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Evaluation of different zinc sources and levels on nursery pig performance

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Evaluation of Different Zinc Sources and Levels on Nursery Pig Performance[1]

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Summary

A total of 294 pigs (PIC 327 × 1050, initially 14.1 lb BW) were used in a 31-d trial to evaluate the effects of increasing levels of two different zinc sources on nursery pig growth performance. Pigs were weaned at 21 d of age and were fed pelleted diets for the first 7 d and a mash diet for 24 d of the 31-d trial. Each treatment had 7 replicate pens with 7 pigs per pen. The 6 experimental diets were: (1) a control diet; (2) a diet with 500 ppm of Zn from Zinco+; (3) a diet with 1,500 ppm of added Zn from Zinco+; (4) a diet with 500 ppm of Zn from zinc oxide (ZnO); (5) a diet with 1,500 ppm of Zn from ZnO; and (6) a diet with 3,000 ppm of Zn from ZnO. All diets contained 110 ppm of Zn from the $ZnSO_4$ provided by the trace mineral premix. Zinco+ (Jefo, Quebec, Canada) is a fat-encapsulated form of ZnO that is suggested to be more bioavailable than ZnO.

From d 0 to 7, neither Zn source nor level influenced pig performance. From d 7 to 21, pigs fed increasing Zn from Zinco+ tended to have increased (linear, $P = 0.06$) ADG and had improved F/G (linear, $P < 0.01$). Pigs fed increasing levels of Zn from ZnO had greater ADG and ADFI (linear, $P < 0.01$) and improved F/G (quadratic, $P = 0.02$). Pigs had greater ($P < 0.01$) ADG and ADFI when fed diets containing 3,000 ppm of Zn from ZnO compared with pigs fed diets with 500 ppm of Zn from Zinco+. Day 21 BW increased with increasing Zn from Zinco+ (linear, $P < 0.03$) and Zn from ZnO ($P < 0.001$), with pigs fed 3,000 ppm of Zn from ZnO having heavier ($P < 0.01$) d-21 BW compared with those fed 500 ppm of Zn from Zinco+.

Overall, from d 0 to 31, increasing Zn from Zinco+ did not affect growth performance, but increasing Zn from ZnO increased ($P < 0.01$) ADG and ADFI. Pigs fed 500 ppm of Zn from Zinco+ had poorer ADG ($P < 0.02$) and ADFI ($P < 0.01$) than pigs fed 3,000 ppm of Zn from ZnO. This study shows the growth benefits of adding 3,000 ppm of Zn from ZnO in diets fed to newly weaned pigs. Lower levels of Zn from Zinco+ did not provide the same growth-promoting potential as the diet with 3,000 ppm of Zn from ZnO.

Key words: growth performance, nursery pig, zinc

Introduction

Zinc is a trace mineral that is essential for optimal protein and energy metabolism. In addition to meeting the basal requirement, research has shown that pharmacological levels (3,000 ppm) of dietary Zn from ZnO fed for the first 2 to 4 wk after weaning

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can increase growth rates and decrease the incidence of diarrhea. However, these high levels of dietary Zn are also associated with increased Zn concentrations in swine waste, which could lead to excess soil Zn concentrations. A recently introduced fat-encapsulated form of ZnO (Zinco+; Jefo, Quebec, Canada) has been suggested to be more bioavailable than the ZnO normally included in pig diets. If proven efficacious, this Zn source would allow for low levels to be fed and achieve the growth benefits while eliminating high concentrations of Zn in swine waste. Little research has been conducted to confirm this response, however, so the objective of this study was to compare the effects of different levels of Zn from Zinco+ and ZnO on the growth performance of nursery pigs.

Procedures

The protocol for this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee. This experiment was conducted in the nursery facility at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The facility is a totally enclosed, environmentally controlled, mechanically ventilated barn. Each pen contains a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pens had wire-mesh floors and allowed approximately 3 ft^2/pig.

A total of 294 pigs (PIC 327 × 1050, initially 14.1 lb BW) were used in a 31-d trial to evaluate the effects of increasing Zn from 2 different sources on nursery pig growth performance. Pigs were weaned at 21 d of age and were randomly allotted to 1 of 6 dietary treatments. Each treatment had 7 replicate pens with 7 pigs per pen and with gender balanced across the treatments. Pig weight and feed disappearance were measured on d 7, 14, 21, and 31 of the trial to determine ADG, ADFI, and F/G.

All dietary treatments were corn-soybean meal–based and fed in three phases, with pellet diets fed from d 0 to 7, then meal diets fed for the rest of the study (Table 1). All diets contained a trace mineral premix that provided 110 ppm of Zn from $ZnSO_4$. The 6 experimental treatments were a control diet, the control diet with 500 or 1,500 ppm of added Zn from Zinco+; or the control diet with 500, 1,500, or 3,000 ppm of added Zn from ZnO. Zinco+ is ZnO coated with a hydrogenated vegetable oil and was provided by the manufacturer. Diet samples were collected from each phase and analyzed for DM, CP, Ca, P, and Zn at Ward Laboratories, Inc. (Kearney, NE).

Data were analyzed as a randomized complete block design using the PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Weight block and room were included in the model as random effects. The effects of increasing Zn dose within source were determined by linear and quadratic polynomial contrasts. Contrast coefficients were determined for unequally spaced treatments using the IML procedure of SAS, and the treatment without supplemental Zn was used as the first dose for each of the treatments. In addition, a pairwise comparison was made between the diet containing 500 ppm of Zn from Zinco+ and the diet with 3,000 ppm of Zn from ZnO. Treatment differences were considered significant at $P \leq 0.05$ and a tendency from $P > 0.05$ to $P \leq 0.10$.

Results and Discussion

The chemical analyses of the experimental diets were similar to those calculated from diet formulation (Table 2).

From d 0 to 7, no differences were observed among pigs fed either Zn from Zinco+ or ZnO ($P > 0.10$) on growth performance (Table 3). From d 7 to 21, pigs fed increasing Zn from Zinco+ tended to have increased (linear, $P = 0.07$) ADG and had improved F/G (linear, $P < 0.01$). Pigs fed increasing Zn from ZnO had greater ADG and ADFI (linear, $P < 0.01$) and improved F/G (quadratic, $P = 0.03$). Pigs had greater ($P < 0.01$) ADG and ADFI when fed diets containing 3,000 ppm of Zn from ZnO compared with pigs fed diets with 500 ppm of Zn from Zinco+. Day-21 BW increased with increasing Zn from Zinco+ (linear, $P < 0.04$) and Zn from ZnO (linear; $P < 0.01$), with pigs fed 3,000 ppm of Zn from ZnO having heavier ($P < 0.01$) d-21 BW compared with those fed 500 ppm of Zn from Zinco+.

From d 21 to 31, ADG and ADFI were not influenced by treatment; however, F/G tended to worsen (linear, $P = 0.08$) when pigs were fed increasing Zn from Zinco+ and worsened (linear, $P = 0.02$) when pigs were fed increasing Zn from ZnO. Pigs fed 3,000 ppm of Zn from ZnO tended to have poorer ($P = 0.10$) F/G than pigs fed 500 ppm of Zn from Zinco+. These data agree with previous research indicating that growth-promoting levels of Zn should be fed only for the first 21 d after weaning.

Overall, from d 0 to 31, increasing Zn from Zinco+ did not affect growth performance, but increasing Zn from ZnO increased (linear; $P < 0.01$) ADG and ADFI. Pigs fed 500 ppm of Zn from Zinco+ had poorer ADG ($P < 0.02$) and ADFI ($P < 0.01$) than pigs fed 3,000 ppm of Zn from ZnO.

In conclusion, this study demonstrates the growth-promoting benefits of adding 3,000 ppm of Zn from ZnO in diets fed to newly weaned pigs. Pigs fed lower levels of added Zn from Zinco+ had poorer performance than those fed the diet containing 3,000 ppm of Zn from ZnO but similar performance to those fed diets containing the same levels of Zn from ZnO. This result suggests that the fat encapsulation around the ZnO of the Zinco+ product resulted in no growth benefits. Additional research could be conducted to determine if Zinco+ reduces the excretion of Zn compared with uncoated ZnO.

Table 1. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3
Ingredient, %			
Corn	37.53	54.60	63.69
Soybean meal (47.5% CP)	19.86	29.54	32.86
Blood meal	1.25	1.25	--
Blood plasma	4.00	--	--
Dried distillers grains with solubles, >6 and <9% oil	5.00	--	--
Fish meal	1.25	1.25	--
Spray-dried whey	25.00	10.00	--
Choice white grease	3.00	--	--
Monocalcium phosphate	0.90	0.80	1.00
Limestone	1.00	1.10	1.03
Salt	0.30	0.30	0.35
L-lysine-HCl	0.23	0.30	0.30
DL-methionine	0.15	0.18	0.12
L-threonine	0.09	0.15	0.12
Trace mineral premix	0.15	0.15	0.15
Vitamin premix	0.25	0.25	0.25
Choline chloride 60%	0.04	--	--
Phytase	--	0.13	0.13
Total	100.00	100.00	100.00
Calculated analysis			
Standardized ileal digestible (SID) amino acids, %			
Lysine	1.40	1.35	1.22
Isoleucine:lysine	56	58	63
Leucine:lysine	128	125	129
Methionine:lysine	32	35	33
Met & Cys:lysine	57	58	57
Threonine:lysine	63	64	63
Tryptophan:lysine	19.0	18.1	18.7
Valine:lysine	71	69	69
Total lysine, %	1.56	1.50	1.37
ME, kcal/lb	1,574	1,491	1,483
NE, kcal/lb	1,179	1,100	1,092
SID lysine:ME, g/Mcal	4.04	4.11	3.73
CP, %	22.2	22.1	21.4
Ca, %	0.85	0.80	0.70
P, %	0.73	0.63	0.61
Available P, %	0.51	0.47	0.41

[1] Experimental diets were fed in 3 phases, with phases 1, 2, and 3 fed from d 0 to 7, 7 to 21, and 21 to 31, respectively. All diets contained 110 ppm of Zn from $ZnSO_4$ from the trace mineral premix.

Table 2. Chemical analysis of experimental diets[1]

Item	Control	Zinco+ 500	Zinco+ 1500	ZnO 500	ZnO 1500	ZnO 3000
Zn ppm	169	458	1,575	605	1,263	2,890

[1] Chemical analyses reported are averages from composite samples collected from d 0 to 31.

Table 3. Evaluation of Zn sources on nursery pig performance[1]

	Control[2]	Added Zn[2], ppm						Probability, $P <$				
		Zinco+		ZnO				Zinco+		ZnO		500 Zinco+ vs. 3000 ZnO
Item	0	500	1,500	500	1,500	3,000	SEM	Lin	Quad	Lin	Quad	
d 0 to 7												
ADG, lb	0.18	0.20	0.20	0.24	0.20	0.24	0.02	0.41	0.66	0.11	0.81	0.11
ADFI, lb	0.40	0.39	0.38	0.42	0.42	0.43	0.02	0.69	0.96	0.40	0.87	0.24
F/G	2.48	2.14	2.09	1.79	2.27	1.80	0.28	0.34	0.53	0.22	0.99	0.35
d 7 to 21												
ADG, lb	0.58	0.60	0.67	0.60	0.70	0.76	0.05	0.07	0.98	0.01	0.60	0.01
ADFI, lb	0.94	0.92	0.98	0.91	1.00	1.10	0.06	0.43	0.54	0.01	0.52	0.01
F/G	1.63	1.52	1.48	1.53	1.43	1.44	0.04	0.01	0.27	0.01	0.03	0.13
d 21 to 31												
ADG, lb	1.14	1.14	1.11	1.19	1.15	1.14	0.05	0.58	0.77	0.66	0.60	0.96
ADFI, lb	1.76	1.78	1.80	1.83	1.83	1.86	0.06	0.44	0.91	0.12	0.49	0.16
F/G	1.55	1.57	1.63	1.55	1.60	1.64	0.03	0.08	0.80	0.02	0.96	0.10
d 0 to 31												
ADG, lb	0.67	0.69	0.70	0.70	0.73	0.77	0.02	0.29	0.82	0.01	0.54	0.02
ADFI, lb	1.08	1.08	1.11	1.09	1.14	1.19	0.03	0.50	0.72	0.01	0.91	0.01
F/G	1.62	1.58	1.58	1.56	1.56	1.56	0.03	0.35	0.38	0.21	0.20	0.62
BW, lb												
d 0	14.3	14.3	14.3	14.3	14.3	14.3	0.05	0.20	0.27	0.48	0.34	0.14
d 7	15.5	15.7	15.8	16.0	15.7	16.0	0.15	0.30	0.83	0.09	0.96	0.07
d 21	23.6	24.1	25.2	24.7	25.5	26.9	0.67	0.04	0.97	0.01	0.66	0.01
d 31	35.0	35.5	36.4	36.5	37.0	38.3	0.69	0.16	0.92	0.01	0.56	0.01

[1] A total of 294 pigs (PIC 327 × 1050) were used in a 31-d study with 7 pigs per pen and 7 pens per treatment.
[2] All diets contained 110 ppm Zn from $ZnSO_4$ provided by the trace mineral premix.