

Nonruminant Nutrition: Feed Ingredients

TH310 Effect of a controlled fermentation process on the content of digestible phosphorus in diets for growing pigs. R. Schemmer*¹, B. Drüning¹, G. Stalljohann², and K.-H. Südekum¹, ¹University of Bonn, Bonn, Germany, ²Agricultural Chamber of North Rhine-Westphalia, Münster, Germany.

This study determined the effect of controlled fermentation processes on P digestibility in diets for growing pigs. Six diets were formulated and adjusted to a maximum of 2.0 g/kg DM of digestible P to minimize regulatory fecal P excretion. The diets were as follows: 1) basal diet (BD; 64.3% pregelatinized wheat starch, 14.8% dried beet pulp, 8.5% potato protein, 6.5% whole-egg powder, 2.2% cellulose, 1.7% soybean oil, 1.2% premix, 0.8% CaCO₃); 2) dry diet (DD)+ 40% BD; 3) fermented diet (FD)+ 40% BD; 4) wheat + 40% BD; 5) barley + 40% BD; and, 6) soybean meal + 50% BD. The DD and FD consisted of (DM basis) wheat (58%), barley (26%), soybean meal (SBM) (15%), and soybean oil (1%). P digestibility values for DD, FD, wheat, barley, and SBM were calculated by subtracting the respective values of BD. The FD was prepared in a batch process at 30% DM (pH, 3.8). Fermentation was induced by a lactic acid bacteria strain and water (25°C). Eight male castrated pigs [(German Landrace × Large White) × Pietrain] from one litter with an initial BW of 24.5 (SD 1.74) kg were used. Each diet was tested simultaneously with 4 pigs using a standardized protocol. Pigs were kept in metabolism cages and consumed their feed in amounts corresponding to 2–2.5 multiples of ME requirement for maintenance. After 7 d for adaptation, feces were completely collected for 7 d to determine P digestibility. Total P concentrations of BD and of wheat, barley, SBM, DD, and FD were 1.84, 3.50, 3.96, 6.81, 4.17, and 4.22 g/kg DM, respectively. The mean (SD) P digestibility values of BD and of wheat, barley, SBM, DD, and FD were 72.7 (3.28), 70.0 (2.54), 51.2 (0.72), 50.9 (5.55), 63.5 (2.87), and 80.8% (1.47), respectively. Fermentation improved P digestibility (DD compared with FD) by 17 percentage units ($P < 0.001$). Furthermore, P digestibility of DD calculated from measured values of ingredients weighted by their dietary inclusion level gave almost perfect accord with measured P digestibility of DD (62.1 versus 63.7%).

Key Words: fermentation, phosphorous digestibility, pigs

TH311 Effects of dietary fat source and feeding pattern on performance, tissue fatty acids composition, and serum insulin and ghrelin dynamics in grower-finisher pigs. J. S. Kim¹, S. L. Ingale¹, K. H. Kim¹, S. Lee¹, J. S. Kim¹, E. H. Kim², D. C. Lee², and B. J. Chae*¹, ¹Department of Animal Resource Science, Kangwon National University, Chuncheon, Gangwon-do, Republic of Korea, ²Department of Biosystem Engineering, Kangwon National University, Chuncheon, Gangwon-do, Republic of Korea.

The present study investigated the effects of dietary fat source and feeding pattern on performance, fatty acids composition of various tissues, and dynamics of serum insulin and ghrelin in grower-finisher pigs. A total of 128 grower-finisher pigs (initial BW, 81.23 ± 0.32 kg) were allotted to 4 treatment groups with 8 pigs per pen and 4 pens per treatment. Pigs were fed diets containing linseed oil or animal fat, either ad libitum or restricted in 2 × 2 factorial arrangement for 28 d. For analysis of serum ghrelin and insulin dynamics blood samples were collected 1 h before feeding (–1 h) and 2, 4 and 6 h after feeding. Data were analyzed as a 2 × 2 factorial arrangement of treatments in completely randomized block design and the main effects of fat source, feeding pattern and their

interaction were determined by the GLM procedure of SAS. Fat source of diet had no effects ($P > 0.05$) on growth performance and ATTD of nutrients. The ADG and ADFI of pigs fed ad libitum were greater ($P < 0.05$) than restricted fed pigs. The G:F of restricted fed pigs was greater ($P < 0.05$) than ad libitum fed pigs. Pigs with restricted feeding had greater ($P < 0.05$) ATTD of DM, CP, and GE than pigs fed ad libitum. Pigs fed linseed oil diet had greater ($P < 0.05$) concentration of polyunsaturated fatty acids in liver and adipose tissues. Pigs offered ad libitum feed had greater ($P < 0.05$) serum insulin during all samplings and increased after feeding in all treatments. Serum ghrelin concentrations in restricted fed pigs were highest ($P < 0.05$) before feeding and declined 2 and 4 h feeding. Also, serum ghrelin concentration of restricted fed pigs was greater ($P < 0.05$) than ad libitum fed pigs during –1 and 6 h sampling. Serum insulin and ghrelin concentration were not affected by dietary fat source. It is concluded that feeding of linseed oil instead of animal fat improved the polyunsaturated fatty acids content of tissues without affecting performance pigs.

Key Words: animal fat, fatty acid, feeding pattern

TH312 Influence of level of fiber inclusion in the diet two different hygiene conditions in weaned pigs. J. D. Berrococo*, B. Saldana, P. Guzman, L. Camara, and G. G. Mateos, Universidad Politecnica de Madrid, Madrid, Spain.

The effects of including addition of fiber source on performance of weaning pigs reared under different hygiene conditions (“clean” vs. “dirty barn”) was evaluated. There was a control diet based that contained 2.2% crude fiber and 8 extra treatments similar to the control diet that included 4 different sources of fiber (SBP, sugarbeet pulp, STR, cereal straw, OH, oat hulls, and WHM, wheat middling) at 2 levels of inclusion (2.5 and 5%). A first batch of pigs were housed a clean barn and afterward, a second batch of pigs of same origin was housed in the same barn without any cleaning. Data on growth performance and nutrient digestibility was analyzed as a completely randomized design with hygiene conditions and source and level of fiber as main effects. In addition, treatment means were compared using these preplanned non-orthogonal contrasts: (1) control vs. all additional fiber diets, (2) control vs. all additional fiber diets in clean hygiene conditions, and (3) control vs. all additional fiber diets in dirty hygiene conditions. For the entire experiment (21 to 42 d of age), pig reared in the clean environment had higher ADG and ADFI ($P < 0.05$) and lower incidence of post weaning diarrhea (PWD; $P < 0.001$) than pig in the dirty environment. Fiber inclusion did not affect pig growth but PWD was lower ($P < 0.01$) in pigs fed the control diet than in pigs fed the fiber containing diets. CP digestibility was not affected by fiber source. Total tract apparent digestibility (TTAD) of all nutrients was higher ($P < 0.001$) for the SBP diet than for the STR diet with diets containing OH or WHM being intermediate. Also, TTAD of the nutrients was higher ($P < 0.001$) for pigs reared in the clean than for pigs reared in the dirty environment. It is concluded that, piglets reared under high hygiene status showed improved nutrient digestibility and growth performance and reduced PWD as compared with pigs reared under low hygiene status. Also, the inclusion of fiber in the diet increased PWD and reduced nutrient digestibility but had little effect on growth performance

Key Words: dietary fiber, pig, sanitary conditions

TH313 Effects of inclusion of spray-dried porcine plasma in lactation diets on sow and litter performance. S. D. Carter^{*1,6}, L. I. Chiba^{2,6}, M. D. Lindemann^{3,6}, M. J. Estienne^{4,6}, and G. J. M. M. Lima^{5,6}, ¹Oklahoma State University, Stillwater, ²Auburn University, Auburn, AL, ³University of Kentucky, Lexington, ⁴Virginia Tech University, Blacksburg, ⁵Embrapa Swine and Poultry, Concordia, SC, Brazil, ⁶S-1044 Committee on Nutritional Systems for Swine to Increase Reproductive Efficiency.

A cooperative study, utilizing 404 primi- and multi-parous crossbred sows from 5 experiment stations (AL, KY, OK, VA, and Brazil), was conducted to determine the effects of inclusion of 0.50% spray-dried porcine plasma (Appetein, APC Inc., Ankeny, IA) in corn-soybean meal diets on sow and litter performance. Crossbred sows were fed corn soybean meal-based diets containing a minimum of 0.50% SID lysine during gestation. Sows were allotted at farrowing, based on body weight and parity, to 2 dietary treatments. The control (C) diet was a fortified corn soybean meal diet. Appetein (App) was added to the control diet at 0.50% at the expense of soybean meal to formulate the test diet. Both diets were formulated to 0.90% SID lysine and 3,414 kcal/kg ME. A common trace mineral and vitamin premix was used at all stations with the exception of Brazil. Chromium picolinate was added to each diet to provide 200 ppb Cr. Sows were allowed ad libitum access to feed. Sows were weighed within 24 h after farrowing, and all litters were adjusted to >10 pigs/litter by d 2 following farrowing. Average sow parity, number of pigs on d 2, and lactation length for the C and App treatments were, respectively: 2.5 and 2.3; 11.0 and 10.7; and 23 and 23 d. The ADFI during lactation for C and App diets were similar (5.65 kg/d; $P > 0.10$). Sow weight after farrowing averaged 217 kg ($P > 0.10$). The number of pigs weaned (9.9 vs. 9.7), litter weaning weights (68.4 vs. 69.1 kg), litter weight gains (51.6 vs. 52.2), sow weight change during lactation (-6.0 vs. -8.3 kg), and return-to-estrus interval (7.5 vs. 7.2 d) were not affected ($P > 0.10$) by dietary treatment. There were no station \times treatment interactions ($P > 0.10$). Additionally, the data were sorted by parity (<3 vs. 3 and greater), ambient temperature (hot vs. thermoneutral), and season (summer vs. winter). No differences between treatments were observed within any data set. These results indicate no benefit of inclusion of spray-dried porcine plasma in lactation diets for sows nursing > 10 pigs and consuming a corn-soybean meal diet containing 0.90% SID lysine.

Key Words: sow, spray-dried porcine plasma, lactation

TH314 Effects of spray-dried plasma replacement for soy protein concentrate on growth performance of weaned pigs. M. Q. Resende*, A. G. Mascarenhas, R. C. Nunes, E. Arnhold, K. A. Teixeira, K. M. Borges, L. V. G. C. Mota, and H. H. C. Mello, *Universidade Federal de Goiás, Goiânia, GO, Brazil.*

Some research demonstrate improvement on piglets growth performance (GP) by including soy protein concentrate (SPC) on post weaning diets, due to reduction of the hypersensitivity to soy allergens. The aim of this work was to assess the spray dried plasma (SDP) replacement for SPC over GP, small intestine histology and blood leucocytes and lymphocytes of post weaned pigs. A total of 54 pigs, weaned at 21 ± 2 d (initial BW: 6.96 ± 0.80 kg), were randomly assigned to 3 diets, 6 replicate pens per diet, and 3 pigs per pen in a randomized block design by initial BW. Corn-soybean mash diets were isonitrogenous and isocaloric: T1) 0% SPD + 5% SPC; T2) 2.5% SPD + 2.5% SPC; T3) 5% SPD + 0% SPC. Experimental diets were fed in 2 dietary phases (0 – 11 d and 11 – 20 d post weaning), and a common diet were fed through 20 – 45 d post weaning. Pigs were allowed ad libitum access to feed and water throughout the 45 d experimental period. The minimum and maximum ambient

temperature was 18°C and 32°C. Animals were weighed at d 0, 11, 20 and 45. Feed intake was recorded at d 11, 20 and 45 post weaning. A pig per pen was euthanized on d 11 to collect small intestine and blood samples. Data were analyzed by ANOVA using the GLM procedure of SAS, and the means of the treatments were compared by Duncan test. T2 showed greater final body weight (9.606, 9.254, 8.659 kg), ADFI (0.324, 0.268, 0.253 g) and ADG (0.212, 0.172, 0.124 g) during 0 – 11 d period, compared with T1 and T3. However there were no statistical differences in GP during 45 d experimental period among treatments. On d 11 no difference were observed in villus height, crypt depth and villus:crypt ratio of duodenum, jejunum and ileum. Related to blood cells, T1 showed fewer leucocytes ($13.501, 16.350, 19.638 \times 10^3/\mu\text{L}$) and lymphocytes ($6.869, 9.164, 10.123 \times 10^3/\mu\text{L}$) counts in blood compared with T2 and T3. This confirms the SDP potential to improve immunity of post weaned pigs, which was not promoted by SPC. We conclude that SDP should not be totally replaced from SPC in piglet diets during the first 11 d after weaning, but the use of both can be recommended.

Key Words: intestinal morphology, lymphocyte, nursery diet

TH315 Growth performance, carcass characteristics and meat quality of pigs fed crude glycerin. C. A. Ordonez-Gomez^{*1,3}, S. Castaneda¹, H. Florez¹, G. Afanador², and C. Ariza-Nieto¹, ¹CORPOICA, Bogota, Colombia, ²Universidad Nacional de Colombia, Bogota, Colombia, ³Universidad Francisco de Paula Santander Ocana, Ocana, Colombia.

The aim of this study was to evaluate the effect of the inclusion level of crude glycerin in the diet of growing pigs on growth performance, carcass characteristics and meat quality. The crude glycerin presented the following composition: 3696 kcal GE/kg, 3579 kcal ME/kg, 8.29% moisture, 82.0% glycerol, 0.79% crude fat, 1.21% sodium and 16 ppm of methanol. Diets were formulated as isocaloric and isoprotein (3200 kcal ME/kg in all phases, 19.1% CP, 0.879% digestible lysine from 20 to 30 kg BW; 17.7% CP, 0.806% digestible lysine from 30 to 50 kg BW; 16.8% CP, 0.747% digestible lysine from 50 to 70 kg BW; 15.5% CP, 0.663% digestible lysine from 70 to 100 kg BW). A total of 36 pigs (average BW 23.05 ± 2.86 kg) were randomly assigned to one of the 3 treatments: 1) control without crude glycerin; 2) 5% crude glycerin; 3) 10% crude glycerin. Pigs were housed in 12 pens; 4 replicates (pens), 3 pigs/replicate. During the study, pigs in each pen were weighed weekly and feed residuals were used to calculate daily feed intake and feed conversion. At the time of slaughter (100 kg BW), one pig per replicate was selected and slaughtered to determine carcass weight (CW), backfat thickness (BF), loin eye area at the last rib on the right side (LA), and lean meat yield (LMY). Loin samples were cut into chops to determine quality attributes such as color, pH, water retention capacity (WRC), and shear force (SF). Data were analyzed using PROC GLM of SAS (Ver. 9.0, SAS Institute, Cary, NC) as a completely randomized block design. Results showed that crude glycerin inclusion did not affect ($P > 0.05$) growth performance (ADG 848 ± 42 g; ADFI 2361 ± 139 g; feed conversion 2.79 ± 0.2 g/g), carcass characteristics (CW 82 ± 8.5 kg; LWY 37.2 ± 7.5 kg) and meat quality (WRC 6.4 ± 2.1 mm²/mm²; SF 5.7 ± 1.5 kg). It can be concluded that crude glycerin inclusion can be used up to 10%, without adversely affecting the performance of growing pigs.

Key Words: crude glycerin, growth performance, pork quality

TH316 Energy concentrations in distillers dried grains with solubles containing different fat concentrations and the effect of corn oil addition on energy concentrations in diets fed to growing pigs. D. Y. Kil¹, J. W. Lee², D. M. D. L. Navarro^{*2}, and H. H.

Stein², ¹Chung-Ang University, Anseong-si, Gyeonggi-do, Republic of Korea, ²University of Illinois at Urbana-Champaign, Urbana.

An experiment was conducted to determine apparent digestible energy (DE) and metabolizable energy (ME) concentrations in 3 sources of distillers dried grains with solubles (DDGS) containing different fat concentrations and the effect of addition of supplemental corn oil to the diets containing low-fat DDGS on DE and ME concentrations of the diets. A total of 48 growing barrows were used in 2 separate periods and each period consisted of 24 barrows. Initial body weights of pigs were 17.5 ± 1.19 and 13.2 ± 1.53 kg for period 1 and 2, respectively. Each period consisted of 5-d adaptation period to the diets and 7-d collection period. Pigs were raised in metabolism crates at all times. Three sources of DDGS were conventional DDGS containing high level of fat (HF-DDGS), DDGS containing medium level of fat (MF-DDGS), and DDGS containing low level of fat (LF-DDGS). The basal diet was formulated with 972 g/kg corn and 3 diets were prepared by mixing 480 g/kg corn with 500 g/kg HF-DDGS, MF-DDGS, or LF-DDGS. Two additional diets were formulated by adding 15.0 or 23.0 g/kg corn oil to the diets containing MF-DDGS or LF-DDGS at the expense of MF-DDGS or LF-DDGS. Results indicated that the LF-DDGS diet had less ($P < 0.01$) DE and ME concentrations than the HF-DDGS diet, but the MF-DDGS diets had DE and ME concentrations that were not different from the HF-DDGS diet or the LF-DDGS diet. Addition of corn oil to the MF-DDGS diet or the LF-DDGS diet increased DE and ME concentrations of these diets, which were close to those of the HF-DDGS diet. The DE and ME concentrations of LF-DDGS and MF-DDGS were less ($P < 0.01$) than those of HF-DDGS, but the energy values for MF-DDGS were not different from those for LF-DDGS. In conclusion, low-fat DDGS has less energy value than conventional high-fat DDGS, and therefore, when low-fat DDGS is included in swine diets at the expense of high-fat DDGS, addition of supplemental oil or fat may be required to compensate for decreased energy concentrations in the diets.

Key Words: distillers dried grains with solubles, fat concentration, pig

TH317 Effect of diet complexity and an enzyme-treated soy protein plus yeast on performance in weanling pigs. T. Tsai^{*1}, H. Kim¹, G. Fitzner², J. K. Apple¹, J. J. Chewning¹, and C. V. Maxwell¹, ¹University of Arkansas, Fayetteville, ²Hamlet Protein Inc., Findlay, OH.

Weaned pigs (n = 288; 20.4 ± 1.26 d, BW 6.52 ± 0.02 kg) were used to test the effect of diet complexity on the efficacy of increased replacement of ETSP with ETSP plus yeast (ETSPY) on growth performance. Pigs were blocked by BW into 8 blocks, allotted to gender-balanced pens (6 pigs/pen), and pens within blocks were assigned randomly to 1 of 6 dietary treatments fed during phases 1 (10 d) and 2 (13 d): (1) complex diets (PC) with SBM, fishmeal, plasma protein (PP), whey, and lactose; (2) simple diets (NC) containing SBM, PP, and whey; (3) NC diets with 20 and 15% ETSP, respectively; (4) NC diets with 33% ETSP replaced by ETSPY; (5) NC diets with 67% ETSP replaced by ETSPY; and 6) NC diets with 100% ETSP replaced by ETSPY. All pigs received a corn-SBM diet during phase 3 (14 d). Nursery diets were formulated with 2.6, 2.5, and 2.5 Mcal NE/kg and 1.47, 1.43, and 1.28% SID Lys, respectively. In phase 1, ADG was similar ($P = 0.07$) between PC- and NC-fed pigs, but ADG and ADFI increased linearly with increasing replacement of ETSP with ETSPY. ADG, ADFI, and G:F did not differ among treatments in phase 2. In phase 3, however, pigs previously fed ETSPY and ETSP diets had greater ADG than those previously fed NC. Results suggest that pigs fed ETSPY had improved growth rates over pigs fed ETSP, especially after withdrawal, and diet complexity did not affect performance of weanling pigs.

Table 1.

	Dietary treatment						SEM	P-value		
	1 (PC)	2 (NC)	3 (100% ETSP)	4 (33% ETSPY)	5 (67% ETSPY)	6 (100% ETSPY)		Linear 3-6	1 vs. 3-6	2 vs. 3-6
0-10 d										
ADG, kg/d	0.17	0.18	0.17	0.17	0.21	0.21	0.01	0.019	0.093	0.581
ADFI, kg/d	0.23	0.22	0.22	0.22	0.24	0.25	0.01	0.021	0.750	0.312
G:F	0.73	0.82	0.79	0.80	0.84	0.81	0.03	0.336	0.014	0.651
10-23 d										
ADG, kg/d	0.44	0.46	0.45	0.46	0.45	0.45	0.02	0.935	0.465	0.722
ADFI, kg/d	0.59	0.60	0.61	0.62	0.62	0.62	0.02	0.595	0.101	0.258
G:F	0.74	0.76	0.73	0.74	0.72	0.71	0.02	0.281	0.302	0.047
23-37 d										
ADG, kg/d	0.71	0.70	0.74	0.72	0.72	0.75	0.01	0.589	0.251	0.022
ADFI, kg/d	1.08	1.08	1.15	1.08	1.13	1.17	0.03	0.496	0.098	0.142
G:F	0.65	0.64	0.64	0.65	0.64	0.64	0.01	0.956	0.490	0.955

Key Words: diet complexity, enzyme-treated soy protein plus yeast, nursery pig performance

TH318 Low oligosaccharide soybean meal improves nursery pig performance. V. Perez^{*1}, N. Bajjalieh², T. Radke¹, and D. Holzgraebe¹, ¹ADM Alliance Nutrition Inc., Quincy, IL, ²Integrative Nutrition Inc., Decatur, IL.

Data from our lab showed a larger swine ME in low oligosaccharide (LO) soybean meal (SBM) vs. conventional (C) SBM. To assess the value of C vs. LO soybeans and 2 processing approaches (SBM or soybean white flakes [SWF; post-hexane oil extraction]), 200 pigs (6.0 ± 0.3 kg BW; ~21 d old) were used in a completely randomized block design with 5 dietary treatments. Each treatment had 10 block-replicates. The ME in SBM and SWF from C and LO was assumed the same. Treatments were (1) Control, with SBM-C and formulated to have ME, Lys (ileal digestible), and Lys:ME as reported in National Swine Nutrition Guide (2010); (2) with SBM-C and formulated with 110 kcal less of ME/kg of diet, but same Lys as Control (so that AA would not limit growth if LO ingredients contribute with extra energy); (3) as diet 2 but using SBM-LO; (4) as diet 2 but using SWF-C; (5) as diet 2 but using SWF-LO. Experimental diets were fed during 25 d post-weaning, following a feeding program of 5, 6, 7 and 7 d for phases 1, 2, 3 and 4, respectively. Then, treatment 1 phase 4 diet was fed to all pigs for additional 7 d. Dietary inclusion of soy products in treatments 1 vs. 2 to 5 was: 20 vs. 30% in phase 1; 30 vs. 32% in phase 2; 35 vs. 38% in phase 3; and 43 vs. 40% in phase 4. Data were analyzed using the MIXED procedures of SAS; block was used as a random effect in the model. From d 0 to 5, pigs fed soybeans LO ate 18% more ($P = 0.07$) than pigs fed soybeans C. Pigs fed SBM-LO diets had equal or better performance than pigs fed Control diets (Table 1), despite the reduction in ME. Pigs fed SWF had the lowest ($P < 0.05$) G:F to d 25 and 32. In conclusion, SBM-LO is a value added option to replace SBM-C in nursery diets.

Table 1. Effect of soybean meal (SBM) and white flakes (SWF), conventional (C) and low oligosaccharide (LO), on nursery pig performance

Response	Control ¹	SBM-C	SBM-LO	SWF-C	SWF-LO	SEM
ADFI d 0-25, g/d ²	484 ^b	463 ^b	522 ^a	474 ^b	490 ^b	17
ADG d 0-25, g/d ²	369 ^{ab}	355 ^{bc}	388 ^a	322 ^d	332 ^{cd}	13
ADFI d 0-32, g/d ²	580 ^b	566 ^b	621 ^a	575 ^b	595 ^{ab}	18
ADG d 0-32, g/d ²	427 ^{ab}	416 ^b	444 ^a	406 ^b	418 ^{ab}	13

^{a-d} Within a row, means with different superscripts differ, $P < 0.05$.

¹Diets had 110 kcal more of ME/kg than the others.

²C vs. LO, $P < 0.05$.

Key Words: soybean meal, nursery pig, oligosaccharide

TH319 Growth performance, intestinal morphology, and blood parameters of piglets fed different soy protein concentrate levels.

M. Q. Resende*, A. G. Mascarenhas, J. H. Stringhini, E. Arnhold, K. A. Teixeira, H. P. F. Xavier, R. D. Silva, and H. H. C. Mello, *Universidade Federal de Goiás, Goiânia, GO, Brazil*.

Piglet's first contact to soybean antigens (conglycinin and β -conglycinin) leads to a transient hypersensitivity, which usually causes diarrhea, low performance, and morphological changes in the small intestine of post weaned pigs. In the current experiment 72 male weanling pigs (initial BW = 6.92 ± 0.98 kg, 21 ± 2 d old) were used to assess the effects of soy protein concentrate (SPC) inclusion in diets on growth performance, intestinal morphology and blood parameters. Pigs were randomly assigned to 1 of 4 treatments with 6 replicate pens per treatment and 3 pigs per pen, in a randomized block design by initial BW. Corn-soybean meal mash diets were formulated to meet pig requirements according to Brazilian tables. Dietary treatments were diet without SPC (0S); diet with 3% of SPC (3S); diet with 6% of SPC (6S); diet with 9% of SPC (9S). Experimental diets were fed in 2 dietary phases (0–11 d and 11–20 d post weaning), and a common diet were fed through 20–45 d post weaning. Pigs were allowed ad libitum access to feed and water throughout the 45 d experimental period. Animals were weighed at d 0, 11, 20 and 45. Feed intake was recorded at d 11, 20 and 45. One pig per pen was euthanized on d 11 to collect samples of small intestine and blood. Statistical analyses were performed by ANOVA using the GLM procedure of SAS. No differences were observed in ADFI, ADG and G:F ratio ($P > 0.05$) within periods of 0–11 d, 0–20 d and 0–45 d after weaning. Although 6S showed 24%, 15%, 14% higher G:F and 28%, 4%, 28% higher ADG compared with 0S, 3S and 9S, respectively, in 0–11 d period. Intestinal morphology, blood leucocytes and eosinophils did not differ among treatments ($P > 0.05$), what indicates that mucosa atrophy was not avoided with SPC inclusion. Despite the better G:F ratio and ADG in the first period, numerically differences showed by 6S were reduced in the 45-d period, thus performance from all treatments were similar in the 45-d experimental period. We concluded that SPC can be recommended in piglet diets after weaning.

Key Words: anti-nutritional factor, nursery diet, weaned pig

TH320 Effects of cocoa powder as a source of theobromine in diets on performance of weanling pigs.

G. L. Cromwell*, M. D. Lindemann, and H. J. Monegue, *University of Kentucky, Lexington*.

Chocolate powders and confectioneries are sometimes used to replace a portion of dried milk or whey products in starter diets for early weaned pigs. Cocoa, a primary component of chocolate, contains methylxanthines; the major one being theobromine (TB) which is known to be toxic in a variety of animals (especially dogs and horses) at relatively

low doses. Whether the amount of TB is sufficient to cause reduced performance in weanling pigs when chocolate-containing ingredients are included in diets is unknown. A 21-d experiment involving 225 pigs initially averaging 20.6 d of age and 6.6 kg BW was conducted to evaluate levels of TB on performance of weanling pigs. Pure cocoa powder (International Ingredient Corp., St. Louis, MO) was used as a source of TB. The cocoa contained 95.5% DM, 26.6% CP, 11.2% fat, 0.93% Lys, and 2.07% TB. Typical phase-1 and phase-2 diets were fed for 10 and 11 d, respectively. Cocoa was added to diets at 0, 0.42, 0.85, 1.27, and 1.69%, which supplied 0, 87, 175, 262, and 350 ppm TB. Dietary Lys was 1.38 and 1.26% in the 2 phases. A common phase 3 corn-soybean meal diet (1.18% Lys) was fed to all pigs for 14 d following the 21-d experimental period. Each diet was fed to 9 pens of 5 pigs each. ADG and ADFI during the 21-d experimental period were quadratically ($P < 0.05$) affected by level of cocoa (361, 383, 398, 366, 363 g/d; 552, 558, 616, 553, 543 g/d), but F:G ratios were not affected (1.54, 1.46, 1.55, 1.51, 1.50). Similar quadratic responses in ADG (619, 611, 656, 613, 630 g/d) and ADFI (1072, 1044, 1140, 1058, 1050 g/d) occurred during the 14-d period when a common diet was fed and over the combined 35-d experimental and post-experimental period (ADG: 464, 474, 501, 465, 470 g/d ADFI: 760, 752, 826, 755, 746 g/d), but F:G was not affected (1.64, 1.59, 1.65, 1.62, 1.58). The results indicate that up to 1.69% cocoa which supplied 350 ppm TB in diets did not negatively influence feed intake or growth rate in weanling pigs when compared with a diet without cocoa. These levels of pure cocoa (1.69%) and TB (350 ppm) exceed those commonly found with reasonable inclusion levels of chocolate powders in pig starter feeds.

Key Words: pig, cocoa, theobromine

TH321 Grain replacement value of honey bee slumgum meal in broiler finisher diet.

O. O. Ojebiyi*, I. O. Oladunjoye, T. B. Olayeni, and M. D. Shittu, *Ladoke Akintola University of Technology, Ogbomosho, Oyo State, Nigeria*.

The objective of this study was to investigate the effect of replacing corn with honey bee slumgum meal (a waste generated after the processing of honey and bee wax) on the performance and organ weights of broiler chickens at the finisher phase. One hundred and forty-four (144) day-old Marshall strain broiler chicks were used for the experiment. The birds were reared on a common starter diet (0–4 wk). Four experimental diets were thereafter formulated for the finisher phase (5–8 wk) with the control diet (T1) containing zero honey bee slumgum meal (HBSM) and 43.7% corn. Honey bee slumgum meal was used to replace corn in the control diet at 25, 50 and 75% in diets 2, 3, and 4 respectively. At the end of the starter phase, birds were randomly divided into the 4 treatment groups with 3 replicates per treatment at 12 birds per replicate in a completely randomized design. Data collected were used to evaluate ADFI, ADG and F:G. At the end of the study, birds were euthanized and the weights of liver, heart, lungs and spleen were obtained and expressed as percentage of BW. Data were analyzed using the proc GLM procedure of SAS. Although ADFI was not different across treatment groups, the final BW of broilers on the control diet (1816 g) and those fed 25% HBSM (1811 g) were comparable ($P > 0.05$) but higher ($P < 0.05$) than the BW of birds fed 50% HBSM (1562 g) and those fed 75% HBSM (1455 g). Similar trends were observed in the values of ADG which were 46, 46, 38 and 33g for broilers fed the control, 25, 50 and 75% HBSM, respectively. Broilers fed the control diet and 25% HBSM had similar ($P > 0.05$) F:G of 1.84 and 1.9, respectively which were lower ($P < 0.05$) than the values for broilers fed 50% (2.3) and 75% HBSM (2.6). The weights of the liver, heart and lungs were not affected ($P > 0.05$) by dietary treatments but spleen weight of birds fed

with 50 and 75% HBSM was higher ($P < 0.05$) than those of control and 25% HBSM. In conclusion, HBSM can be used to replace 25% of corn in broiler finisher diets without an adverse effect on BW and ADG.

Key Words: broiler, finisher, slumgum

TH322 Use of modified soy protein in aquaculture feeds as a replacement for fishmeal. B. M. Vester Boler^{*1}, D. M. Gatlin², E. A. Koutsos¹, and B. L. Miller¹, ¹Purina Animal Nutrition, Gray Summit, MO, ²Texas A&M University, College Station.

Fishmeal is a commonly used protein source in aquaculture feeds due to its high acceptability and amino acid content. Due to environmental sustainability, availability, and ingredient cost concerns of fishmeal, investigation of other protein sources is needed. Twelve tanks of all-male tilapia fingerling (starting weight 2.5 g) were stocked at normal stocking density ($n = 12/\text{tank}$) in a recirculating system consisting of 38-L aquaria. Tanks were randomly assigned 1 of 3 dietary treatments ($n = 4$ tanks/treatment) and fed for 10 wk at a constant feeding rate across diets (6% of BW initially and 3% of BW at conclusion of the trial). Diets were isonitrogenous (46% calculated crude protein) and included a control diet containing menhaden fishmeal (FM) as the protein source, a negative control consisting of soybean flour (SF), and a diet containing 50% of protein from modified soy protein and 50% from fishmeal (MSP). Modified soy protein is manufactured by blending defatted soy flake with alcohol and reducing agent, heating it to 90°C and a pressure 10 psig, and finally removing the alcohol through venting. Weight gain and survival were determined at wk 6, 8, and 10. At the end of the study hepatosomatic index, intraperitoneal fat ratio, and feed efficiency were determined. Weight gain, as a percent of initial weight, was lower ($P < 0.01$) in fish fed SF, but did not differ in fish fed MSP compared with FM at any week (Table 1). Survival did not differ among treatments ($P = 0.34$). Hepatosomatic index ($P = 0.37$) nor intraperitoneal fat ratio ($P = 0.11$) differed among treatments. Feed efficiency was lower ($P = 0.03$) in fish fed SF compared with MSP and FM. Fish fed MSP had equal performance to those fed traditional fishmeal-based diets. Modified soy protein has potential use in future aquaculture diets to reduce the amount of fishmeal used.

Table 1. Weight gain (% from initial) in tilapia fed fishmeal (FM), modified soy protein (MSP), and soybean flour (SF) diets

Week	Treatment			SEM	P-value
	FM	MSP	SF		
6	687 ^b	638 ^b	427 ^a	3.5	0.002
8	1074 ^b	1087 ^b	704 ^a	3.5	<0.001
10	1602 ^b	1547 ^b	999 ^a	3.5	<0.001

^{a,b}Means within a row lacking a common superscript differ ($P < 0.05$).

Key Words: fish meal, aquaculture

TH323 Complete replacement of soybean meal in pig diets with hydrolyzed feather meal with blood by amino acid supplementation based on standardized ileal digestibility. S. D. Brotzge^{*1}, L. I. Chiba¹, C. K. Adhikari¹, H. H. Stein², S. P. Rodning¹, and E. G. Welles¹, ¹Auburn University, Auburn, AL, ²University of Illinois, Urbana.

The possibility of replacing soybean meal (SBM) in finisher pig diets completely with hydrolyzed feather meal with blood (FM) was evaluated. Corn-SBM, positive control (POS) diets were formulated to con-

tain 6.6 and 5.2 g true ileal digestible (TID) Lys/kg during the finisher 1 (F1) and finisher-2 (F2) phases, respectively. Corn-FM negative control (NEG) diets were formulated to be iso-N to the POS diets, and 2 diets were formulated by supplementing the NEG diets with AA based on the 1998 NRC TID (NRC) or determined standardized ileal digestible AA values (SID) in FM to alleviate AA deficiencies. When pigs weighed 50.0 ± 2.9 kg, 32 gilts and 32 barrows (2 gilts or 2 barrows/pen) were randomly assigned to 1 of 4 F1 diets, and they were switched to F2 diets at 79.0 ± 2.0 kg. Pigs had ad libitum access to feed. At 107.7 ± 3.3 kg, blood samples were collected and pigs were slaughtered. Pigs fed the POS diets had greater overall ADFI ($P = 0.083$) and total Lys intake ($P = 0.029$) than those fed the SID diets, which resulted in a slightly greater ADG ($P = 0.094$) in pigs fed the POS diets, but there was no difference in the efficiency of feed or Lys utilization. Pigs fed the SID diets had greater G:F ($P = 0.057$) and gain:total Lys intake ($P < 0.001$) than those fed the NRC diets. Pigs fed the POS diets had greater fat-free lean accretion ($P = 0.020$) than those fed the SID diets, but similar LM area, fat-free carcass %, and the efficiency of lean gain. Serum glucose was not affected by dietary treatments. Pigs fed the POS diets had greater urea-N ($P = 0.003$) and lower cholesterol ($P = 0.002$) than those fed the SID diets. As expected, pigs fed the NEG diet had reduced total protein ($P < 0.001$) and increased urea-N ($P = 0.001$), triglyceride ($P < 0.001$), and cholesterol ($P < 0.001$) compared with those fed the POS diets. The results indicate that pigs fed the SID diets utilized feed and Lys as efficiently as those fed the POS diets, but they had slightly reduced BW and lean gain, perhaps, because of slightly reduced feed and Lys intake.

Key Words: hydrolyzed feather meal, standardized ileal digestible amino acids, pigs

TH324 Hen performance as influenced by dietary *Aspilia africana* leaf. O. O. K. Oko^{*}, E. A. Agiang, and P. O. Ozung, University of Calabar, Calabar, Cross River State, Nigeria.

The identification and validation of alternative antibiotic growth promoters is a major research focus in animal production. Phytobiotics also referred to as phyto-genic feed additives (PFAs) are a group of plant-derived substances which are currently thought to be the ideal alternatives to antibiotics. Recent studies have reported the positive effects and economic effect of PFAs on feed intake, weight gain and feed efficiency in poultry and pigs. *Aspilia africana* leaf (AaL) is one of such plants with high phytonutrients and bioactive components with potential phytobiotic actions. The study investigated the effects of dietary AaL on the egg production performances of 360 (24 wk-old) laying hens over a period of 24 wk. Four treatments of 90 birds per treatment with 15 birds per replicate of 6 were studied in a completely randomized design. A corn-soybean mash diet was formulated (0%) and 2%, 5% AaL or 0.2% terramycin were added into the basal diet. Egg production traits were measured weekly throughout the experiment and a one-way ANOVA at $P \leq 0.05$ was conducted. Results indicated significant ($P \leq 0.05$) improvement in the production performance of birds fed AaL and terramycin diets. Compared with the control, hens fed AaL diets had 7.20, 6.90, 1.50 and 43.77% increase in hen-day production, shell thickness, yolk weight and yolk color, respectively than those fed terramycin (6.23, 3.45, 0.62 and 23.58%) diets. While feed intake and percentage cracked eggs had decreased ($P \leq 0.05$) by 6.00 and 19.41% in AaL- fed hens against the 4.25 and 16.47% decrease observed in terramycin-fed hens. These findings further demonstrated that *Aspilia africana* leaf has strong egg promoting potentials in poultry.

Key Words: growth promoter, egg quality, bush marigold

TH325 Utilization of high levels of crude glycerin in commercial layer diets. Y. Avellaneda*^{1,2}, R. Ortiz^{1,2}, G. Afanador², and C. Ariza-Nieto¹, ¹CORPOICA, Mosquera, Cundinamarca, Colombia, ²Universidad Nacional de Colombia, Bogota, Cundinamarca, Colombia.

The objective of this study was to determine the highest level of acceptability of crude glycerin in the feeding systems of commercial layers, for this, an experiment was carry out to evaluate the inclusion of this resource by up to 15% of the diet. The crude glycerin (CG) presented the following composition: 3042 kcal / kg AMEn (determined previously through a balance study), 3453 Kcal / Kg of EB, 8.29% moisture, 82.0% glycerol, 0.79% crude fat, 1.21% sodium and 16 ppm of methanol). Two hundred sixteen 60-wk-old Babcock Brown laying hens were randomly assigned to one of the 6 crude glycerin levels (0, 3, 6, 9, 12 and 15%). Hens were housed in individually cages equipped with an automatic nipple drinker and a feeder channel side during 2 mo and their performance was record every other week during the study. Six hens housed adjacent, sharing the same trough were consider an experimental unit (replicate). During the study, eggs were collected daily and weighed weekly by each replica and feed residuals were used to calculate daily feed intake and feed conversion. The data were analyzed as a completely randomized design, with one covariate (egg production of last month, before the start of the experiment). The linear, quadratic, and cubic effects of crude glycerin level were evaluated using SAS procedures, version 9.0. The results showed that the inclusion of CG up to 15% did not affect hen performance in terms of egg production ($94.5 \pm 7.0\%$) or egg weight ($67.5 \pm 2.4\text{g}$); however, feed intake decreased linearly with the level of inclusion of CG in diet. Layers supplemented with 12 or 15% of CG consumed ($P < 0.05$) 4.6% less feed compared with the control group and 3% of supplementation. The groups with highest levels of CG presented ($P < 0.05$) a better feed conversion compared with the 3% CG group. In conclusion, CG with low levels of methanol may be used at high levels (up to 15%) without adversely affecting the performance of laying hens.

Key Words: crude glycerin, acceptability, layer diet

TH326 Dietary hop (*Humulus lupulus*) β-acids improve growth performance of weanling pigs. M. Sbardella*, C. Andrade, D. P. Perina, and V. S. Miyada, Universidade de São Paulo (USP/ESALQ), Piracicaba, SP, Brazil.

Hop (*Humulus lupulus*) β-acids have shown antimicrobial activity in vitro, as well inhibition capacity of *Clostridium perfringens* in chick gastrointestinal tract. The purpose of this study was to evaluate the effects of dietary levels of hop β-acids on growth performance of weanling pigs. Two hundred 21 d-weaned pigs (6.23 ± 0.32 kg BW) were used in a randomized complete block design experiment with 5 treatments, 8 replications per treatment, and 5 animals per experimental unit (pen). The treatments were: basal diet (based on corn, soybean meal, dried milk and dried plasma) with 40 ppm of colistin (antimicrobial treatment) and basal diet with 0 (negative control), 120, 240 or 360 ppm of hop β-acids. Feed and water were provided ad libitum during all 35 d-experimental period. Statistical analyses were performed by ANOVA using the MIXED procedure of SAS. Polynomial orthogonal contrasts were performed to determine the dose-response to dietary hop β-acids. Added dietary levels of hop β-acids improved linearly ($P < 0.05$) final BW, ADG, and G:F ($P = 0.003$) of weanling pigs (Table 1). The antimicrobial treatment improved ($P < 0.03$) BW, ADG and G:F compared with negative control treatment, but did not differ from any dietary levels of hop β-acids. No effects ($P > 0.05$) of hop β-acids or antimicrobial agent were observed on ADFI. Dietary levels of hop β-acids up to 360 ppm and 40 ppm of colistin improved growth performance, showing that hop β-acids may be used as alternative of antimicrobial growth promoters for weanling pigs.

Table 1. Effects of dietary levels of hop β-acids on growth performance of weanling pigs

	Colistin	Dietary level, ppm				P-value	SEM	CV (%)
		0	120	240	360			
Initial BW, kg	6.23	6.22	6.23	6.23	6.23	0.424	0.32	14.87
Final BW, kg ¹	20.94	19.61*	20.51	20.79	21.46	0.043	0.92	13.13
ADG, g/d ²	425	387*	414	421	441	0.045	18	13.04
ADFI, g/d	693	663	683	689	703	0.550	28	11.71
G:F ³	0.61	0.58*	0.61	0.61	0.63	0.004	0.01	4.38

¹Linear effect of β-acids on Final BW ($BW = 0.0049x + 19.716$; $R^2 = 0.96$; $P = 0.003$).

²Linear effect of β-acids on ADG ($ADG = 0.14x + 390.51$; $R^2 = 0.96$; $P = 0.003$).

³Linear effect of β-acids on G:F ($G:F = -0.0001x + 0.5863$; $R^2 = 0.94$; $P = 0.000$).

*Lower than antimicrobial treatment by orthogonal contrast-test ($P < 0.03$).

Key Words: feed additive, growth promoter, swine