128 Evaluation of zinc sources for the newly weaned pig. G. A. McCully*, G. M. Hill, J. E. Link, R.L. Weavers, M. S. Carlson and D. W. Rozeboom, Michigan State University, East Lansing.

To determine the efficacy of high dietary concentrations of zinc (Zn) in the newly weaned pig diet, 120 crossbred pigs (21 days of age) were weaned and fed a two phase starter regime which met or exceeded all nutrient needs (NRC, 1988). Pigs in study 1 were allotted to treatments by sex and litter and blocked by weight. The dietary treatments were (1) 150 ppm Zn or (2) 3000 ppm Zn provided as Zn oxide. Pens were evaluated daily for fecal consistency. Scores (1-5) were assigned by an individual blinded to treatments (1 = no loose stools, 5 = all very watery stools). Average daily gain was calculated for phase 1 (wk 1), phase 2 (wk 2 and 3) and the entire study (wk 1-3). No differences were observed during wk 1, however, pigs fed 3000 ppm gained significantly (ps.01) better and had lower (ps.05) fecal scores during wk 2 and 3 and for the entire study than pigs fed 150 ppm Zn. The objective of the second study (n = 50) was to determine if other chemical forms of Zn would enhance growth as observed with Zn oxide. Utilizing the same study parameters as in study 1, the dietary treatments were (1) 150 ppm Zn as Zn oxide (control); (2) 3000 ppm Zn, as Zn acetate; (3) 3000 ppm Zn, as Zn carbonate; (3) 3000 ppm Zn, as Zn oxide and (4) 3000 ppm Zn, as Zn sulfate. Average daily gain was lower (ps.02) during wk 1 for pigs fed acetate compared to 150 ppm Zn. When compared to the control (150 ppm), only pigs fed the oxide form gained significantly better (ps.0003) at 2 and 3 wk and overall. These results indicate that supplementation with 3000 ppm Zn in a traditional weaning program provides enhanced growth with improved stool consistency when the oxide form of Zn is used.

**Key Words:** Zn sources, Weanling pig, Zn oxide

130 Excess dietary zinc for pigs weaned at 28 days. F. M. LeMieux*, L. V. Ellison, T. L. Ward, L. L. Southern, and T. D. Bidner, Louisiana State University Agricultural Center, Baton Rouge.

Two similar experiments were conducted to assess excess dietary Zn for pigs weaned at 28 days of age. The pigs were allotted to treatment on the basis of BW, gender, and ancestry, and each treatment was replicated with four pens of four pigs each. The experimental periods were 21 and 22 days, initial BW were 6.2 and 6.8 kilograms, and final BW were 10.2 and 12.5 kilograms in Exp. 1 and 2, respectively. At the termination of the experiments, plasma was collected from each pig, and one (Exp. 1) or two (Exp. 2) pigs per replicate were killed for determination of tissue Zn concentrations. Hematocrits were determined weekly on each pig. A corn-soybean meal basal diet formulated to provide 1.10% lysine was used. The treatments in both experiments were the basal diet supplemented with 0, 3,000, 6,000, or 12,000 ppm Zn from ZnO. Responses to dietary treatments were similar in both experiments unless indicated otherwise. Daily gain and feed intake were increased by 3,000 and 6,000 ppm Zn but were decreased by 12,000 ppm Zn (quadratic, P<.01). Gain:feed was improved (P<.01) in Exp. 1 by 3,000 and 6,000 ppm Zn but was decreased by 12,000 ppm Zn in both experiments (quadratic, P<.01). Liver Zn was increased by all dietary Zn levels, but the increase in liver Zn at 12,000 ppm Zn was proportionally less than the increase observed from the 3,000, or 6,000 ppm Zn levels (cubic, P<.01). Bone and pancreas (pancreas, Exp. 1 only) Zn concentrations were increased (linear, P<.01) by dietary Zn. In Exp. 2, the effect of dietary Zn on bone Zn was quadratic (P<.02); bone Zn was increased proportionally more from the 12,000 ppm Zn level than from the 3,000 or 6,000 ppm Zn levels. Bone ash percentage was decreased by 12,000 ppm dietary Zn (Exp. 1, linear, P<.02; Exp. 2, quadratic, P<.08). Hematocrit was not affected (P > .10) by dietary Zn after 7 days but was increased (linear, P<.03) by dietary Zn after 14 (Exp. 1) and 21 (Exp. 1 and 2) days. The addition of 3,000 or 6,000 ppm Zn to diets for pigs weaned at 28 days improved growth performance, but 6,000 ppm was no more effective than 3,000 ppm. The 12,000 ppm level of Zn clearly depressed growth. All levels of dietary Zn increased tissue concentrations of Zn.

**Key Words:** Pigs, Zinc, Liver, Bone, Pancreas, Plasma, Growth

129 **The effect of increasing zinc oxide supplementation on starter pig growth performance.** J. W. Smith, II*, M. D. Tokach, R. D. Goodband, J. L. Nelssen, W. B. Nessmith, Jr., K. Q. Owen, and B. T. Richert, Kansas State University, Manhattan.

A 28 d growth assay utilized 420 pigs (initially 4.5 kg and 13 d of age) to examine the effects of increasing Zn levels, from ZnO, on starter pig performance. The pigs were blocked by weight and allotted to each of five dietary treatments with 10 or 12 pigs per pen and 8 replicate pens per treatment. ZnO replaced corn starch to form dietary Zn levels of 165, 1,000, 2,000, 3,000, and 4,000 ppm. Diets were formulated in two phases: phase I (d 0 to 14) and phase II (d 14 to 28). Phase I diets were pelleted, formulated to 1.6% lysine and .45% methionine, and contained 7.5% porcine plasma, 1.75% blood meal, and 25% dried whey. Phase II diets were fed in the meal form, formulated to 1.30% lysine and .36% methionine, and contained 10% dried whey and 2.5% blood meal. Pigs were maintained on the same mineral level throughout the entire 28 d trial. From d 0 to 14, increasing levels of ZnO increased (linear, P < .004) ADG, ADFI, and feed efficiency (G/F). During d 14 to 28, increasing levels of ZnO increased ADG (quadratic, P < .02), ADFI (linear, P < .01), and G/F (quadratic and linear, P < .01). For the entire 28 d trial, increasing levels of ZnO increased ADG (linear P < .04), ADFI (linear, P < .01), and G/F (quadratic, P < .08). These results support previous research that illustrated the growth-promotant response due to supplementing starter pig diets with ZnO. In conclusion, feeding 4,000 ppm Zn from d 0 to 14 and 2,000 ppm Zn from d 14 to 28 resulted in maximum growth performance in this trial.

| | | Zn, ppm | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item | | 165 | 1,000 | 2,000 | 3,000 | 4,000 | CV | Linear | Quad |
| d 0 to 14 | ADG, g | 155 | 168 | 177 | 176 | 202 | 10.6 | .001 | .500 |
| | G/F | .70 | .76 | .77 | .76 | .83 | 9.9 | .004 | .953 |
| d 14 to 28 | ADG, g | 315 | 328 | 356 | 345 | 325 | 7.8 | .290 | .016 |
| | G/F | .53 | .53 | .54 | .54 | .46 | 5.0 | .002 | .001 |
| d 0 to 28 | ADG, g | 237 | 250 | 265 | 260 | 260 | 8.4 | .039 | .203 |
| | G/F | .58 | .59 | .60 | .59 | .56 | 6.5 | .521 | .073 |

**Keywords** Zinc oxide, Starter pigs, Performance

131 Impact of zinc oxide and copper sulfate supplementation on the newly weaned pig. M.S. Carlson*, G.M. Hill, J.E. Link, G.A. McCully, D.W. Rozeboom, and R.L. Weavers, Michigan State University, East Lansing.

Three experiments were conducted to investigate the interaction between copper sulfate (Cu) and zinc oxide (Zn) in growth promotion of the newly weaned pig. All experiments utilized a 2 X 2 factorial design with treatments as follows: 1) 11 ppm Cu, 150 ppm Zn (LCuLZn) 2) 250 ppm Cu, 150 ppm Zn (HCuLZn) 3) 11 ppm Cu, 3000 ppm Zn (LCuHZn) and 4) 250 ppm Cu, 3000 ppm Zn (HCuHZn). All other nutrients met the requirements for 10-20 kg pigs (NRC, 1988). During wk 1 of experiments 1 (n = 40) and 2 (n = 40), pigs gained similarly (P > .01) in all treatment groups. Pigs responded with a linear increase in ADG (P = .0001) during wk 2 and over the entire 3 wk period. Pigs fed the HCuHZn diet had greater ADG (P = .0001) than pigs fed the LCuLZn diet. In experiment 3, pigs (n = 40) were fed their respective treatments from weaning through market weight to determine if a Cu deficiency could be induced with continuous high Zn supplementation past the nursery phase. During the first 3 wks of the nursery period, pigs responded to experimental diets with a linear increase in ADG (P = .0001). Through wk 3, pigs fed the HCuHZn diet gained 408 g/d while pigs fed the LCuLZn diet gained 285 g/d (P = .0003). However, during wk 4, pigs fed the LCuHZn diet had greater ADG than pigs fed the LCuLZn, HCuLZn, and HCuHZn diets, 690 g/d vs 395, 502, 502 g/d, respectively (P = .002). Through wk 5, pigs fed the high Zn diets had 23 % greater ADG (471 g/d vs. 364 g/d) than pigs fed the adequate Zn diets (P = .01). Blood samples were collected on day 0 and 35 for determination of serum Cu and Zn concentrations, ceruloplasmin (CP) and superoxide dismutase (SOD) activities. Through wk 5, pigs fed 3000 ppm Zn diets had greater serum Zn concentrations (P = .0001) than pigs fed 150 ppm Zn diets. Dietary treatments had no effect (P > .01) on pigs' serum Cu concentrations, CP or SOD activity. Therefore, 3000 ppm Zn as zinc oxide improves pig performance with no evidence of a copper deficiency through the fifth week post-weaning.

**Key Words:** Zinc oxide, Copper, Pig