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# EFFECTS OF DIFFERENT ZINC OXIDE SOURCES ON WEANLING PIG GROWTH PERFORMANCE[1]

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## Summary

A total of 192 pigs (initially 13.6 lb and 18 d of age) were used in a 27-d growth assay to determine the effects of different ZnO sources on weanling pig growth performance. The four experimental treatments consisted of a control diet or three diets containing Zn from ZnO from one of three different sources. For the entire trial, no differences occurred in growth performance of pigs fed the different ZnO sources; however, all sources increased ADG and ADFI compared to pigs fed the control diet. Economics and ingredient availability should dictate which ZnO source to use in weanling pig diets to promote growth.


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

## Introduction

Previous trials at Kansas State University and other universities have demonstrated the beneficial effects of adding high levels of dietary ZnO (3,000 ppm of Zn) on growth performance of weanling pigs. However, not all trials have demonstrated the same magnitude of response, and others have observed no response at all. Questions remain as to whether the inconsistencies observed in growth performance were results of differences in the ZnO sources used in the trials. Different techniques can be used to manufacture and/or process ZnO, and consequently, the quality of the resulting ZnO will vary greatly. Recent research from the University of Illinois has shown that the bioavailability of Zn from different ZnO sources differs considerably (39.5 to 95.5%) when added at low levels in diets fed to Zn-depleted chicks. However, the influence of pharmacological levels (20 to 30 × NRC requirement estimate) of Zn from different ZnO sources on weanling pig growth performance has not been tested. Therefore, the objective of this trial was to determine the effects of high levels of Zn from one of three different commercially available ZnO sources on weanling pig growth performance.

## Procedures

A total of 192 weanling pigs (initially 13.6 lb and 18 d of age; PIC) was used in a 27 d growth assay. Pigs were blocked by initial weight and allotted randomly to each of four dietary treatments. Each treatment had six replications (pens) and eight pigs per pen.

The four experimental treatments consisted of a basal diet with no additional Zn or the basal diet with added ZnO from one of three different commercially available sources. Added Zn levels were 3,000 ppm of Zn from d 0 to 14 and 2,000 ppm of Zn from d 14 to 27. All diets contained 165 ppm of Zn from ZnO provided by the trace mineral premix. The experimental diets were fed in meal form and contained no feed grade medication. Diets (Table 1) were fed in three phases (d 0 to 7, 7 to 14, and 14 to 27) with

[1]The authors thank Eichman Brothers, St. George, KS, for the use of facilities and pigs for this experiment.

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decreasing nutrient concentrations and specialty protein sources in each subsequent phase. The ZnO replaced cornstarch in the basal diet to provide the experimental treatments. Complete trace mineral profiles were determined for each Zn source (Table 2). The sources varied considerably in their respective trace mineral profiles; however, diets were not equalized based on mineral concentrations other than Zn from the sources.

Pigs were housed in an environmentally controlled nursery in 5 × 5 ft pens on a commercial farm in northeast Kansas. Pens contained one self-feeder and two nipple waters to provide ad libitum access to feed and water. Pigs were weighed and feed disappearance was determined on d 0, 7, 14, 21, and 27 to determine ADG, ADFI, and F/G.

Data were analyzed in a randomized complete block design using the general linear model (GLM) of SAS with pen as the experimental unit. Orthogonal contrasts were used to compare ZnO sources and to compare the control treatment to treatments containing added ZnO.

### Results and Discussion

Analysis of the Zn sources resulted in a wide variation in the concentration of other trace minerals found in the ZnO sources (Table 2). These differences exist because of the different procedures used to manufacture the sources. One Zn source was manufactured by the Waells process, which is known to produce some of the purest feed-grade ZnO available in the United States. Another of the sources is actually a by-product of the iron industry and contains Zn that has been shown to be bound to iron as a relatively unavailable zinc-ferrite complex. The third ZnO source is a product sold as a blend of other commercially available ZnO sources.

For the entire experiment, all three ZnO sources had similar ($P$>.28; Table 3.) effects on growth performance of the pigs. From d 0 to 7, pigs fed diets containing high levels of ZnO tended to have greater ($P$<.09) ADG compared to pigs fed the control. Pigs fed high levels of ZnO had similar ($P$>.59) ADFI but improved ($P$<.04) F/G compared to pigs fed the control.

From d 7 to 14 and d 0 to 14, ADG and ADFI were increased ($P$< .02) when high levels of ZnO was added to the diets. Feed to gain ratio was not influenced ($P$>.32) by high levels of ZnO from d 7 to 14; however, when d 0 to 7 and d 7 to 14 data were combined, F/G was improved ($P$<.04) by adding high levels of ZnO to the diets.

From d 14 to 27 and 0 to 27, adding ZnO to the diets increased ($P$<.002) ADG and ADFI compared to control diets. Feed to gain ratio was not affected ($P$>.29) by adding ZnO to diets from d 14 to 27, although for the overall data, d 0 to 27, F/G tended to be improved ($P$<.09) for pigs fed diets containing high levels of ZnO compared to pigs fed the control diet.

These results are similar to those of some experiments conducted at Kansas State University showing a beneficial response in growth performance of pigs fed pharmacological levels of ZnO. Possible explanations of why other experiments have not shown a similar response include differences in initial weight, age, genetics, or health status of the pigs. The results of this experiment suggest that 3,000 ppm of Zn from ZnO should be added from d 0 to 14 after weaning and 2,000 ppm of Zn added from d 14 to 27 to improve pig growth performance. These data also suggest that no differences occur in growth performance of pigs fed Zn from different ZnO sources when added at growth promotional levels (30 × NRC requirement estimate); however, differences might exist if sources were added at lower concentrations. Price and availability of the different sources should help dictate which source to use for growth promotion.

**Table 1. Diet Composition (As-Fed Basis)**

| Ingredient, % | Day 0 to 7 | Day 7 to 14 | Day 14 to 27 |
|---|---|---|---|
| Corn | 38.81 | 45.78 | 52.07 |
| Dried whey | 25.00 | 20.00 | 10.00 |
| Soybean meal (46.5% CP) | 12.18 | 21.30 | 28.50 |
| 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 |
| Spray-dried blood meal | 1.75 | 2.50 | 2.50 |
| Monocalcium phosphate | .69 | 1.26 | 1.59 |
| Limestone | .50 | .76 | .99 |
| Cornstarch[a] | .40 | .40 | .40 |
| Salt | .25 | .30 | .30 |
| Vitamin premix | .25 | .25 | .25 |
| L-Lysine HCL | .15 | .15 | .15 |
| Trace mineral premix[b] | .15 | .15 | .15 |
| DL-Methionine | .12 | .15 | .10 |
| Total | 100.00 | 100.00 | 100.00 |
| | | | |
| Calculated analysis, % | | | |
| Lysine | 1.70 | 1.55 | 1.40 |
| Methionine | .48 | .44 | .39 |
| Ca | .90 | .90 | .85 |
| P | .80 | .80 | .75 |

[a]Zinc oxide replaced cornstarch to provide the experimental treatments.
[b]Provided per ton of complete feed: 36 g Mn; 150 g Fe; 150 g Zn from ZnO; 15 g Cu; 270 mg I; and 270 mg Se.

**Table 2. Analyzed Trace Mineral Profiles of Zinc Oxide Sources[a]**

| | ZnO Source | | |
|---|---|---|---|
| Mineral | 1 | 2 | 3 |
| Ca, % | 2.31 | .14 | 2.03 |
| Cu, ppm | 305.4 | 94 | 352.3 |
| Fe, % | 1.74 | 9.90 | 2.68 |
| K, % | .08 | .03 | .13 |
| Mg, % | .24 | .15 | .17 |
| Mn, ppm | 2,738 | 984 | 1,554 |
| Na, % | .39 | .08 | .51 |
| P, % | <.01 | .02 | .01 |
| S, % | .13 | .32 | .18 |
| Zn, % | 73.4 | 69.9 | 74.5 |

[a]Values are the means of two analyses of each source reported on an as-fed basis.

**Table 3. Influence of Different Zinc Oxide Sources on Weanling Pig Growth Performance[a]**

| Item | Control | ZnO Source 1 | ZnO Source 2 | ZnO Source 3 | SEM | Contrasts, $P <$ Control vs 1,2,3 | 1 vs 2 | 1 vs 3 | 2 vs 3 |
|---|---|---|---|---|---|---|---|---|---|
| Day 0 to 7 | | | | | | | | | |
| ADG, lb | .31 | .38 | .38 | .38 | .033 | .09 | .91 | .98 | .89 |
| ADFI, lb | .42 | .43 | .46 | .43 | .025 | .59 | .38 | .97 | .40 |
| F/G | 1.40 | 1.14 | 1.25 | 1.11 | .091 | .04 | .50 | .80 | .28 |
| Day 7 to 14 | | | | | | | | | |
| ADG, lb | .68 | .81 | .85 | .82 | .049 | .02 | .61 | .91 | .70 |
| ADFI, lb | .84 | .98 | .96 | .96 | .032 | .004 | .72 | .62 | .89 |
| F/G | 1.25 | 1.23 | 1.15 | 1.19 | .055 | .32 | .29 | .58 | .61 |
| Day 0 to 14 | | | | | | | | | |
| ADG, lb | .49 | .60 | .61 | .60 | .030 | .007 | .73 | .92 | .81 |
| ADFI, lb | .63 | .70 | .71 | .69 | .023 | .02 | .82 | .74 | .57 |
| F/G | 1.28 | 1.19 | 1.16 | 1.16 | .042 | .04 | .63 | .59 | .96 |
| Day 14 to 27 | | | | | | | | | |
| ADG, lb | 1.03 | 1.25 | 1.25 | 1.25 | .050 | .0018 | .94 | .94 | .99 |
| ADFI, lb | 1.47 | 1.73 | 1.69 | 1.69 | .052 | .0012 | .60 | .62 | .98 |
| F/G | 1.43 | 1.39 | 1.40 | 1.35 | .048 | .29 | .63 | .57 | .93 |
| Day 0 to 27 | | | | | | | | | |
| ADG, lb | .75 | .91 | .92 | .91 | .033 | .0007 | .82 | .92 | .91 |
| ADFI, lb | 1.03 | 1.20 | 1.18 | 1.17 | .028 | .0003 | .72 | .57 | .84 |
| F/G | 1.38 | 1.32 | 1.29 | 1.28 | .037 | .09 | .56 | .49 | .91 |

[a]Values represent the means of 192 pigs (initially 13.6 lb and 18 d of age); eight pigs per pen and six pens per treatment.