

Nonruminant Nutrition: Feed Ingredients I

579 Effects of 5.4 or 9.6% oil dried distillers grains with solubles on finishing pig growth performance and carcass characteristics. A. B. Graham*, R. D. Goodband, M. D. Tokach, J. M. DeRouchey, S. S. Dritz, and S. Nitikanchana, *Kansas State University, Manhattan.*

A total of 1198 pigs (PIC 337 × 1050, initially 46.1 kg) were used to determine the effects of 5.4 or 9.6% oil corn dried distillers grains with solubles (DDGS) in finishing diets on growth performance and carcass characteristics. Pigs were allotted to a corn-soybean meal-based control diet or diets with 20 or 40% 5.4% oil DDGS (29.53% CP, 8.90% ADF, and 21.75% NDF) or 9.6% oil DDGS (29.63% CP, 15.25% ADF, and 28.58% NDF). There were 26 or 27 pigs per pen and 9 replications per treatment. Data were analyzed using the PROC Mixed procedure of SAS as a 2 × 2 factorial plus control with main effects of DDGS source and level and their interactions. From d 0 to 82, ADG was unaffected by DDGS source or level. However, there was a DDGS source by level interaction ($P < 0.01$) observed for G:F. Increasing 5.4% oil DDGS linearly decreased ($P < 0.01$) G:F, whereas there was no change in G:F in pigs fed 9.6% oil DDGS. Two pigs per pen were slaughtered (n = 9) for IV analysis. The remaining pigs (n = 9) were slaughtered to calculate carcass yield (farm weight/plant weight) and HCW. Regardless of DDGS source, carcass yield and HCW decreased (linear, $P < 0.04$) with increasing DDGS. There was also a DDGS source by level interaction ($P < 0.01$) observed for jowl iodine value (IV). Increasing DDGS increased jowl IV, but the magnitude was greater in those fed the 9.6% oil DDGS compared with those fed 5.4% oil DDGS. In summary, the two DDGS sources used in this experiment resulted in similar ADG and reduction in carcass yield. However, pigs fed low oil DDGS also had reduced G:F relative to pigs fed the high oil diets.

Table 1.

Item	DDGS source and % of diet					SEM
	Control	5.4% oil		9.6% oil		
	0	20	40	20	40	
ADG, kg	1.03	1.04	1.02	1.03	1.03	0.10
G:F ¹	0.398	0.386	0.370	0.398	0.390	0.004
Final BW, kg	129.6	129.8	128.5	129.4	129.9	1.1
Carcass yield, % ²	76.2	76.0	74.3	75.4	75.2	0.46
HCW, kg ²	95.4	94.0	92.9	93.3	93.8	0.81
Jowl IV ¹	66.6	70.7	75.0	71.1	77.4	0.53

¹DDGS source × level interaction, linear $P = 0.01$.

²DDGS linear, $P < 0.05$.

Key Words: corn, DDGS, pig

580 Effects of 9.4 or 12.1% oil dried distillers grains with solubles on finishing pig growth performance and carcass characteristics. A. B. Graham*, R. D. Goodband, M. D. Tokach, J. M. DeRouchey, S. S. Dritz, and S. Nitikanchana, *Kansas State University, Manhattan.*

A total of 270 pigs (PIC 327 × 1050, initially 46.5 kg) were used to determine the effects of 9.4 or 12.1% oil corn dried distillers grains with solubles (DDGS) on finishing pig growth performance and carcass characteristics. Pigs were allotted to a corn-soybean meal-based control diet or diets with 20 or 40% 9.4% oil DDGS (29.40% CP, 19.57% ADF, and 34.50% NDF, as-fed) or a 12.1% oil DDGS (28.53% CP, 17.57% ADF, and 31.38% NDF, as-fed). There were 8 pigs per pen

and 7 replications per treatment. Diets were fed over 3 phases (47 to 73, 73 to 100, and 100 to 122 kg). Data were analyzed using the PROC Mixed procedure of SAS as a 2 × 2 factorial plus control with main effects of DDGS source and level and their interactions. From d 0 to 75, increasing 9.4% oil DDGS increased then decreased ADG but it was not different among pigs fed 12.1% oil DDGS (quadratic interaction, $P < 0.02$). Increasing DDGS tended (linear, $P < 0.07$) to decrease ADFI and increase G:F. All pigs were slaughtered (n = 7) on d 75 for calculation of carcass yield (farm weight/plant weight), HCW and jowl iodine value (IV). Regardless of source, increasing DDGS decreased (linear, $P < 0.05$) carcass yield and HCW. Increasing DDGS increased (linear, $P < 0.01$) jowl IV. In summary, increasing the two DDGS sources (9.4 and 12.1% oil) used in this experiment resulted in reduced carcass yield and HCW but increased jowl IV.

Table 1.

Item	DDGS source and % of diet					SEM
	Control	9.4% oil		12.1% oil		
	0	20	40	20	40	
ADG, kg ¹	1.01	1.05	.98	1.00	1.00	0.16
ADFI, kg ²	2.85	2.81	2.68	2.76	2.73	0.05
G:F ²	0.355	0.375	0.366	0.363	0.378	1.01
Final BW, kg	122.0	125.1	119.9	121.6	121.9	1.68
Carcass yield, % ³	72.6	71.9	71.0	72.3	71.2	0.18
HCW, kg ³	88.6	89.2	84.7	87.6	86.8	1.11
Jowl IV ³	66.8	73.1	77.5	73.4	80.0	0.42

¹DDGS source × level interaction, quadratic $P = 0.02$.

²Linear effect of DDGS, $P < 0.07$.

³Linear effect of DDGS, $P < 0.05$.

Key Words: corn, DDGS, pig

581 Effects of mix time on nutritional value of diets without and with inclusion of DDGS and wheat midds when fed to finishing pigs. M. E. Morts*, J. D. Hancock, K. L. Kohake, and J. D. McAtee, *Kansas State University, Manhattan.*

A total of 200 finishing pigs (avg initial BW of 76 kg) were used in a 54-d growth assay to determine the effects of mix time in diets without and with inclusion of cereal grain co-products. The pigs were sorted by sex and ancestry and assigned to pens (5 pigs/pen and 10 pens/treatment) in a completely randomized design. Treatments were arranged as a 2 × 2 factorial with main effects of mix time (60 and 420 s) and inclusion of cereal grain co-products (without and with 30% DDGS and 10% wheat middlings). All diets were formulated to be at least 120, 120, and 110% of requirements for essential amino acids, vitamins, and minerals, respectively, as suggested in the 2012 National Research Council guidelines for swine feeding. Feed and water were consumed on an ad libitum basis until the pigs were harvested (avg BW of 134 kg) at a commercial abattoir for collection of carcass data. As for results, there were no interactions among mix time and inclusion of cereal grain co-products ($P > 0.08$) for ADG, ADFI, G:F, hot carcass weight (HCW), dressing percentage (DP), or fat thickness at the last rib (BF). As for main effects, increasing mix time from 60 to 420 s did not affect measurements of growth performance or carcass value ($P > 0.43$). However, pigs fed diets with DDGS and wheat middlings had reduced ($P < 0.05$) ADG, HCW, DP, and BF compared with pigs fed the simple corn-soy diet. In conclusion, increasing mix time from 60 to 420 s did not change

the negative effects of DDGS and wheat middlings on rate of gain and carcass yield in finishing pigs.

Table 1. Results by diet and feed mix time

	Corn-Soy		DDGS-Midds		SE
	60 s	420 s	60 s	420 s	
ADG, g	1,011	1,014	966	954	17
ADFI, kg	3.41	3.49	3.52	3.33	0.14
G/F, g/kg	297	291	274	287	13
HCW, kg	100.4	100.8	97.6	97.7	3.8
DP, %	74.2	74.2	73.8	73.8	0.7
BF, mm	26.3	26.9	23.6	22.7	1.4

Key Words: mix time, DDGS, pig

582 Impact of dietary leucine levels on the optimal valine to lysine ratio in diets for 10 to 25 kg pigs. J. K. Htoo^{*1}, C. F. M. de Lange², and C. L. Zhu², ¹*Evonik Industries AG, Hanau, Germany*, ²*University of Guelph, Guelph, Canada*.

Feeding diets containing excess Leu can reduce feed intake and performance of pigs, which is attributed to interactions with the other branch-chained AA, Ile and Val. The objective of this study was to test if dietary Leu levels affect the dietary Val requirements (Val:Lys ratio) to optimize growth performance of 10 to 25 kg pigs. A 3-wk study was conducted with 144 Yorkshire pigs (initial BW 10.4 ± 1.1 kg) with 6 pen replicates (2 barrows and 2 gilts per pen) per treatment according to a 2 × 3 factorial design with 2 levels of Leu (adequate and excess) and 3 levels of Val (slightly below, at or slightly above estimated requirement). Diets were formulated based on barley, wheat, soybean meal, corn gluten meal and using analyzed AA contents and published standardized ileal digestibility (SID) of AA in the protein containing ingredients to exceed requirements for other AA. Contents of SID Lys and Ile were similar across all diets at 1.13 and 0.68%. Diets 1 to 3 were formulated to contain 1.18% SID Leu (64, 68 and 72% SID Val:Lys) and L-Leu was added to diets 4 to 6 to contain 1.80% SID Leu (64, 68 and 72% SID Val:Lys). The corrected SID Val:Lys ratios in diets 1 to 6 based on the analyzed AA in the diets were 67, 72, 73, 66, 70 and 73%, respectively. Pigs had free access to pelleted feed and water. There were no interactive effects ($P > 0.10$) of dietary Leu and Val:Lys on growth performance. During wk 1, ADG (454 vs. 411 g/d for adequate vs. excess Leu) and G:F (0.67 vs. 0.61 for adequate vs. excess Leu) were influenced ($P < 0.01$) by dietary Leu but not by the Val:Lys ratio ($P > 0.10$). Feed intake was not affected ($P > 0.10$) by treatment during wk 1, 2, 3 or wk 1–3. During wk 1–3, ADG was not affected by treatment (600, 577, 567, 562, 556 and 580 g/d for diets 1 to 6) while G:F was higher ($P < 0.05$) for pigs fed diets with adequate Leu vs. excess Leu (0.64 vs. 0.62), and there was a tendency ($P = 0.06$) toward a negative effect of increasing SID Val:Lys on G:F. These results suggest that the lowest Val:Lys ratio (67%) was optimal while dietary Leu did not affect the requirement for Val in 10 to 25 kg pigs.

Key Words: leucine, lysine, performance

583 Effects of graded corn cob levels on physicochemical properties of digesta and visceral organs in growing pigs. A. Wate^{*}, S.P. Ndou, and M. Chimonyo, *University of KwaZulu-Natal, Pietermaritzburg, South Africa*.

The objective of the study was to investigate the effects of graded levels of corn cob (CC) meal incorporated in the diet on the physicochemi-

cal properties of digesta and sizes of gastrointestinal (GIT) organs of growing pigs. Understanding changes in physicochemical properties of digesta assists feed compounders to identify appropriate fiber inclusion levels that minimize nutrient losses through excretion or overfeeding. A total of 18 pigs with initial body weight (BW), 14 ± 1.2 kg were allocated each to one of the 5 corn cob levels (80, 160, 240, 320 and 400 g/kg DM) and a control diet. The control diet contained 18.09 MJ/kg DM and crude protein of 24.78 g/kg DM. After 4 weeks, weights of the GIT compartments were recorded and the contents were sampled for analyses of water concentration, water holding capacity (WHC), swelling capacity, nutrient contents and short chain fatty acids (SCFA) concentrations. Proc GLM (SAS, 2009) was used to determine the effects of inclusion level of CC on physicochemical measures of digesta and size of GIT organs and means were compared using PDIF. The sizes of visceral organs of pigs feeding diets with less than 240 g/kg DM were not different. Pigs fed on diets containing at least 240 g/kg CC diets had higher ($P < 0.001$) stomach and the colon weights, compared with the control. Water holding capacity was lowest in the stomach and highest in the cecum. From the stomach to the distal colon, the WHC of digesta was higher compared with the control diet ($P < 0.05$). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and WHC of diets containing less than 240 g/kg DM of CC did not change markedly along the digesta. Propionic and acetic acid concentration was higher ($P < 0.05$) in the colon of pigs that consumed a diet based on 80 and 160 g/kg DM of CC. In conclusion, high increment levels of CC beyond 240 g/kg DM increase the size of GIT organs as well as bulkiness of digesta during transit in the gut of growing pigs.

Key Words: bulky content, physicochemical properties, dietary fiber

584 Effect of dietary supplementation of fermented Hamcho (*Salicornia herbacea*) on growth performance and meat quality in broiler chicks. M.-J. Ku^{*1}, S.-W. Kim¹, K.-S. Kim¹, S.-K. Lee¹, D.-Ju. Yu¹, Y.-S. Choi¹, A.-A. Yun¹, D.-H. Park¹, S.-S. Lee², and W.-H. Kim¹, ¹*Livestock Research Institute, Jeollanamdo Agricultural Research & Extension Service(JARES), Gangjin-gun, Jeollanam-do, Republic of Korea*, ²*Sunchon National University, Suncheon, Jeollanam-do, Republic of Korea*.

Hamcho (*Salicornia herbacea*), known as Ginseng of the Sea, grows around mudflats and salt marsh in Korea's islands touched by sea water. It contains dozens of nutrients including minerals and amino acid. The study was conducted to investigate the effect of dietary supplementation of fermented Hamcho (FH) on growth performance and meat quality in broiler chickens. Total of one hundred eighty 1-d-old Ross male broiler chicks were divided into 3 groups and fed control (basal diet), antibiotic (basal diet + oxytetracycline 5 ppm) or FH (basal diet + FH 0.5%) diet for 5 weeks, respectively. The birds were arranged in a completely randomized design having 4 replications with 15 chicks per replication. The feed intake and feed conversion rate in the group fed diets containing 0.5% FH were improved by 12.7% and 11.7% as compared with those of control ($P < 0.05$). For the analysis of meat quality, we used chicken breast from slaughtered chickens. The method employed in the analysis is as follows: 1; Water holding capacity was determined by Hamm (1960). 2; Shear force by Yoon (2003). 3; Fatty acid content by gas chromatography (Agilent Technologies, USA) after fatty acid methyl ester (FAMES). The FH group showed the highest and lowest values, 60.31 ± 1.61 and 1.86 ± 0.08, in water holding capacity and shear force indicating keeping quality parameters ($P < 0.05$). Oleic acid (18:1n-9) and α -linolenic acid (18:3n-3) content were higher in the FH group (45.356 ± 0.48 and 0.706 ± 0.03) than those of the other groups ($P < 0.05$). Also, docosahexaenoic acid (DHA, 22:6n-3) was

only detected in the FH group (0.206 ± 0.07). The results demonstrated that the fermented Hamcho used in this study enhanced the productivity and the meat quality, thus can be used as broiler feed additives for stimulating growth and feed efficiency.

Key Words: broiler chick, fermented Hamcho (*Salicornia herbacea*), growth performance

585 In vitro degradation and fermentation characteristics of expeller-pressed canola meal and cold-pressed canola cake simulating the pig intestine. T. A. Woyengo*¹, R. Jha², E. Beltranena^{1,3}, and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²University of Hawaii at Manoa, Honolulu, ³Alberta Agriculture and Rural Development, Edmonton, AB, Canada.

Expeller-pressed canola meal (EPCM) and cold-pressed canola cake (CPCK) serve as sources of protein and energy in pig feeds. However, limited or no information exists on their fermentation characteristics in the pig intestine; this information is important for understanding contribution of a feedstuff to energy needs of pigs via hindgut fermentation. Thus, a study was conducted to determine in vitro fermentation characteristics of EPCM and CPCK in comparison with soybean meal (SBM). Samples were hydrolyzed using pepsin at pH 2.0 for 2 h, and then with pancreatin at pH 6.8 for 4 h. Residues were then incubated in a buffer solution with minerals and fresh pig feces as inoculum. Accumulated gas production was measured for 72 h, and the measured gas production was modeled to estimate kinetics of gas production. Concentration of VFA was measured in fermented solutions using gas chromatograph. Data were subjected to ANOVA and means were separated by probability of difference. On DM basis, SBM, EPCM, and CPCK contained 51, 35, and 30% CP; 1.5, 12, and 23% ether extract; and 9, 21, and 18% NDF, respectively. In vitro DM degradability for SBM, EPCM, CPCK were 82, 68, and 70% ($P < 0.05$), respectively. Total gas production for SBM, EPCM, and CPCK were 207, 114, and 99 mL/g DM ($P < 0.05$), respectively. Total VFA production was higher ($P < 0.05$) for SBM than for CPCK or EPCM (4.10 vs. 2.04 vs. 2.47 mmol/g DM). In conclusion, the in vitro degradability and fermentability of SBM were higher than those for CPCK or EPCM likely due to the lower fiber content. The CPCK had higher in vitro DM degradability, but lower in vitro fermentability than EPCM. Thus, CPCK or EPCM compared with SBM contribute less energy to pigs via hindgut fermentation. EPCM may contribute more dietary energy to pigs via hindgut fermentation, but it contributes lower dietary fat than CPCK.

Key Words: canola meal, canola cake, in vitro fermentation

586 Comparative utilization of processed chicken offal and blood meals in diets of young pigs containing maize offal. A. O. K. Adesehinwa*¹ and B. Adebayo², ¹Livestock Improvement Programme, Institute of Agricultural Research & Training, PMB 5029, Moor Plantation, Ibadan, Oyo State, Nigeria, ²Nigerian Institute of Animal Science, Southwest Zonal Office, Moor Plantation, Ibadan, Oyo State, Nigeria.

One hundred eight young pigs weighing 8.86 ± 0.2 kg body weight, randomly assigned to 6 isonitrogenous (20%CP) dietary groups were used to evaluate responses to 0, 25 and 50% inclusions of maize offal (a by-product of maize milling consisting mainly of the aleurone layer and some adulterants of germs and endosperm) as a replacement for maize in diets supplemented with either chicken offal meal (COM) (ground dried poultry processing by-product comprising heads, viscera, feathers, beaks etc) or blood meal (BM) (ground dried animal blood in a factorial design). Each treatment group comprising 18 pigs had 6 replicates of 3 pigs/replicate. Weekly record of feed intakes and weight gains were taken for the 56-d trial period. Two pigs/replicate were randomly selected and bled at the first and last weeks of the trial to determine the serum total proteins, albumin, globulin, creatinine, urea, cholesterol and glucose. All statistical data were subjected to ANOVA and where statistical significance were observed, the means were compared using the Duncan's multiple range test (SAS). The results showed that the dry matter intake was neither affected ($P > 0.05$) by the maize offal nor the protein sources. The performance of the pigs fed diets supplemented with COM were superior ($P < 0.05$) in terms of DWG (0.49, 0.47 and 0.38 kg), F:G (1.75, 1.82 and 2.22) and metabolizable energy intake per gain (6205, 6366 and 7779 kcalME/kg compared with 0.37, 0.37 and 0.32 kg; 2.25, 2.33 and 2.90 and 7927, 8046 and 10066 kcalME/kg obtained for pigs fed BM-supplemented diets respectively. The results obtained at the 0 and 25% were comparable, but superior ($P < 0.05$) to that obtained at 50% for both protein sources. The serum metabolites were neither influenced ($P > 0.05$) by maize offal nor the protein sources, except the urea (33.3, 30.5 and 29.5 mg/dL for COM; 24.0, 22.8 and 26.5 mg/dL for BM) and globulin (2.88, 3.43 and 3.53g/dl for COM; 2.88, 3.15 and 3.28 g/dL for BM) contents. It could therefore be concluded that up to 25% maize can be replaced with maize offal in diets of young pigs, with better performance obtained with COM.

Key Words: unconventional feed source, young pig, feed utilization