0.01) whole intestine weights, mainly due to the reduction ($P < 0.02$) in rinsed stomach and full large-intestine weights. Lowering dietary DDGS and Middlings during a 19 d withdrawal period increased yield through reduced large intestine weight and content, improved carcass yield, and jowl IV. The addition of CWG improved G:F; however, CWG did not improve carcass characteristics.

Table 1.

	1	2	3	4	5	6	7	
d 0 to 73:	Low	High	High	High	High	High	High	
					3% Added Fat			
d 73to 92:	Low	Low	Med	High	Low	Med	High	SEM
ADG, kg	0.85	0.84	0.85	0.84	0.86	0.84	0.85	0.013
G:F	0.34	0.33	0.33	0.33	0.34	0.34	0.35	0.004
Final BW, kg	124.5	123.0	123.8	124.0	124.9	124.8	124.5	1.499
Carcass yield, %	72.6	72.6	71.8	71.9	73.0	72.3	71.5	0.305
HCW, kg	90.6	89.4	89.0	89.2	91.2	90.6	88.9	1.332
Lean, %[a]	52.8	53.0	53.3	53.4	53.0	52.6	53.4	0.305
Backfat, mm[a]	18.9	17.5	17.0	17.0	18.6	17.7	16.5	0.603
Jowl IV	69.4	77.8	78.5	79.2	77.3	78.6	81.2	0.502

[a]Adjusted to a common HCW.

Key Words: DDGS, fiber, wheat middlings, pig

161 Effects of feeding diets containing highly oxidized corn dried distillers grains with solubles (DDGS) with increasing vitamin E levels to wean-finish pigs on growth performance, carcass composition, and pork fat quality. R. Song*[1], C. Chen[1], L. J. Johnston[2], B. J. Kerr[3], T. E. Weber[3], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]West Central Research and Outreach Center, Morris, MN, [3]USDA-ARS-NLAE, Ames, IA.*

Lipid peroxidation in animal feed can reduce growth performance and meat quality. Weanling pigs (n = 432; BW = 6.6 ± 0.4 kg) were used to evaluate the effects of feeding highly oxidized DDGS with 3 levels of vitamin E (α-tocopheryl acetate) on growth performance, carcass composition, and pork fat quality. The DDGS source used in this study contained the highest thiobarbituric acid reactive substances (TBARS) value and peroxide value (5.2 ng/mg oil and 84.1 mEq/kg oil, respectively) among 30 other DDGS sources sampled. Pens within blocks were assigned randomly to 1 of 6 dietary treatments in a 2 × 3 factorial design. Pigs were fed corn-soybean meal (CON) or 30% DDGS diets with 3 levels of vitamin E: none supplemented (No-E), NRC (11 IU/kg, 1X-E), or 10X NRC (110 IU/kg, 10X-E). All diets were formulated on a standardized ileal digestible (SID) AA and available P basis with similar calculated ME content. Compared with CON, inclusion of 30% DDGS in diets reduced ($P < 0.001$) final BW (110 vs. 107 kg), overall ADG (0.76 vs. 0.74 kg/d) and G:F (0.39 vs. 0.37). Increasing dietary vitamin E level increased overall G:F ($P = 0.03$). Hot carcass weight, dressing percentage, backfat depth and loin muscle area were reduced ($P < 0.01$) in pigs fed DDGS compared with CON, but percentage of fat-free carcass lean was not affected. Feeding DDGS increased ($P < 0.001$) PUFA concentration, particularly linoleic acid ($P < 0.001$), and iodine value ($P < 0.001$) in belly fat and backfat compared with pigs fed CON. Dietary vitamin E levels did not affect fatty acid profile in belly or back fat. Alpha-tocopherol concentration in LM was higher ($P < 0.001$) in 10X-E than No-E or 1X-E dietary treatments. Compared with CON, feeding DDGS increased α-tocopherol concentration in LM in pigs fed No-E (1.0 vs. 3.1 μg/g, $P = 0.005$), but not in those fed 1X-E or 10X-E. These results indicate that feeding highly oxidized, 30% DDGS diets to wean-finish pigs may reduce growth performance. However, supplementation of additional vitamin E in the diet did not counteract these effects, but did improve G:F and α-tocopherol level in LM at the 10X NRC level.

Key Words: DDGS, growth performance, pig, vitamin E

162 Effects of dietary L-carnitine and dried distillers grains with solubles (DDGS) on growth, carcass characteristics, and loin and fat quality of finishing pigs. W. Ying*[1], J. M. DeRouchey[1], M. D. Tokach[1], S. S. Dritz[1], T. A. Houser[1], R. D. Goodband[1], J. L. Nelssen[1], and J. C. Woodworth[2], *[1]Kansas State University, Manhattan, [2]Lonza Inc., Allendale, NJ.*

A total of 1,104 barrows and gilts (PIC 337 × 1050, initially 36 kg BW) were used to evaluate the effects of dietary L-carnitine and corn DDGS on growth, carcass traits, and loin and fat quality. Dietary treatments were arranged as a 2 × 3 factorial with main effects of added DDGS (0 or 30% in phases 1, 2, and 3 and 20% in phase 4) and L-carnitine (0, 50, or 100 mg/kg). Each treatment had 7 mixed gender pens with 26 or 27 pigs per pen. Overall (d 0 to 109), pigs fed L-carnitine had increased ($P < 0.02$) ADG and final BW. A DDGS × L-carnitine interaction (quadratic, $P < 0.01$) was observed for G:F. Pigs fed 50 mg/kg L-Carnitine without DDGS had better G:F than pigs fed 0 or 100 mg/kg, but in diets with DDGS, pigs fed 50 mg/kg L-carnitine had poorer G:F compared with those fed 0 or 100 mg/kg. Increasing dietary L-carnitine increased HCW (quadratic, $P < 0.03$), carcass yield (quadratic, $P < 0.07$), and backfat (quadratic, $P < 0.04$), with the maximum response observed at 50 mg/kg. Increasing L-carnitine increased (linear, $P < 0.03$) purge loss of the loin, indicative of decreased water holding capacity. Adding L-carnitine to diets did not affect drip loss, color or marbling score of the loin. Feeding dietary DDGS tended ($P < 0.06$) to decrease visual loin marbling score. Feeding DDGS increased ($P < 0.001$) linoleic acid, PUFA, unsaturated fatty acid:saturated fatty acid ratios, and jowl iodine value; however, feeding L-carnitine did not alter jowl fatty acid profile. In conclusion, feeding L-carnitine improved ADG and HCW, with the maximal response observed at 50 mg/kg, but dietary L-carnitine did not improve loin or fat quality.

Table 1. Effect of L-carnitine and DDGS on growth and carcass traits

DDGS, %:	0	0	0	30	30	30	
L-Carnitine, mg/kg:	0	50	100	0	50	100	SEM
ADG, g	814	853	842	828	845	841	11
ADFI, kg	2.40	2.42	2.47	2.46	2.55	2.41	0.04
G:F	0.34	0.35	0.34	0.34	0.33	0.35	0.01
HCW, kg	92.4	95.4	93.2	92.6	94.2	94.1	0.9
Yield, %	74.7	75.9	75.0	75.0	75.2	75.1	0.3
Loin depth, cm[a]	6.36	6.39	6.34	6.23	6.21	6.23	0.10
Backfat, mm[a]	16.7	17.5	17.2	16.5	17.2	16.5	0.3
Purge loss, %	2.71	3.38	3.47	2.46	2.92	3.45	0.38
Iodine value, g/100g	66.5	66.9	66.9	74.7	73.3	74.0	0.6

[a]Adjusted to a common HCW.

Key Words: DDGS, L-carnitine, pig

163 Effect of replacing soybean meal (SBM) with corn high protein dried distillers grains with solubles (HPDDGS) on growth performance, carcass characteristics, and carcass fat quality in finishing pigs. D. L. Goehring*[1], M. D. Tokach[1], J. M. Nelssen[1], J. M.

DeRouchey[1], R. D. Goodband[1], S. S. Dritz[1], and J. L. Usry[2], *[1]Kansas State University, Manhattan, [2]Ajinomoto Heartland LLC, Chicago, IL*

A total of 204 pigs (PIC 327 × 1050, 58.8 kg BW) were used in a 73-d study to determine the effects of replacing SBM with HPDDGS (33% CP; 9% fat; Lifeline Foods, St. Joseph, MO) and crystalline AA on growth performance, carcass characteristics, and carcass fat quality. Pens were balanced by initial BW and gender (6 pigs/pen) and randomly allotted to 1 of 4 treatments: corn-SBM control, the control diet with 50 or 100% of the SBM replaced with HPDDGS and high levels of crystalline AA (L-Lys, L-Trp and L-Thr), and 100% of SBM replaced with HPDDGS and low levels of crystalline AA. High crystalline AA diets required 30, 27.5, and 17.5% HPDDGS while low crystalline AA diets required 40, 37.5, and 27.5% to replace SBM from 58 to 84, 84 to 109, and 109 to 128 kg, respectively. There were 8 or 9 replications/treatment. Replacing 100% of the SBM with HPDDGS and crystalline AA decreased ($P < 0.02$) ADG, ADFI, carcass yield, and back fat and increased ($P < 0.001$) jowl fat iodine value (IV), but had no effect ($P > 0.45$) on G:F, loin depth, or lean percentage. Replacing 50% of SBM with HPDDGS and crystalline AA did not influence ($P > 0.26$) performance, but increased ($P < 0.001$) IV. Increasing the level of crystalline AA included in the diet when replacing SBM with HPDDGS did not influence performance, but increased ($P < 0.01$) carcass yield and decreased ($P < 0.001$) IV. HPDDGS and crystalline AA can replace 50% of the SBM in finishing diets without negatively effecting performance, or carcass yield. Replacing 100% of SBM with HPDDGS reduced growth rate, but increasing crystalline AA levels can partially help mitigate the negative effects on carcass yield and fat IV.

Table 1. SBM replaced with DDGS

Item	0%	50% with High AA	100% with High AA	100% with Low AA	SEM
ADG, kg	0.95	0.96	0.91	0.90	0.01
ADF, kg	2.91	2.92	2.79	2.77	0.04
G:F	0.328	0.327	0.327	0.326	0.001
Final BW, kg	128.3	128.8	126.2	125.2	1.49
Carcass yield, %	73.1	72.7	72.5	71.6	0.23
HCW, kg	93.8	93.9	91.6	90.0	1.27
Lean %	51.8	51.5	51.5	51.7	0.28
Loin depth, mm	58.1	57.2	55.6	54.6	0.90
Backfat, mm	20.9	21.2	20.8	20.0	0.55
Jowl IV	69.8	72.1	74.8	78.0	0.44

Key Words: amino acids, DDGS, finishing pig

164 Digestibility of neutral detergent fiber, energy and amino acids in nine corn co-products fed to growing pigs. N. Gutierrez*[1], B. J. Kerr[2], and J. F. Patience[1], *[1]Iowa State University, Ames, [2]USDA-ARS-NLAE, Ames, IA.*

An experiment was conducted to determine the apparent ileal digestibility (AID) and apparent total tract digestibility (ATTD) of energy and neutral detergent fiber (NDF), and the AID of AA of 9 corn co-products fed to growing pigs. One source of conventional corn bran (CB-NS; 40.6% NDF), corn bran with solubles (CB-S; 30.9% NDF), corn distillers dried grains with solubles (DDGS) produced conventionally (DDGS-CV; 34.5% NDF), uncooked DDGS (DDGS-BPX; 30.8% NDF), reduced oil DDGS (DDGS-RO; 38.7% NDF), high protein distillers dried grains (HP-DDG; 31.1% NDF), dehulled degermed corn (DDC; 3.8% NDF), corn germ meal (CGmM; 46.2% NDF), and corn gluten meal (CGnM; 12.1% NDF) were used. A total of 20 growing pigs (initial BW: 25.9 Â ± 2.5 kg BW) were fitted with a T-cannula in the distal ileum and allotted to 10 dietary treatment groups in a 4-period incomplete block design with 8 observations per treatment. Treatments included a corn-SBM based basal diet and 9 diets obtained by mixing 70% of the basal diet with 30% of the test ingredient. Fecal and ileal samples were collected from all pigs in each of the 4 14-d periods. Feed was provided at 90% of predicted ad libitum intake. The insoluble non-starch polysaccharides (NSP) content ranged from 61% in CGnM and DDC to 99% in CB-NS. The AID of NDF (19.4% in CB-S vs. 60.6% in CGnM; $P = 0.03$) and GE (30.6% in CGmM vs. 85.6% in DDC; $P < 0.01$), and the ATTD of NDF (6.0% in CB-NS vs. 94.6% in CGnM; $P < 0.01$) and GE (40.5 in CB-NS vs. 99.5% in DDC; $P < 0.01$) were different among the 9 corn co-products. The DE (1,842 in CB-S vs. 5,034 kcal DE/kg of DM in CGnM) and ME (1,816 in CB-S to 4,369 kcal ME/kg of DM in CGnM) were also different ($P < 0.01$). The AID of Lys (11.4% in DDC vs. 65.9% in CGnM) differ ($P < 0.01$) but was not correlated to NDF content. In conclusion, fiber in corn co-products is mostly insoluble, and AID and ATTD of NDF may contribute to differences in energy digestibility of corn co-products. Differences in AID of Lys in corn co-products may be the result of content, solubility, and AID of NDF, as well as processing and addition of solubles during ethanol production.

Key Words: corn co-products, fiber, pigs

165 Effect of dietary fiber from corn bran on growth performance and apparent total tract digestibility of dietary energy in growing and finishing pigs. N. A. Gutierrez*[1], B. J. Kerr[2], and J. F. Patience[1], *[1]Iowa State University, Ames, [2]USDA-ARS-NLAE, Ames, IA.*

An experiment was conducted to determine the effects of dietary fiber from corn bran on growth performance and apparent total tract digestibility (ATTD) of energy in growing and finishing pigs. Corn bran with solubles (23% NDF) was used to increase the dietary fiber level. For both growing and finishing pigs (31.2 ± 1.4 kg BW and 85.4 ± 4.7 kg BW, respectively), 35 barrows and 35 gilts were allotted to 7 dietary treatment groups with 10 replicate pigs per treatment for 28 d. Treatments included a basal corn-SBM diet (NE = 2.39 and 2.50 Mcal/kg for growing and finishing pigs, respectively), and 6 experimental diets formulated with 3 levels of added corn bran (7.5, 15, and 22.5% for growing and 8, 16, and 24% of corn bran for finishing pigs) with (2, 6, or 8%) or without soybean oil to create 3 treatments with constant NE and 3 treatments with declining NE as bran increased. Constant SID Lys:NE ratios (3.85 and 2.33 g/Mcal of NE for growing and finishing pigs, respectively) were maintained across treatments. Pigs were housed individually in pens with free access to feed and water. In growing pigs, BW, ADFI, and ADG were not affected ($P > 0.10$) by corn bran level with constant NE. Body weight (49.5 vs. 47 kg; $P = 0.10$) and ADG (1.04 vs. 0.92 kg/d; $P = 0.06$) showed a tendency to decrease at the highest corn bran level with declining NE. Gain to feed ratio increased ($P < 0.001$) from 0.46 to 0.49 with increasing corn bran and constant NE, and decreased ($P < 0.001$) from 0.46 to 0.43 with increasing corn bran level and declining NE. In finishing pigs, growth performance was not affected ($P > 0.10$) by corn bran level and constant NE, but BW (102.8 vs. 99.4 kg; $P = 0.03$), ADG (1.02 vs. 0.84 kg/d; $P = 0.01$), and G:F (0.33 vs. 0.28; $P < 0.001$) decreased with corn bran level and declining NE. In growing and finishing pigs, the ATTD of GE, DM, and CP decreased (linear, $P < 0.001$) with corn bran level regardless of fat presence in the diet. In conclusion, addition of fat overcomes the detrimental effects of increased fiber on growth per-