

losses (BEL) of phosphorus (P) in growing pigs fed P-free diets with various cellulose concentrations. Twelve barrows with an initial mean BW of 49.6 kg (SD = 3.2) were individually housed in metabolism crates that were equipped with a feeder and a nipple drinker. Pigs were allotted to 4 experimental diets according to a crossover design. Experimental diets, based mainly on corn starch, sucrose, and gelatin, were formulated to contain 0, 4, 8, or 12% of cellulose. Each period consisted of a 5-d adaptation and a 5-d collection period. The marker-to-marker method was used for fecal collection. The feed intake and P intake were linearly and quadratically increased ($P < 0.05$) with increasing cellulose concentration in the diet. There were linear and quadratic increases ($P < 0.05$) in the feces output and feces output per feed intake with increasing cellulose concentration in the diet. However, the P content in the feces was decreased ($P < 0.001$) with increasing dietary cellulose concentration. The apparent total tract digestibility of DM and ash were linearly and quadratically decreased ($P < 0.05$) with increasing cellulose concentration in the diet. However, the BEL of P as mg per kg of DMI (ranged from 157 to 207 mg/kg of DMI) and total P output were not affected by the dietary cellulose concentrations. In conclusion, the dietary cellulose affects the digestibility of DM and ash, but the cellulose up to 12% does not affect the endogenous loss of P.

Key Words: cellulose, metabolic fecal phosphorus, swine

per treatment. The 4 dietary treatments were formed by increasing phytase (Optiphos 2000, Enzyvia LLC) to provide 250, 500, 1000, and 2000 phytase units (FTU)/kg. Diets were corn-soybean meal-based and contained 15% bakery meal and decreasing levels of dried distillers grains with solubles in each phase. Diets were fed in 4 phases from approximately 36 to 59, 59 to 82, 82 to 109, and 109 to 131 kg BW and all phases contained the same phytase concentrations. The first 250 FTU/kg of phytase was considered to provide 0.10% P release in meeting the dietary available P levels of 0.29, 0.28, 0.24, and 0.23% and STTD P levels of 0.32, 0.31, 0.27, and 0.27% in phase 1, 2, 3, and 4, respectively, with further additions exceeding the phosphorus requirement. All other nutrients were provided at or above requirement of the pigs as defined by NRC (2012). All data were analyzed as a completely randomized design with pen as the experimental unit. Overall (d 0 to 92) increasing dietary phytase did not influence ($P > 0.05$) ADG but reduced (cubic, $P < 0.01$) ADFI, resulting in increased G:F (cubic, $P < 0.01$). The cubic response occurred because ADFI was reduced and G:F increased with increased phytase inclusion from 250 to 500 FTU/kg with no response from 1000 to 2000 FTU/kg. Phytase addition to the diet did not influence ($P > 0.05$) carcass measurements. These results suggest that providing phytase up to 500 FTU/kg has the potential to improve feed efficiency.

Key Words: Finishing pigs, phosphorus, phytase

NONRUMINANT NUTRITION: GROW-FINISH NUTRITION AND MANAGEMENT

337 Influence of a superdose of phytase on finishing pig performance and carcass characteristics. J. R. Flohr*, R. D. Goodband, M. D. Tokach, K. B. Langbein, S. S. Dritz, J. M. DeRouchey, J. Woodworth, Kansas State University, Manhattan.

A total of 1188 finishing pigs (PIC 337 × 1050; initially 36.4 kg) were used in a 92-d experiment to determine the influence of providing phytase above that needed to meet the P requirement for growth and carcass characteristics. At initiation of the study pens were randomly allotted to treatments based on initial BW. There were 27 pigs per pen and 11 replications

338 Influence of copper sulfate and tribasic copper chloride on feed intake preference in finishing pigs. K. F. Coble^{1,*}, J. M. DeRouchey¹, M. D. Tokach¹, J. Woodworth¹, R. D. Goodband¹, S. S. Dritz¹, J. L. Usry² and K. Card¹, ¹Kansas State University, Manhattan, ²Micronutrients, Social Circle, GA.

When supplemented at 125 to 250 ppm, Cu has consistently been demonstrated to increase ADG, mainly through increased feed intake. A total of 150 pigs (initially 86.6 kg) were used in a 15-d study to determine if pigs have a preference to consume diets containing added Cu from either copper sulfate (CuSO₄) or tribasic copper chloride (TBCC, IntelliBond C; Micronutrients, Indianapolis, IN). Pigs were placed in pens by sex (5 pigs/pen), with each sex accounting for 15 pens. On d 0, pens of pigs were individually weighed and pens were randomly allotted to 1 of 3 dietary preference

Table 337.

Item	Added phytase (FTU)/kg				SEM	Linear	Quadratic	Cubic
	250	500	1000	2000				
d 0 to 92								
ADG, kg	1.04	1.03	1.04	1.02	0.008	0.25	0.27	0.54
ADFI, kg	2.64	2.53	2.61	2.57	0.028	0.49	0.72	0.01
G:F	0.393	0.409	0.400	0.398	0.004	0.88	0.20	0.01
BW, kg								
d 0	36.4	36.3	36.4	36.3	0.54	0.94	1.00	0.94
d 92	130.9	130.1	130.9	129.5	1.05	0.42	0.68	0.52

Table 338. Effects of CuSO₄ and TBCC on feed intake preference of finishing pigs

Item	ADFI, kg	ADFI, %
Comparison 1		
Control	1.67	65.7
CuSO ₄	0.91	34.4
Probability, <i>P</i> <	0.01 (0.154) ¹	0.01 (5.69)
Comparison 2		
Control	1.50	57.0
TBCC	1.13	43.0
Probability, <i>P</i> <	0.03 (0.112)	0.02 (3.71)
Comparison 3		
CuSO ₄	0.89	35.0
TBCC	1.59	65.0
Probability, <i>P</i> <	0.01 (0.130)	0.01 (5.26)

¹Values in parentheses indicate the SEM for each presented *P*-value.

comparisons with 10 replications per comparison with average BW of the pen and sex balanced across comparisons. Treatment diets used were a corn-soybean control with no supplemental Cu beyond that provided in the diet premix (8 ppm), or the control diet with 150 ppm added Cu from either CuSO₄ or TBCC. Pens contained 2 identical 2-hole feeders, each with 1 of 2 treatment diets. Feeders were rotated daily within each pen to prevent location bias. The comparisons tested were: 1) control vs. CuSO₄, 2) control vs. TBCC, and 3) CuSO₄ vs. TBCC. For comparison 1, pigs consumed 66% of their daily intake from the control diet (*P* < 0.01) and only 34% from the CuSO₄ diet. For comparison 2, pigs consumed 57% of their daily intake from the control diet (*P* < 0.03) and 43% from the TBCC diet. For comparison 3, pigs consumed 65% (*P* < 0.01) of their daily intake from the diet containing TBCC and only 35% from the diet with the added CuSO₄. In summary, when given a choice, pigs preferred to consume a diet without high levels of added Cu; however, when given the choice between diets containing either Cu source, pigs preferred diets containing TBCC.

Key Words: copper finishing pig, preference

339 Effects of dietary level of distillers dried grains with solubles (DDGS) and pig removal program at harvest on the growth performance, carcass characteristics, and fat quality of growing-finishing pigs. S. J. Hardman^{1,*}, A. Gaines², C. Puls¹, J. E. Estrada¹, B. Peterson², M. Ellis¹, ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The effect of increasing dietary level of distillers dried grains with solubles (DDGS) and pig removal program at harvest on growth performance, carcass characteristics, and fat quality of growing-finishing pigs was evaluated in a study performed on a commercial wean-to-finish facility. A randomized complete block design was used with 6 treatments: 1) 0% DDGS; all pigs in pen sent for harvest at one time (1 group); 2) 0% DDGS; pens sent for harvest in 6 groups over time (6 groups);

3) 20% DDGS; 1 group; 4) 40% DDGS; 1 group; 5) 40% DDGS; 6 groups; 6) 60% DDGS; 1 group. A total of 1632 pigs housed in groups of 34 were used. Diets were fed from 23.4 ± 1.15 kg to 128.9 ± 1.91 kg for pens sent for harvest as 1 group. For pens sent for harvest in 6 groups, the heaviest pigs were taken off test at a pen mean BW of 112.1 ± 2.04 kg; subsequently, the heaviest pigs were taken off test every 7 d. At harvest, 1 barrow and 1 gilt/pen close to the pen mean were selected for fat quality evaluation. Increasing DDGS inclusion level linearly reduced (*P* ≤ 0.001) ADG, ADFI, and carcass yield, but had no effect (*P* > 0.05) on G:F and 10th rib backfat thickness. Iodine value increased (*P* ≤ 0.001) with increasing DDGS level for belly fat, jowl fat, and backfat. Variation in body weight at harvest, and ADG and G:F were lower (*P* ≤ 0.01) for pens sent for harvest in 1 compared to 6 groups. Carcass yield was lower (*P* ≤ 0.001) for pens sent for harvest in 6 compared to 1 group. There was no effect (*P* > 0.05) of pig removal program on fat iodine value. These results suggest that increasing dietary levels of DDGS increases fat iodine value; however, sending pigs for harvest in 1 compared to 6 groups has no effect on iodine value.

Key Words: pigs, DDGS, iodine value

340 Effect of feeding diets containing 40% distillers dried grains with solubles (DDGS) and supplemented with minimally refined cottonseed oil or crude glycerol on growth performance and carcass composition of growing-finishing pigs. C. E. J. Villela^{1,*}, R. Cox¹, G. C. Shurson¹, K. M. Compart¹, P. E. Urriola¹, L. J. Johnston², ¹University of Minnesota, Saint Paul, ²University of Minnesota, West Central Research and Outreach Center, Morris.

Feeding corn-soybean meal diets containing > 20% DDGS reduces fat firmness in pork carcasses, but supplementing these diets with cottonseed oil or crude glycerol may improve pork fat firmness. However, the addition of cottonseed oil or crude glycerol in 40% DDGS diets for growing-finishing pigs has not been evaluated. Thus, the objective of this study was to assess the effect of feeding crude glycerol or minimally-refined cottonseed oil on growth performance and carcass composition of growing-finishing pigs. Mixed sex pigs (*n* = 216; initial BW = 24 ± 4 kg) were blocked by BW and allotted to 1 of 3 dietary treatments: 1) a basal corn-soybean meal diet with 40% DDGS (CON); 2) CON plus 5% minimally-refined cottonseed oil (COT); or 3) CON plus 8% crude glycerol for the last 6 wk before harvest (GLY). Although diets were not isocaloric, AA to ME ratios were equal among diets within each of the 3 feeding phases. Carcass composition was estimated using real-time ultrasound 2 d before harvest. Overall, ADFI of pigs fed COT (2.30 kg/d) was less (*P* < 0.01) than pigs fed CON and GLY (2.47 and 2.49 kg/d, respectively). Pigs fed COT (0.93 kg/d) had greater (*P* < 0.01) ADG compared with pigs fed CON and GLY (0.88 and 0.87 kg/d, respectively). Greater (*P* < 0.01)