132 Interaction between zinc oxide and copper sulfate on starter pig performance.

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Two experiments were conducted to examine the effects of supplementing starter pig diets with ZnO and (or) $CuSO_4$ on starter pig performance. In Exp. 1, 240 pigs were used in a 28-day growth assay. Four dietary treatments were used in this trial: 1) control (165 ppm Zn and 16.5 ppm Cu), 2) 3,000 ppm Zn, 3) 250 ppm Cu, and 4) 3,000 ppm Zn + 250 ppm Cu. The pigs were blocked by weight and allotted to each of the four dietary treatments in a 2 x 2 factorial arrangement with 9, 10, or 11 pigs per pen and 6 replicate pens per treatment. Diets were formulated in two phases: phase I (d 0 to 14 postweaning) and phase II (d 14 to 28 postweaning) with 1.6 and 1.25% lysine, respectively. Pigs were fed the same experimental mineral level during the entire 28 d growth assay. From d 0 to 14, feeding 3,000 ppm Zn, with or without 250 ppm Cu, improved ADG (P < .01) compared with pigs fed the control or added Cu diets. There was no improvement in ADG or G/F for pigs fed the diet with 250 ppm Cu from $CuSO_4$ as compared with pigs fed the control diet. From d 14 to 28, there was a Zn x Cu interaction. High levels of ZnO improved ADG and average daily feed intake (ADFI) when added to the control diet but not when added to the diet containing 250 ppm Cu. Pigs fed diets with added Zn and (or) Cu had similar G/F. For the entire 28 day trial, pigs fed the diets with added Zn had improved ADG, ADFI and G/F compared to pigs fed the control diet. In Exp. 2, 264 pigs were fed a common phase I diet supplemented with ZnO (3,000 ppm Zn). On d 14, pigs were switched to the diets containing experimental mineral levels. Phase II experimental diets were identical to those of the first experiment. Similar to phase II in Exp. 1, there was a Zn x Cu interaction for ADG (P < .05). Zinc oxide improved ADG when added to the control diet, but not when added to the diet containing $CuSO_4$. Feeding high levels of ZnO in the phase I diets may have had a carryover effect in phase II as we found no improvement in pig performance when high levels of Cu were added to the phase II diet. The results from these experiments indicate that feeding 3,000 ppm of Zn from ZnO is a viable means of increasing starter pig performance with optimum response when the diet does not contain growth-promotant levels of $CuSO_4$ (250 ppm).

			Control	Zn	Cu	Zn + Cu	CV
Exp. 1	d 0 to 14	ADG, g[a]	241	263	236	268	14.2
		G/F	.87	.92	.89	.96	12.7
	d 14 to 28	ADG, g[b]	295	418	372	377	12.2
		G/F[c]	.56	.67	.68	.64	9.6
Exp. 2	d 14 to 28	ADG, g[c]	368	395	350	341	5.6
		G/F	.58	.60	.58	.56	7.4

[a]Zn effect (P < .01)
[bc]Zn x Cu effect (P < .01, and .05, respectively)

Keywords: Zinc, Copper, Starter pigs, Performance

133 Mineral utilization in phytase-and-zinc supplemented diets for pigs.

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Forty-eight pigs (barrows:gilts, 1:1) with an average initial weight of 9.4 kg were used in a 2 X 2 factorial experiment to determine the influence of dietary phytase (0 or 1500 phytase units/kg) and zinc (0 or 100 mg/kg) supplementation on mineral utilization. Pigs were individually housed and allowed ad libitum access to feed and water for 21 d. Blood was collected for plasma mineral analysis. The twenty-four barrows were placed in metabolism cages following blood collection, maintained on their previous diet, and used for a 10-d mineral balance study. Diets were typical corn-soybean meal diets containing 18% CP, 1.05% lysine, .80% Ca, and .62% P and were formulated to meet or exceed current recommendations for all nutrients except Zn. Growth rate was highest (P<.05) for pigs fed phytase. Daily feed intake and gain:feed ratio were unaffected by dietary treatment. Plasma P (P<.01), Mg (P<.05) and Cu (P<.10) concentrations increased with phytase addition. Plasma Zn with concentration increased when phytase was added to the 0 mg Zn diet while the addition of phytase to the diet with 100 mg Zn did not increase plasma Zn concentration. Apparent P and Cu balance was improved (P<.05) with phytase addition, however, Cu balance was reduced (P<.05) by Zn supplementation. Zinc balance was increased (P<.05) with supplemental dietary Zn and phytase and absorption and retention of Zn were greatest (P<.10) when both phytase and supplemental Zn were present. These results indicate that the growth promoting effect of phytase may be due to an overall increase in the availability of dietary minerals.

	Phytase, PU/kg:	0		1500		P<		
Item	Zn, mg/kg:	0	100	0	100	Phy	Zn	PhyX Zn
Gain, g/d		257	333	412	405	.05		
Final plasma concentration, mg/L								
P		119	135	135	145	.01	.01	
Zn		.35	1.21	.83	1.21	.01	.01	.01
Mg		17.4	17.9	19.3	18.7	.01		
Mineral retention								
P, g/d		2.97	3.00	3.59	3.70	.05		
Zn, mg/d		6.97	34.34	9.85	56.88	.05	.05	.10
Cu, mg/d		2.95	1.66	4.86	1.81	.05	.05	.05
Mg, g/d		.341	.235	.289	.284		.05	.10

Key Words: Pigs, Phytase, Zinc, Minerals

134 Effects of dietary calcium on the efficacy of phytase and on the utilization of phosphorus in low phosphorus diets for pigs.

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Four experiments involving 166 pigs were conducted to assess the effects of feeding low-Ca diets on the efficacy of phytase (Natuphos™, BASF, Parsippany, NJ) and on the utilization of P in low-P diets. In Exp. 1 and 2, pigs (5 reps of 1 pig/pen/exp) were fed corn-soy (.95% lysine) diets from 19 to 43 kg. Diets in Exp. 1 were: (1) .65% Ca, .34% P, (2) .65% Ca, .49% P, (3) as 1 + phytase (1,000 units/kg), (4) as 1 + phytase (2,000 units/kg), (5, 6, 7) as 1, 2, and 3 but with .50% Ca. Diets in Exp. 2 were the same as Diets 1, 2, 3, 5, 6, and 7 in Exp. 1. Two additional diets consisted of .415% P at both Ca levels. Means common to both trials are shown below. ADG, F/G, and breaking strength (BS) of the metatarsals and metacarpals (MM) and femurs were improved (*P*<.01) by adding inorganic P or phytase to the low-P, adequate-Ca diet. Bone BS increased slightly (nonsignificant, *P*=.20) with the 2,000 vs 1,000 unit/kg level of phytase. Reducing Ca to .50% in the low-P diet also improved ADG and F/G (*P*<.05), but not bone BS. The efficacy of phytase was similar in the low-Ca vs adequate-Ca diet. In Exp. 3 and 4, pigs (3 reps of 3 pigs/pen/exp) were fed corn-soy diets (.65% lysine) from 52 to 104 kg. Diets were: (1) .50% Ca, .30% P, (2) .50% Ca, .40% P, (3) as 1 + phytase (1,250 units/kg), (4) .30% Ca, .30% P, (5) as 4 + phytase. ADG and bone BS increased (*P*<.01) when inorganic P or phytase was added to the low-P, adequate-Ca diet. ADG was increased (*P*<.01) but bone BS was not affected when Ca was reduced in the low-P diet. Phytase was ineffective when added to the low-P, low-Ca diet. The results indicate that reducing dietary Ca below NRC standards does not improve the efficacy of phytase. Reducing Ca improves the utilization of P for growth, but it does not improve bone BS, apparently due to insufficient Ca for bone mineralization.

	Exp. 1 and 2 (Growing Pigs)						Exp. 3 and 4 (Finishing Pigs)				
Ca, %:	.65	.65	.65	.50	.50	.50	.50	.50	.50	.30	.30
P, %:	.34	.49	.34	.34	.49	.34	.30	.40	.30	.30	.30
Phytase:			+			+			+		+
ADG, g	599	710	688	666	752	696	851	931	929	918	918
F/G	2.71	2.19	2.32	2.42	2.20	2.37	3.51	3.40	3.42	3.54	3.44
MM strength, kg	37	63	57	35	57	59	139	166	173	140	145

Key Words: Pigs, Phytase, Calcium, Phosphorus

135 Impact of dietary available phosphorous concentration on dissectable tissue content and distribution in high and moderate lean growth pigs.

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From each of a high and moderate (mod) lean growth (LG) genotype, seven sets of six littermate barrows (20 ± 2 kg BW) were allotted within litters to a corn-soy mixture containing one of six dietary available phosphorous (P) concentration (.080, .110, .155, .222, .323 and .475%). Dietary P concentrations were achieved by using single sources of each ingredient preanalyzed for P, adjusting the ratio of monocalcium-dicalcium phosphate (21.7% P), $CaCO_3$ and corn starch and assuming the NRC (1988) P bioavailabilities. Pigs were penned individually and self-fed a 1.15% available lysine diet fortified to provide 110% or more of NRC (1988) requirements for all nutrients but P. At 109± 4 kg, pigs were killed, carcasses were separated into wholesale cuts and physically dissected into muscle, bone, skin and fat tissues. Dissectable tissue weights were adjusted for water loss during storage and dissection. Data were analyzed as a split-plot design with genotype the whole-plot and P the sub-plot. Carcasses of high LG pigs contained more muscle and less fat tissue. As dietary P increased, carcass muscle content increased linearly, the ratio of bone to muscle was not affected, the ratio of dissectable fat to muscle and fat in dissectable muscle declined linearly, and the proportion of carcass muscle in the ham-loin (HL) increased linearly in both genotypes. However, increasing dietary P from .08 to .155%, which represent P concentrations below the requirements of both genotypes during the majority of the growth stage evaluated, resulted in greater responses in carcass muscle (+2.40 vs +.37%) and fat to muscle tissue ratio (-.088 vs -.016) in the high vs mod LG genotypes, respectively. Based on these data, increasing dietary P from .080 to .475% increases the proportion of high phosphorous containing proteineous tissues (muscle, bone) relative to fatty tissue in pigs.

		Dietary Available P, %						Probability		
Item	LG Genotype	.080	.110	.155	.222	.323	.475	LG	P	LGxP
Muscle, %	High	53.28	52.61	55.68	55.80	55.96	57.19	.01	.01	.74
	Mod	46.48	46.91	46.85	48.21	48.81	49.62			
Bone/Muscle	High	.212	.224	.223	.212	.225	.213	.07	.20	.73
	Mod	.234	.249	.241	.235	.252	.255			
Fat/Muscle	High	.583	.597	.495	.503	.474	.456	.01	.01	.65
	Mod	.803	.762	.787	.732	.678	.641			
Muscle Fat, %	High	9.24	9.69	8.64	8.18	8.44	7.84	.01	.02	.60
	Mod	11.63	12.62	10.34	10.95	9.77	10.35			
HL Muscle, %	High	56.16	56.24	56.63	57.06	57.03	56.56	.02	.07	.84
Carc. Muscle	Mod	55.38	54.30	55.40	55.91	55.98	56.03			

Key Words: Pigs, phosphorous, muscle