used with an adaptation period of 10 d followed by a 5-d total collection of feces and urine. The diets were formulated by replacing the reference diet (corn and soybean meal) with 0, 10 or 20% macauba pulp presscake. The treatments were: T1 = Reference diet (RD), T2 = 90% RD+10% macauba pulp presscake, and T3 = 80% RD+20% macauba pulp presscake. The DCDM, DCCP, and DCFB for a 20% dietary inclusion level of macauba presscake were 16.5%, -2.25%, and 30.80%, respectively, which were not significantly different from the values observed with a 10% dietary inclusion level. The DE value for macauba pulp presscake in T2 (10%) was 2888.3 and T3 (20%) was 2900.6 kcal/kg. The ME for the same treatments was 2690.0 and 2680.5 kcal/kg, respectively. Diet DM digestibility values were 79.1% in T2 and 72.0% T3, while CP digestibility in T2 and T3 were 77.9% and 71.2%, respectively. Diet NDF digestibility for T2 was 64.3% and T3 was 55.7%. Significant difference ($P < 0.05$) for diet nitrogen balance (NB) was found only in fecal nitrogen (FN), showing that diet fiber increased the excretion of endogenous nitrogen. The inclusion level of macauba pulp presscake in the diet had an effect on the digestibility of DM, CP, and NDF, where the apparent digestibility coefficient decreased with the increase of macauba pulp inclusion, without influencing the DE, ME and NB values. This diet is considered to have a low nutritional value and its use is not recommended for growing pigs with 28 to 40 kg of body weight. The possible usage as alternative foods to feed pigs will depend on the understanding of their possibilities and limitations as well as reduction of production costs. Inclusion rates of this ingredient in pork diet must be considered, especially the fiber content values.

Key Words: alternative feed, biodiesel, by-products

1348 (W166) Different corn hybrids fed to growing pigs. I. Chemical composition, energy concentration, and digestibility of nutrients. Y. Liu[*1], R. C. Sulabo[1], T. E. Sauber[2], and H. H. Stein[1], *[1]University of Illinois at Urbana-Champaign, Urbana, [2]Pioneer Hi-Bred International Inc., Johnston, IA.*

Fifty-two barrows (26.8 ± 3.42 kg) were used in five experiments to determine the variability in the chemical composition, energy concentration, and digestibility of nutrients in 48 different corn hybrids sourced from DuPont Pioneer (Johnston, IA) and fed to growing pigs. In Exp. 1, 12 ileal cannulated barrows were allotted to a 12 × 12 Latin square design with 12 diets and 12 7-d periods. In Exp. 2 to 5, 10 ileal cannulated barrows were allotted to a 10 × 10 Latin square design with 10 diets and 10 7-d periods. In all experiments, corn was 97.0% (as-fed basis) of the diet and the only ingredient contributing energy, starch, ADF, NDF, lipids, and AA to the diets. The only difference in diet composition among diets was that different corn hybrids were used. Descriptive statistics for chemical component, energy concentration, and digestibility of nutrients in corn hybrids were determined using PROC MEANS. Correlation coefficients among chemical components, energy concentration, and digestibility of nutrients in all corn hybrids were determined using PROC CORR. On an as-fed basis, the GE concentration of the corn hybrids ranged from 3736 to 3989 kcal/kg, with an average of 3884 ± 63.6 kcal/kg. The average concentration of acid-hydrolyzed ether extract (AEE), starch, NDF, ADF, and ash was 3.86 ± 0.59%, 62.91 ± 1.79%, 8.13 ± 1.40%, 2.43 ± 0.53%, and 1.02 ± 0.28%, respectively. The average apparent ileal digestibility of GE, CP, AEE, NDF, ADF, and starch of the corn hybrids was 75.44 ± 4.38%, 62.63 ± 7.62%, 57.64 ± 7.62%, 19.02 ± 21.52%, −7.56 ± 19.53%, and 95.35 ± 2.48%, respectively, whereas the average apparent total tract digestibility of GE, CP, AEE, NDF, ADF, and starch was 87.78 ± 1.70%, 77.62 ± 4.36%, 53.53 ± 7.85%, 54.20 ± 13.03%, 38.46 ± 16.36%, and 99.90 ± 0.09%. On a DM basis, DE of the corn hybrids ranged from 3803 and 4217 kcal/kg DM with an average of 4058 ± 93 kcal/kg. The DE of corn hybrids may be predicted using the model: DE, kcal/kg DM = 1.719 × CP– 11.600 × AEE + 2.188 × NDF + 5.198 × ADF + 0.378 × Starch + 2.480 × GE– 7320.52 ($R^2 = 0.77$, RMSE = 54.3; $P < 0.001$). In summary, the chemical composition, energy concentration, and digestibility of nutrients varied among corn hybrids.

Key Words: chemical compositions, corn, pigs

1349 (W167) Different corn hybrids fed to growing pigs. II. Concentrations and digestibility of amino acids.

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A total of 42 barrows (initial BW: 28.2 ± 2.91 kg) were used in four experiments to determine the variability in concentration and digestibility of AA in corn hybrids sourced from DuPont Pioneer (Johnston, IA) and to develop prediction equations to estimate the concentration of digestible AA in corn hybrids fed to growing pigs. In Exp. 1, 12 ileal cannulated barrows were allotted to a 12 × 12 Latin square design with 12 diets and 12 7-d periods. In Exp. 2, 3, and 4, 10 ileal cannulated barrows were allotted to a 10 × 10 Latin square design with 10 diets and 10 7-d periods. All diets had the same composition with the only difference being that different corn hybrids were used in each diet. Corn was included as 97.0% (as-fed basis) of the diet and was the only AA-contributing ingredient. Descriptive statistics for each chemical component of corn hybrids were determined using PROC MEANS. Simple linear regression analyses were performed using PROC REG of SAS. On an as-fed basis, the average concentration of CP, Arg, His, Ile, Leu, Lys, Met, Phe, Thr, Trp, and Val in the corn hybrids was 7.95 ± 0.79%, 0.36 ± 0.03%, 0.22 ± 0.02%, 0.30 ± 0.03%, 1.00 ± 0.14%, 0.21 ± 0.04%, 0.16 ± 0.02%, 0.41 ± 0.04%, 0.28 ± 0.03%, 0.05 ± 0.01%, and 0.40 ± 0.03%, respectively. The average standardized ileal digestibility (SID, %) of CP in the corn hybrids was 84.59 ± 4.92%. The average SID of indispensable AA was 92.63 ± 3.34% for Arg, 87.75 ± 3.99% for His, 86.96 ± 3.30% for Ile, 89.87 ± 2.58% for Leu, 85.25 ± 14.34% for Lys, 91.93 ± 2.49% for Met, 89.29 ± 2.74% for Phe, 80.75 ± 4.81% for Thr, 79.46 ± 6.74% for Trp, and 86.02 ± 3.89% for Val, respectively. The concentrations of standardized ileal digestible AA is not accurately estimated from the concentration of CP ($0.11 \leq R^2 \leq 0.78$). However, the concentration of each AA can be used to predict the concentration of digestible AA in corn ($R^2 \geq 0.80$). In summary, the variability in AA composition and digestibility of corn hybrids differed between individual AA. The concentration of digestible AA cannot be predicted from CP, but the concentration of each AA can be used to predict the concentration of digestible AA in corn.

Key Words: amino acid digestibility, corn, pigs

1350 (W168) A high dietary electrolyte balance reduces growth performance and CP and Zn total tract apparent digestibility in weanling piglets.

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It is generally accepted that dietary electrolyte balance (dEB, Na + K– Cl, in mEq/kg diet) influences feed intake and growth performance of pigs. However, there is a not clear optimal recommendation for piglets. The objective of this study was to assess the effect of diets differing in the mineral source and dEB on feed intake, total tract apparent digestibility and growth of weanling pigs. A total of 240 piglets (21 d after weaning, initial BW 13.4 ± 1.17 kg) were blocked by BW into three blocks (heavy, middle and light), and then distributed into eight pens per block (10 pigs/pen) and randomly assigned to one of four experimental diets differing in the dEB level: 16 and 133 mEq/kg diets (VL, L), based on the incorporation of CaCl (3.6 g/kg); and 152 and 269 mEq/kg diets (H, VH), based on the addition of calcium carbonate (10.6 g/kg), without or with sodium bicarbonate (10 g/kg), respectively. Titanium dioxide (3 g/kg) was used as indigestible marker. The diets were offered for 16 d when performance was evaluated. One fecal sample was collected per pen on d 7 to measure whole-tract digestibility, and five venous blood samples per treatment were collected on d 12 to measure acid-base status of animals. Piglets fed VL and L diets reached higher BW on d 16 (19.01 kg and 19.46 kg, respectively) than did piglets fed VH diet (17.05 kg, $P < 0.05$). Diet L also promoted a lower ($P < 0.05$) feed:gain ratio (2.10) and a higher ($P < 0.05$) digestibility of the CP (74.6%) and Zn (13.0%) than did diet VH (3.23, 68.2 and 1.1%, respectively). The VL diet reduced blood TCO2, bicarbonate and base excess values, as compared with L, H and VH diets ($P < 0.01$), reflecting the acidogenic nature of that diet. In conclusion, the results show that a high dEB diet (269 mEq/kg) may reduce piglets' performance and the total tract digestibility of nutrients, possibly associated to its higher acid-binding capacity (427 mEq/kg).

Key Words: dietary electrolyte balance, digestibility, growth performance

1351 (W169) Acceptance and palatability of different inclusion levels of protein solutions by feed restricted and non-restricted nursery pigs.

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The aim of the present work was to study the productive performance of nursery pigs when sweet milk whey (SMW) is replaced by porcine digestive peptides (PDP; 620 g/kg of CP, Bioibérica SA, Palafolls, Barcelona, Spain). A total of 240 pigs were randomly distributed after weaning into two groups (12 pens/group) depending on the presence of SMW or PDP on their diets. The SMW group was fed a pre-starter (0 to 14 d) and starter (15 to 33 d) diet with 142 g/kg and 49 g/kg SMW respectively; the PDP group was offered an iso-caloric and iso-proteic diet with 20 g/kg of PDP and 300 g/kg of wheat replacing dairy products. Feed intake and body weight were measured weekly to calculate average daily feed intake (ADFI), average daily gain (ADG) and gain: feed ratio (GFR). A choice test and one-feeder test of 30 min each were performed in another group of animals 3 wk wk weaning (36 pen pairs) to evaluate the preference and acceptance for both diets, respectively. Feed intake was recorded by measuring the initial and final weight of the feeders. SMW and PDP diet positions were balance across pig's pairs. Data were analyzed with ANOVA using the GLM procedure (performance values) or the PROC MIXED (preference and acceptance values) of the statistical package SAS. Despite clear differences on feed preference (211 vs. 77 g; $P = 0.039$) and acceptance (287 vs. 192 g; $P = 0.001$) between diets with or without whey respectively, no effects were observed on performance at the end of the nursery period (20.92 vs. 21.13 kg for BW, 0.62 vs. 0.63 kg/d for ADFI and 0.52 vs. 0.53 kg/d for ADG). Despite the reduced preferences and acceptance observed, the use of dairy products appears to be unnecessary if a high valuable protein source is offered during nursery.

Key Words: familiarity, feed preferences, lactose

1352 (W170) Nutritional value of whey permeate and egg products fed to growing pigs.

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Inedible eggs from egg-breaking plants have high AA and fat content. Instead whey permeate (WP), co-product from dairy industry, has high lactose content. Thus, blends of eggs and WP can be good sources of protein and energy in swine diets; however, their nutritional value is unknown. A study was conducted to determine standardized ileal digestibility (SID) of AA and calculated NE value for dried whole egg (egg), and two blends of WP and egg (70% WP and 30% egg, 7030PE; and 60% WP and 40% egg, 6040PE). Eight ileal-cannulated barrows (35.1 kg BW) were fed four diets in a replicated 4 × 4 Latin square design. The diets were a pre-grower-corn-starch-based basal diet, and this basal diet with energy- and AA-yielding ingredients replaced with 30% of egg, or 40% of 7030PE or 6040PE. Energy and nutrient digestibility in the test products was determined by difference method. The SID of AA were calculated using published values for basal ileal endogenous AA losses. On DM basis, egg, 7030PE, and 6040PE contained 48.9, 18.6, and 21.4% CP; 3.60, 0.98, and 1.17% Lys; and 39.3, 8.89, and 12.4% ether extract, respectively. The SID of Lys was greater ($P < 0.05$) for egg (86.9%) than for 7030PE (73.6%) or 6040PE (70.8%). However, egg had lower ($P < 0.05$) SID of Arg, Ile, and Phe than 7030PE or 6040PE. The 7030PE and 6040PE were similar in apparent total tract GE digestibility and SID of all AA except His. The NE (on DM basis) for egg (4.67 Mcal/kg) was greater ($P < 0.05$) than that for 7030PE (3.34 Mcal/kg), which was lower ($P < 0.05$) than that of 6040PE (3.61 Mcal/kg). In conclusion, the proportion of egg (30 vs. 40%) in the egg-WP blend did not affect the digestibility of GE and of most AA; however, the NE value was greater for the blend with 40% egg due to the high fat content in egg. Egg-WP blends had lower Lys digestibility than egg, implying that Lys was partly damaged by the blending and drying process. Nonetheless, the egg-WP blends had high AA digestibility and NE values, and hence they can be good sources of AA and energy in swine diets.

Key Words: egg, whey permeate, pig

1353 (W171) Inclusion of recycled wastes from the food industry in phase I diets for piglets: Effects on nutrient digestibility and growth performance.
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We studied the effects of inclusion of food by-products in the phase I diet on growth performance and total tract apparent digestibility (TTAD) of nutrients in 288 weaned pigs (7.9 ± 0.15 kg BW). On DM bases, the ingredients tested were a) lactal, a combination of yogurt (52%), milk (26%), and 22% of a wheat flour + broken rice meal mixture, b) lactal-cheese, a combination of yogurt (39%), milk (20%), cheese (19%), and 22% of the cereal mixture, and c) Infant, a mixture of out of date infant formulas based on cereals. In phase I (d 0 to 21 of experiment) there were eight dietary treatments arranged as a 2 × 4 factorial with two levels of lactose (7% and 10%) and four feed formulation: 1) a control commercial diet, 2) a diet with 15% lactal (LACTAL), 3) a diet with 15% lactal-cheese (LACTAL-cheese), and 4) a diet with 15% lactal-cheese and 20% Infant formula (INFANT). All diets were formulated to be isonutritives. On d 13 to 15 of the experiment, 300 g of feces per pen were collected by rectal massage for the TTAD analysis. From d 21 to 35 (phase II) all pigs received a common diet. Each treatment was replicated six times and the experimental unit was the individual pen with six pigs. Data were analyzed as a completely randomized design, with level of lactose and feed formulation as main effects. In phase I, an increase in dietary lactose increased ($P < 0.05$) ADFI and ADG but did not affect G:F. Pigs fed the INFANT diets (with 7 or 10% lactose) had higher ADFI ($P < 0.05$) than pigs fed the LACTAL diets, with pigs fed the other diets being intermediate. In phase II, pig growth was not affected by previous dietary treatment. Cumulatively, ADFI was higher ($P < 0.05$) for pigs fed the INFANT diet than for pigs fed the LACTAL diets. TTAD of DM, OM, GE, and CP was higher ($P < 0.05$) for pigs fed the high lactose level diets. Similar results were obtained for pigs fed the INFANT diets ($P < 0.05$). It is concluded that an increase in lactose content of the diet improved piglet performance and that the food by-products tested can substitute successfully high quality ingredients, such as dried whey and heat processed cereals, in phase I diets for weanling pigs.

Key Words: cheese, food by-products, infant formulas, lactose, yogurt

1354 (W172) Effect of wheat and wheat with corn distillers grain on growth performance in nursery pigs.
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An experiment was conducted to evaluate the effect of substituting wheat or wheat and corn distiller's grains with solubles (DDGS) for corn in the phase 2 and 3 starter diets. The objective of this study was to determine if wheat is a viable alternative to corn in starter diets. A total of 126 pigs (4 to 6 pigs per pen and 8 pens per treatment) were blocked by weight and randomly assigned treatments within block. Pigs were weaned at 20 ± 2 d and fed a common diet (ME 3.4 kcal/kg; 1.5% SID lysine) 0 to 7 d post weaning, initial weight of 6.3 kg, NS. The three experimental diets [1, control, corn diet (C); 2, 30% wheat (W); and 3, 30% wheat and 30% DDGS (WCD)] were fed in two phases: phase 2 (ME:3.3 kcal/g, 1.4% SID lysine) from d 7 to 21 post-weaning, and phase 3 diets (ME: 3.3 kcal/g, 1.2% SID lysine) from d 21 to 35. All diets were formulated to meet the dietary requirements according to the 2012 Swine NRC. Body weight gain and feed disappearance were determined weekly. Data were analyzed using PROC GLM of SAS. Overall, pigs fed 30% W (21.6 kg) had body weights that were similar to those fed the C diet (21.0 kg, $P = 0.17$). Pigs fed the WCD diet were significantly heavier (22.6 kg, $P < 0.01$) than those fed C (21.0 kg). The ADFI was similar among treatments in phase 2 (569 g/d, NS), but was greater in those fed WCD in phase 3 (C, 888; W, 870; WCD 1006 g/d; $P < 0.02$) and overall (C, 728; W, 718; WCD 791 g/d; $P < 0.02$). The G: F was improved in pigs fed WCD in phase 2 (C, 0.62; W, 0.62; WCD 0.67; $P < 0.02$), but not in phase 3 or overall. In conclusion, these results indicate that wheat can be substituted for corn in nursery diets and that wheat in combination with DDGS may be superior to corn based diets.

Key Words: wheat, DDGS, nursery pig performance

1355 (W173) Effects of dietary protein and rapidly fermentable carbohydrate contents on microbial fermentation profile in the hindgut of weanling pigs.
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Protein fermentation in the hindgut of piglets leads to the production of potentially toxic metabolites such as ammonia, which may increase the risk of postweaning diarrhea. In this way, the objectives in this study were to determine the effects of dietary CP and dried citrus pulp (DCP, rapidly fermentable carbohydrate source) contents on short-chain fatty acids (SCFA), branched-chain fatty acids (BCFA), and ammonia concentrations in the colon digesta of weanling pigs. One hundred eight barrows weaned at 21 d of age were blocked by initial BW (5.82 ± 0.16 kg) and randomly assigned to one of four treatments with nine replicate pens per treatment and three pigs per pen. Treatments were arranged in a 2 × 2 factorial, with 2 CP contents (HCP and LCP, high- and low-CP diets, respectively) and 2 DCP contents (0 and 7.5%, as-fed basis). The HCP treatments consisted of feeding a 20 and 21%

CP diet (as-fed basis) during the pre-starter I (1 to 14 d) and pre-starter II (15 to 28 d) phases, respectively. For the LCP treatments, diets were reduced by 4% units compared with the HCP diets in both phases. The AA contents in the diets were balanced by supplementation with crystalline AA, such as L-Lys, DL-Met, L-Thr, L-Trp, L-Val, and L-Ile to maintain constant ratios in relation to standardized ileal digestible Lys. Colon digesta samples were collected from one randomly selected pig per pen on d 7 and 28 postweaning for determinations of SCFA and BCFA by gas chromatography, and ammonia concentrations by colorimetry. Statistical analyses were conducted using the PROC MIXED of SAS. Feeding pigs diets containing 7.5% DCP increased ($P < 0.01$) acetic acid concentrations, and decreased propionic ($P < 0.05$) and valeric ($P < 0.01$) acids concentrations, whereas butyric acid production was not affected ($P > 0.05$) by treatments. Dietary DCP inclusion increased ($P < 0.05$) isobutyric acid concentrations in the colon only at 28 d postweaning. Adding 7.5% DCP to the diet resulted in lower isovaleric acid ($P < 0.01$) and ammonia ($P < 0.01$) concentrations in the colon only for pigs fed the LCP diet. In conclusion, low-protein AA-supplemented diets with 7.5% DCP inclusion depresses harmful protein fermentation in the hindgut, and therefore may be contributing to enhance intestinal health of weanling pigs.

Key Words: intestinal health, piglets, protein fermentation

1356 (W174) Effects of dietary supplementation rice bran extracton production performance, feed intake, egg quality and excreta microbiota in laying hens.

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This experiment was conducted to evaluate the effects of dietary supplementation of rice bran extract on production performance, feed intake, egg quality and excreta microbiota in laying hens. A total of 288 Hy-line Brown (46-wk old) laying hens were randomly assigned to 1 of 3 treatments. The trial lasted for 20 wk. The dietary treatments were as follows: 1) CON, free antibiotics diet; 2) RB01, CON +0.01% rice bran extract; 3) RB02, CON + 0.02% rice bran extract. There were 8 replicates per treatment with 12 birds per replicate. Daily records of egg production and feed consumption were kept throughout the experimental period. Egg production was expressed as an average production of hen per day, which was calculated from the total number of eggs divided by the number of experimental time (week as a unit) and summarized on an average basis. A total of 42 salable eggs (no shell defects or cracks) were randomly collected biweekly from each treatment at 1700 h (3 eggs per replication). The egg quality of the collected eggs was then determined at 2000 h on the day of collection. All data were arranged to evaluate by analysis of variance following the GLM procedure in a completely randomized design using the SAS software program (SAS Institute, 1996). Laying hens were blocked with identical age. The difference among treatment was compared using the Duncan's multiple range test. The treatment effect was observed significant with the probability value below 0.05. The egg production of RB02 was higher (92.3 vs. 88.1%; 93.3 vs. 90.3%; $P < 0.05$) than CON at wk 5 and 6. Moreover, the *E. coli* content of excreta microflora of CON was higher (6.62 vs. 6.37 $\log_{10}$cfu/g; $P < 0.05$) than RB02. The Lactobacillus content of CON was lower (7.44 vs. 7.72 $\log_{10}$cfu/g; $P < 0.05$) compared with RB02. In conclusion, dietary supplementation of 0.02% rice bran extract can increase egg production performance and *Lactobacillus content*, and decrease *E. coli* content in laying hens.

Key Words: egg quality, excreta microbiata, feed intake, laying hens, production performance, rice bran extract

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1357 (W175) Injection of glycosaminoglycans and vitamin C in incubation on the weight loss and shell conductance of the eggs.

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Injection of nutrients into eggs can improve the incubation process. This study injected different percentages of a supplement consisting of glycosaminoglycans and vitamin C into eggs and evaluated the effect during incubation on weight loss and shell conductance of the eggs. Two hundred forty fertile broiler (Cobb) eggs from breeder hens at 43 wk of age were used. The eggs were 64 ± 4 g each. The experimental design was completely randomized with five treatments (non-injected eggs, eggs injected with milli-Q water, eggs injected with glycosaminoglycans and vitamin C at 2, 4, and 6% diluted with 100 µL of milli-Q water), distributed in three horizontal Ecological Premium, model IP 120, incubators, with three repetitions and 16 eggs per treatment. Each 100 g of the supplement were composed of: 30,000 mg of chondroitin sulfate, 30,000 mg of glucosamine and 5000 mg of vitamin C and vehicle q.s 100 g. The supplement was injected into the albumen, approximately 6 mm below the eggshell on d 4 of incubation. The injection site was then covered with a label identifying the treatment and repetition. Statistical analsyses were performed using the Statistical Analysis System SAS (2002) program with the averages compared by Tukey test at 5% probability. The weight loss was calculated as a percent from the difference between the weight of the egg at the start of the incubation and at d 18 of incubation. Shell conductance was calculated by weight loss in grams until the transfer/saturation vapor pressure (23.86 mm/Hg at 25°C). Shell conductance is the ability to exchange gases between the egg and the environment, and

is related to the weight loss. The higher the conductance and loss of mass, the greater the evaporative heat loss from the egg will be. In this study, the weight loss was approximately 7.6% and conductance was 0.320 and both were not significantly affected ($P > 0.05$) by the treatments. Therefore, the intra-egg injection of the glycosaminoglycans and vitamin C supplement did not alter the heat loss from evaporation.

Key Words: ascorbic acid, chondroitin, nutrition in ovo

1358 (W176) Effect of material bioconversion natural complex on growth performance, nutrient digestibility, blood characteristics, and fecal microbiota in weanling pigs. J. H. Cho*, M. Begum, and I. H. Kim, *Dep. of Animal Science, Dankook University, Cheonan, South Korea.*

A total of 150 weanling pigs [(Yorkshire × Landrace) × Duroc] with an average initial body weight (BW) of 5.76 ± 1.36 kg were used in a 6-wk trial to investigate the effect of material bioconversion natural complex on growth performance, nutrient digestibility, blood characteristics, fecal characteristics in weanling pigs. All these weanling pigs were randomly allotted into one of the five experimental diets according to their initial BW and sex (6 replicate pens/treatment, 5 pigs/pen, 2 barrows and 3 gilts/pen). Dietary treatments consisted of 1) NC, free antibiotics diet; 2) PC, NC + 0.1% tiamulin; 3) STR1, NC + 0.1% fermented material 1; 4) STR2, NC + 0.1% fermented material 2; and 5) STR3, NC + 0.1% fermented material 3. STR is material bioconversion natural complex powder produced from fermentation of mulberry leaves and turmeric with bacterial of mulberry yellow mushroom. STR1, STR2, STR3 contains 1.5, 3, and 6% of active complex powder, respectively. All diets, in mash form, were formulated to meet or exceed the nutrient requirements (NRC, 2012) for weanling pigs. During wk 3 to 6, pigs fed with PC, STR2 and STR3diets had higher (457, 463, 453 vs. 393 g; $P < 0.05$) ADG than NC treatments. During the overall period, pigs fed NC diet had lower (342 vs. 385, 388 g; $P < 0.05$) ADG than PC and STR2 treatments and the G:F in PC, STR2 and STR3 treatments was significantly higher (0.745, 0.740, 0.715 vs. 0.638; $P < 0.05$) compared with NC treatment. The ATTD of dry matterin STR2 treatment was higher (83.35 vs. 81.36%; 81.27 vs. 79.06%; $P < 0.05$) than NC treatment atthe end of wk 3 and 6. Moreover, the ATTD of nitrogen in PC and STR2 treatments was higher (81.81, 81.35 vs. 78.54%; $P < 0.05$) than NC treatment at the end of 3 wk. Pigs fed with PC diet had higher (8.21 vs. 7.43 $\log_{10}$cfu/g; $P < 0.05$) *Lactobacillus* population than those fed with NC diet. But there was no difference ($P > 0.05$) detected on *E. coli*, and *Salmonella* content at 6 wk. Through the experimental period, there was no difference ($P > 0.05$) observed on fecal score among dietary treatments. During the whole experimental period, no significant difference ($P > 0.05$) was observed on fecal moisture or fecal pH among dietary treatments. In conclusion, supplementation of material bioconversion natural complex may be helpful to improve the growth performance and nutrient digestibility, increase *Lactobacillus* concentrations of weanling pigs.

Key Words: nutrient digestibility, growth performance, *Lactobacillus* population, material bioconversion natural complex, weanling pigs

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1359 (W177) The effects of fermented cotton seed meal on growth performance and egg quality in laying hens. Y. Wang*[1], A. Li[1], Y. Hou[1], Y. Li[2], X. Zhang[1], and H. Wei[1], *[1]Academy of State Administration of Grain, Beijing, China, [2]Animal Diseases Control and Prevention Centre of Miyun City, Beijing, China.*

Cottonseed meal (CSM) is very rich in China, but its nutrient bioavailability is low. Microbial solid-state fermentation is an effective way to improve the nutrient bioavailability of CSM. Therefore, deeply evaluating the nutritional value of fermented cottonseed meal (FCSM) in poultry, pig and ruminants can provide important data support for its reasonable application in animal feed and alleviate the shortage of high quality protein feedstuff. The objective of this study was to evaluate the effects of FCSM on growth performance and egg quality in laying-hens. A total of 660 47-wk-old laying hens were randomly divided into two groups with 110 birds/replicate. A corn-soybean meal (SBM) based control diet was formulated and the experimental diets included FCSM to replace 15% SBM on a kg basis. The trial period was 2 mo. Laying rate, feed to egg ratio, and egg quality were measured. The statistical analysis was performed with SPSS 18.0 software for Windows. Independent sample *t* test was used and a probability level of $P \leq 0.05$ was considered statistically significant. The results indicated that, compared to non-fermented CSM, free gossypol (FG) content of FCSM declined from 706 mg/kg to 257mg/kg, apparent metabolism energy (AME) increased from 8.93 MJ/kg to 9.37 MJ/kg. The number of *Saccharomyces cerevisiae* and *Bacillus subtilis* in FCSM was 1.86×10^8 and 3.1×10^8, besides, the content of small peptides (molecular weight < 600 Da) in FCSM was higher than CSM. No difference was found between treatments regarding the laying rate ($P = 0.383$), feed to egg ratio ($P = 0.318$). Compared to control diet, the FCSM had no adverse effects on yolk relative weight ($P = 0.201$), Haugh unit ($P = 0.499$), yolk color ($P = 0.817$), egg shell strength ($P = 0.923$). In conclusion, FCSM can be used in laying hen diets at up to 15% of the total diet as a promising alternative protein source.

Key Words: laying hen, fermented cotton seed meal, growth performance

1360 (W178) Soybean meals and soy protein concentrates as main source of protein in phase 1 diets for piglets: Growth performance data.

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In total, 192 weanling pigs were used to study the growth performance and incidence of post-weaning diarrhea (PWD) in piglets fed diets based on soybean meals (SBM) of different origins or soy protein concentrates (SPC) from 21 to 58 d of age. In phase 1 (21 to 49 d of age) piglets received one of eight diets that differed in the source of soy protein used. Six of the diets were based ($n = 2$) on SBM from three different origins [USA, Argentina (ARG), and Brazil (BRA)] and the other two diets were based on 2 SPC with 60 or 65% CP, respectively. All diets were isonutritive and contained the same amount of dietary CP from soy origin. In phase 2 (49 to 58 d of age) all pigs received a common commercial diet. In phase 1, growth performance was not affected by diet but PWD was higher in pigs fed the ARG SBM than in pigs fed the other diets ($P < 0.05$). From 28 to 35 d of age, piglets fed the SPC tended to grow faster ($P = 0.056$) than piglets fed the SBM. From 35 to 42 d of age piglets fed USA SBM showed higher ADG ($P < 0.05$) and better G:F ratio ($P < 0.05$) than the average of piglets fed the other diets. However, no differences among diets were observed in phase 2. Cumulatively (21 to 58 d of age), the only difference observed among treatments was for G:F ratio that tended to be better for pigs fed the USA SBM as compared with the average of pigs from all the other treatments ($P = 0.064$). Also, PWD was higher in piglets fed ARG SBM than in piglets fed the other diets ($P < 0.01$). In conclusion, soy source had little effect on performance of pigs but G:F ratio tended to be better in pigs fed SBM of USA origin and PWD was higher in pigs fed the ARG SBM. Therefore, the choice of soy source (SPC and SBM) and SBM origin (USA, ARG, and BRA) might depend at high extent on the objectives and the relative cost of available sources.

Key Words: piglet growth, soybean meal origin, soy protein concentrate

1361 (W179) Standardized total tract digestibility of phosphorus in camelina (*Camelina sativa*) meal fed to growing pigs without or with phytase supplementation.

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A study was conducted to determine the apparent (ATTD) and standardized (STTD) total tract digestibility of phosphorus (P) in camelina meal fed to growing pigs and the effect of phytase supplementation on STTD of P in camelina meal. Eighteen growing pigs (average initial BW of 18.1 ± 0.70 kg) were placed individually in metabolism crates which allowed for the total but separate collection of feces and urine. Pigs were allotted to one of three experimental diets, containing either 1) 20% camelina meal without phytase, 2) 20% camelina meal with 500 FTU/kg phytase or 3) a constarch-gelatin based P-free diet, in a completely randomised design to give six replicates per diet. The P-free diet formulated to contain 18.0% CP was used to determine endogenous P losses (EPL) to estimate STTD of P in camelina meal. Pigs were fed their respective diets in two equal portions at 0830 and 1630 h. Daily feed allowance was based on the body weight at the beginning of experiment and was calculated to supply 2.6 times the estimated maintenance energy requirements. The experiment lasted for 14 d, and pigs were adapted to their respective diets for the initial 9 d followed by a 5-d period of total collection of feces and urine. The ATTD of P and EPL were 55.4% and 108 ± 48.9 mg/kg DMI, respectively, whereas the STTD of P was 57.4%. Phytase supplementation increased ($P < 0.05$) the ATTD and STTD of P in camelina meal to 68.3 and 70.0%, respectively. Phytase supplementation increased ($P < 0.05$) P retention (66.8 vs. 54.6%) and reduced ($P < 0.05$) P output in the feces (0.50 vs. 0.71 g/d). The standardized total tract digestible P content in camelina meal was estimated at 5.45 g/kg.

Key Words: camelina meal, endogenous losses, phosphorus, pig

1362 (W180) Effects of adding a dried food waste product to the diets of finishing pigs on growth, feed intake, and nutrient digestibility.

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A study was conducted to measure the effects of adding a dried food waste product (DFWP) to the diets of late finishing pigs. The product was derived from bakery and vegetable food waste being aerobically digested (BioGreen 360) and heated to over 150°C during drying. Before mixing the diets, the DFWP used in the study was analyzed for nutrient content and found to have 84.0% DM, 10.95% CP, 15.42% EE, 0.42% Lys, 0.17% Ca, and 0.22% P. Nine finishing pigs (132 kg BW) were allotted randomly to one of three dietary treatments: 1) corn-SBM-based control diet; 2) control with 5% DFWP added; and 3) control with 10% DFWP added. All diets were balanced for lysine, Ca, and P (NRC, 2012). The study was conducted in three 1-wk periods, with each pig being fed a different diet each week with a 5-d adjustment period followed by a 2-d collection of feces. Pigs were weighed weekly and feed disappearance was measured daily. Fecal grab samples were dried and analyzed for DM, CP, EE, and ADF. Acid-insoluble ash was used as an indigestible marker for digestibility calculations. During the experiment, average daily gain (ADG) increased linearly ($P < 0.05$) with increasing DFWP addition to the diet. Average daily feed intake (ADFI) decreased numerically in pigs fed diets with 10% DFWP, as expected due to the high fat content of DFWP. Digestibility

estimates for DM, CP, fat, and ADF were not influenced by collection period and were pooled across period to estimate the effect of dietary DFWP addition. DM digestibility averaged 94.6% for all diets and was not influenced ($P > 0.10$) by DFWP addition. CP digestibility was also not affected ($P > 0.10$) by DFWP addition to the diet and were 81.1%, 81.2%, and 80.9% for Diets 1, 2, and 3, respectively. Fat digestibility (51.9%, 55.3%, and 62.8% for Diets 1, 2, and 3, respectively) increased linearly ($P < 0.01$) with increasing DFWP addition to the diet and was higher ($P < 0.10$) than the control diet when 5 or 10% DFWP was added. ADF digestibility was not affected ($P > 0.10$) by DFWP addition to the diet. Based on this experiment, the DFWP produced by the Biogreen 360 food waste digester is palatable for growing pigs, increases the fat digestibility of a corn-SBM based diet, and does not negatively influence protein or ADF digestibility when added up to 10% of the diet.

Key Words: pigs, food waste, digestibility

1363 (W181) Determination of the effect of the level of corn starch in the diet on the energy value of crude glycerin in swine. C. Ordoñez-Gomez*[1,2], C. Ariza-Nieto[3], and G. Afanador-Tellez[2], *[1]Universidad Francisco de Paula Santander-Ocaña, Colombia, [2]Universidad Nacional de Colombia, Bogotá, [3]CORPOICA, Mosquera, Colombia.*

Crude glycerin (CG), a byproduct of biodiesel, generates interest in animal feed because of its energy value. To determine the effect of the level of starch in the diet on the digestible energy (DE) of crude glycerin in swine this study was developed. The DE was determined for crude glycerin with 10 barrows placed in metabolic cages using 0.5% chromium oxide as an indigestible dietary indicator. The treatments consisted in two starch levels (SL) 10 and 12%, and five levels of CG substitution 0, 2.5, 5, 7.5 and 10%. Each period consisted of 5-d adjustment period, a 2-d collection period. During the collection period, feces and urine were collected separately and stored at 0°C until analysis to calculate metabolized energy (ME). The data were subjected to multiple linear regression analysis determining the value of the DE and ME of CG, as the slope of the line and N metabolism data as a Latin square design using the GLM and REG modules of SAS ver. 9.2. DE value of diet corrected by dietary starch content was described as, DE of diet corrected by starch (Kcal/kg) = 2952.1 +30.9(period) +4427.3(CG) + 31.5(SL)- 691.5(CG: SL). According to the slope, DE value of CG depended of SL ($P < 0.001$) estimated in 4427 and 3769 Kcal/kg DM for 10 and 12% of SL, respectively. ME of CG was determined as 3436 Kcal/kg DM, no effect ($P > 0.05$) of SL on the value of the ME of the CG was observed, although no quadratic effect of level of CG was observed ($P > 0.05$). An increase ($P < 0.001$) in urinary energy (UE) was observed as CG increased in the diet; UE (Kcal/kg DMI) = 159.6 +7.99(CG). There was an interaction between CG and SL ($P < 0.001$) which caused an increased in the amount of nitrogen digestible (AND) when CG increased by the 10% SL. However, the AND decreased when CG was increased by the 12% SL. According to these results, it was established that SL affects DE value of CG and the nitrogen metabolism in pigs.

Key Words: energy, crude glycerin, starch

1364 (W182) Effect of the substitution of soybean meal and sorghum for cull chickpeas on the apparent digestibility of nutrients in diets for growing pigs. J. M. Uriarte*, R. Barajas Cruz, J. A. Romo Rubio, H. R. Guemez Gaxiola, J. M. Romo Valdez, J. F. Nuñez, and N. A. López, *Universidad Autónoma de Sinaloa, Culiacán, México.*

The objective of this experiment was to determine the effect of the substitution of soybean meal and sorghum for cull chickpeas (CP average value of 24%, and 3.0 Mcal ME/kg, crude fat 5%) on apparent digestibility of nutrients in diets for growing pigs. Six pigs (BW = 36.15 ± 1.5 kg; Large White × Landrace × Large White × Pietrain) were used in a replicated Latin square design. Pigs were assigned to consume one of three diets: 1) Diet with 18.2% CP and 3.2 Mcal ME/kg, containing sorghum 68.6%, soybean meal 27.4%, and premix 4.0% (CONT); 2) Diet with 17% CP and 3.2 Mcal ME/kg with sorghum 48.5%, cull chickpeas 35%, soybean meal 10.0%, vegetable oil 2.5%, and premix 4.0% (CHP35), and 3) Diet with 20.5% CP and 3.1 Mcal ME/kg with sorghum 17.0%, cull chickpeas 70%, soybean meal 5.0%, vegetable oil 4.0%, and premix 4.0% (CHP70). Pigs were individually placed in metabolic crates (0.6 × 1.2 m). The adaptation period was 6 d and sample collection period was 4 d. From each diet and period, one kg of diet was taken as a sample and the total fecal production was collected. Feed Intake (1.88, 1.86 and 1.68 kg/day) was not affected by treatments ($P = 0.10$) for CONT, CHP35 and CHP70, respectively. Apparent digestibility of DM (82.9, 83.7 and 82.9%) was equal ($P = 0.81$) across treatments. Apparent digestibility of crude protein was not altered ($P = 0.35$) by CHP inclusion (78.4, 77.5 and 76.0%). These results suggest that cull chickpeas can be used up to 70% in growing pig diets without affecting nutrient digestibility.

Key Words: chickpeas, digestibility, pigs