INFLUENCE OF ADDED ZINC FROM ZINC OXIDE OR A ZINC AMINO ACID COMPLEX ON STARTER PIG GROWTH PERFORMANCE [1]

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Summary

A total of 360 pigs (initially 11.5 lb and 16 d of age) was fed a negative control diet containing no added Zn; one of six diets containing 165 ppm Zn from zinc oxide from the trace mineral premix and added AvailaZn (0, 100, 200, 300, 400, or 500 ppm of Zn); or a positive control diet containing 3,165 ppm added Zn from zinc oxide. Pigs fed the positive control diet had higher (P<.02) ADG and ADFI compared to pigs in all other treatments for the duration of the trial. Pigs fed diets containing AvailaZn had numerically higher ADG and ADFI than pigs fed diets containing no added Zn for the entire trial. These results are similar to previous research showing maximum growth performance exhibited by pigs fed high levels (3,000 ppm) of Zn from zinc oxide.

(Key Words: Early-Weaned Pigs, Growth, Zinc.)

Introduction

A previous study at Kansas State University compared the effects of added Zn from zinc sulfate or a zinc amino acid complex (AvailaZn) to a diet containing no additional Zn and a diet containing 3,000 ppm Zn from zinc oxide. All diets contained 165 ppm Zn (zinc oxide) from the trace mineral premix. Although pigs fed the zinc sulfate and AvailaZn diets had lower ADG and ADFI compared to pigs fed high levels of zinc oxide, all pigs showed improvements in growth performance over those fed the diets containing no additional Zn. Previous research at Kansas State University and other universities, has also shown this growth promotional effect of adding 3,000 ppm Zn from zinc oxide. However, adding high levels of Zn from other inorganic Zn sources has not resulted in a growth promotional response. Other research has shown that adding lower levels of Zn (250 ppm) from an organic zinc amino acid complex to diets containing 250 ppm Zn from zinc sulfate improved performance in a similar manner as high levels of zinc oxide. Many of the trials showing the similar response between organic sources and zinc oxide used only 2,000 ppm Zn from zinc oxide as the positive control, which does not produce the growth promotional response of 3,000 ppm Zn. The objective of this trial was to determine if pigs fed diets containing Zn from a zinc amino acid complex (AvailaZn) would show similar growth responses compared to pigs fed diets containing 3,000 ppm of Zn from zinc oxide.

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Procedures

A total of 360 weanling pigs (initially 11.5 lb and 16 d of age; PIC L-C22 barrows) was used in a 34-d growth assay to determine the influence of added Zn from zinc oxide or a zinc amino acid complex (AvailaZn) on weanling pig growth performance. Pigs were blocked by initial weight and allotted randomly to each of eight dietary treatments. Each treatment had five pigs per pen and nine replications (pens) per treatment.

All experimental diets were fed in meal form. Diets fed from d 0 to 5 after weaning were formulated to contain 1.70% lysine, .48% methionine, .90% Ca, and .80% P (Table 1). Diets fed from d 5 to 10 were formulated to contain 1.55% lysine, .44% methionine, .90% Ca, and .80% P. Diets fed from d 10 to 20 were formulated to contain 1.40% lysine, .39% methionine, .85% Ca, and .75% P. Diets fed from d 20 to 34 were formulated to contain 1.30% lysine, .36% methionine, .75% Ca, and .70% P. The eight experimental diets consisted of a negative control diet containing no added Zn; six diets containing 165 ppm of Zn from zinc oxide from the trace mineral premix and one of six levels of added Zn from AvailaZn (0, 100, 200, 300, 400, or 500 ppm Zn); and a positive control diet containing 165 ppm of Zn from the trace mineral premix plus 3,000 ppm of added Zn from zinc oxide. Pigs were fed the same experimental Zn concentrations throughout the 34 d study. Zinc oxide and AvailaZn replaced cornstarch in the negative control diet to form the experimental treatments.

Pigs were housed in the Kansas State University SEW buildings for the entire trial. Each pen was 4 × 4 ft in area and contained one nipple waterer and one five-hole self-feeder to provide ad libitum access to feed and water.

Pigs were weighed and feed disappearance was determined on d 0, 5, 10, 20, and 34 to calculate ADG, ADFI, and F/G. Diet samples were collected from each phase and analyzed to determine dietary zinc concentrations. Two pigs per pen were selected randomly and bled on days 20 and 34 to determine serum Zn levels. Samples were centrifuged, and the serum from the two pigs in each pen was pooled for analysis.

Data were analyzed as a randomized complete block design with pen as the experimental unit. Linear and quadratic polynomials were used to test the effects of increasing AvailaZn. Contrast statements were used to investigate the mean differences between the positive and negative controls and the mean of the diets containing AvailaZn. Significance was determined using $\alpha = .05$.

Results and Discussion

From d 0 to 10, ADG was highest (P<.03; Table 3) for pigs fed diets containing 3,000 ppm of Zn from zinc oxide compared to pigs fed any other diet. Pigs fed diets containing 3,000 ppm of Zn from zinc oxide had higher (P<.03) ADFI compared to pigs fed diets containing no added Zn but similar (P> .10) ADFI compared to the mean of diets containing AvailaZn. Feed:gain ratio was not different (P>.10) across experimental treatments. From d 0 to 10, pigs fed diets containing AvailaZn had ADG, ADFI, and F/G similar (P>.10) to the negative control. Increasing AvailaZn had no effect (P>.10) on ADG, ADFI, or F/G.

From d 10 to 20, pigs fed diets containing 3,000 ppm of Zn from zinc oxide had the highest (P<.002) ADG and ADFI compared to all other treatments. Pigs fed AvailaZn had ADG and ADFI similar (P>.10) to those of pigs fed diets containing no added Zn. Pigs fed AvailaZn had improved (P<.02) F/G compared to the positive and negative controls. This improved feed efficiency did not increase ADG from d 10 to 20 because of the lower feed intakes of pigs fed AvailaZn. Increasing levels of AvailaZn from 100 to 500 ppm of added Zn did not affect (P>.10) ADG, ADFI, or F/G.

From d 20 to 34, pigs fed 3,000 ppm of Zn from zinc oxide tended to have increased (P<.09) ADG compared to the negative control but did not differ (P>10) from pigs fed diets containing AvailaZn. Average daily feed intake was maximized (P<.007) for pigs fed diets containing 3,000 ppm of Zn from zinc oxide compared to all other treatments. The higher feed intake but similar ADG of pigs fed 3,000 ppm of Zn from zinc oxide contributed to the higher (P<.05) F/G of the positive control compared to all other treatments. Pigs fed diets containing AvailaZn had improved (P<.003) F/G compared to the positive control diet, but F/G was not different (P>.10) compared to the diet containing no added Zn. Increasing AvailaZn supplementation tended to decrease (linear, P<.10) ADFI and improve F/G of pigs fed the highest level of added AvailaZn.

Overall from d 0 to 34, pigs fed diets containing 3,000 ppm of Zn from zinc oxide had the highest (P<.02) ADG and ADFI compared to pigs fed any other diet. Average daily gain and ADFI were similar (P>.10) between the negative control and diets containing AvailaZn. Feed to gain ratio was not different (P>.10) among the negative control diet and diets containing AvailaZn or the positive control diet, whereas diets containing AvailaZn had improved (P<.004) F/G compared to diets containing 3,000 ppm of Zn from zinc oxide. Similar to d 20 to 34, increasing AvailaZn decreased (linear, P<.05) F/G primarily because of lower feed intakes exhibited by pigs fed the highest level of AvailaZn.

Analyzed Zn concentrations of the diets (Table 2) generally increased with increasing Zn additions. However, some analyzed concentrations showed considerable variation from calculated values. These differences could be due to the 20% variation permitted for Zn analysis.

Pigs fed diets containing 3,000 ppm of Zn from zinc oxide had the highest (P<.008) blood serum Zn concentrations compared to all other treatments on d 20 and d 34. Pigs fed diets containing AvailaZn had higher (P<.008) serum Zn concentrations than pigs fed the negative control diet containing no additional Zn. Increasing levels of added Zn from AvailaZn had no effect (P>.10) on serum Zn concentration. The heparin tubes used to collect the blood also were analyzed for Zn concentration and found to contain .05 mg/L Zn. Therefore, the total analyzed serum Zn values were adjusted by subtracting .05 mg/L.

In conclusion, pigs fed diets containing 3,000 ppm Zn from zinc oxide exhibited the best ADG and ADFI compared to pigs fed all other treatments. These results agree with past research conducted at Kansas State University and other universities showing the benefits of increased growth performance from pharmacological levels of Zn from zinc oxide. The results of this trial agree with our first trial showing reduced growth performance of pigs fed AvailaZn compared to pigs fed diets containing growth-promotional levels of Zn from zinc oxide. Contrary to research conducted at other universities, pigs fed diets containing Zn from the zinc amino acid complex did not exhibit growth performance similar to pigs fed diets containing high levels of Zn from zinc oxide. These results suggest that 3,000 ppm Zn from zinc oxide should be added to the diets of weanling pigs.

Table 1. Diet Compositions (As-Fed Basis)

Ingredient, %	Day 0 to 5[a]	Day 5 to 10[b]	Day 10 to 20[c]	Day 20 to 34[d]
Corn	38.69	45.66	51.95	58.72
Dried whey	25.00	20.00	10.00	-
Soybean meal (46.5% CP)	12.18	21.30	28.50	34.39
Spray-dried animal plasma	6.75	2.50	-	-
Select menhaden fish meal	6.00	2.50	-	-
Lactose	5.00	-	-	-
Soy oil	2.00	2.00	3.00	3.00
Spray-dried blood meal	1.75	2.50	2.50	-
Monocalcium phosphate	.70	1.27	1.60	1.48
Limestone	.51	.77	1.0	.97
Cornstarch[e]	.50	.50	.50	.50
Salt	.25	.30	.30	.35
Vitamin premix	.25	.25	.25	.25
L-Lysine HCL	.15	.15	.15	.15
Trace mineral premix[f]	.15	.15	.15	.15
DL-Methionine	.12	.15	.10	.04
Total	100.00	100.00	100.00	100.00

[a]Diets were formulated to contain 1.70% lysine, .48% methionine, .90% Ca, and .80% P and were fed from d 0 to 5 after weaning.
[b]Diets were formulated to contain 1.55% lysine, .44% methionine, .90% Ca, and .80% P and were fed from d 5 to 10.
[c]Diets were formulated to contain 1.40% lysine, .39% methionine, .85% Ca, and .75% P and were fed from d 10 to 20.
[d]Diets were formulated to contain 1.30% lysine, .36% methionine, .75% Ca, and .70% P and were fed from d 20 to 34.
[e]Zinc sources replaced cornstarch to provide the experimental treatments.
[f]Provided per ton of complete feed: 36 g Mn; 150 g Fe; 15 g Cu; 270 mg I; and 270 mg Se.

Table 2. Analyzed Zinc Concentrations (ppm) of Formulated Diets[a]

		Added Zinc (ppm)							
	AvailaZn	0	0	100	200	300	400	500	0
Item	ZnO	0	165	165	165	165	165	165	3,165
Day 0 to 5									
Zn		55	202	309	395	512	577	708	2,886
Day 5 to 10									
Zn		105	223	342	346	485	585	717	3,507
Day 10 to 20									
Zn		102	198	238	348	457	574	658	2,872
Day 20 to 34									
Zn		108	162	287	325	515	593	621	2,358

[a]Values (as-fed basis) represent one sample per diet for each time period.

Table 3. Influence of Added Zinc from Zinc Oxide or a Zinc Amino Acid Complex on Starter Pig Growth Performance[a]

		Added Zinc (ppm)									Contrasts (P <)[b]		
	AvailaZn	0	0	100	200	300	400	500	0				
Item	ZnO	0	165	165	165	165	165	165	3,165	CV	1	2	3
Day 0 to 10													
ADG, lb		.27	.28	.28	.29	.29	.30	.27	.35	24.16	.03	.68	.02
ADFI, lb		.35	.39	.38	.42	.39	.41	.36	.43	19.56	.03	.16	.12
F/G		1.28	1.36	1.34	1.51	1.33	1.39	1.44	1.28	16.35	.98	.16	.17
Day 10 to 20													
ADG, lb		.64	.64	.68	.68	.65	.66	.68	.78	13.33	.002	.47	.001
ADFI, lb		.89	.83	.88	.89	.85	.89	.84	1.08	12.53	.001	.45	.001
F/G		1.40	1.31	1.31	1.30	1.31	1.35	1.24	1.38	7.12	.76	.007	.02
Day 20 to 34													
ADG, lb		1.16	1.20	1.21	1.22	1.25	1.20	1.17	1.23	7.34	.09	.14	.42
ADFI, lb[c]		1.69	1.77	1.83	1.73	1.76	1.74	1.68	1.89	7.57	.004	.23	.007
F/G[c]		1.46	1.47	1.51	1.42	1.41	1.45	1.43	1.53	4.72	.05	.58	.003
Day 0 to 34													
ADG, lb		.75	.77	.79	.80	.79	.78	.76	.84	8.42	.004	.17	.02
ADFI, lb		1.06	1.10	1.13	1.12	1.09	1.10	1.05	1.22	8.13	.001	.33	.001
F/G[d]		1.42	1.42	1.43	1.40	1.37	1.41	1.37	1.46	3.40	.16	.26	.004
Day 20 Serum[e]													
Zn, mg/L		.27	.69	.73	.81	.76	.71	.71	1.91	25.42	.001	.001	.001
Day 34 Serum[e]													
Zn, mg/L		.54	1.13	.94	1.02	.96	.96	1.00	2.24	33.01	.001	.008	.001

[a]A total of 360 pigs (initially 11.5 lb and 16 d of age), five pigs per pen and nine replications per treatment.
[b]Contrasts were: 1) 0 ppm added Zn vs. 3,165 ppm added Zn (Zinc oxide), 2) 0 ppm added Zn vs. AvailaZn, and 3) 3,165 ppm added Zn (Zinc oxide) vs. AvailaZn.
[c]Linear AvailaZn (P<.10).
[d]Linear AvailaZn (P<.05).
[e]Values represent treatment means of pooled samples from two pigs per pen.