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INTERACTIONS OF COPPER, SELENIUM, AND VITMAIN E FOR WEANLING SWINE

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Summary

One-hundred and sixty pigs were utilized to evaluate possible interactions between copper (Cu), selenium (Se), and vitamin E (E) on growth and immunity of starter pigs. Copper (260 ppm) added to the diet did not effect Se and/or E utilization for growth, feed efficiency (FE), or immunity. However, addition of 260 ppm of Cu to the diets of starter pigs resulted in an 8% improvement in feed intake (FI) and a 13% improvement in average daily gain (ADG) for the first 2 wk on test. There was no effect on performance due to E additions. However, addition of .3 ppm Se to the diets resulted in an overall 5% improvement in FE and a 7% improvement in ADG. Additions of dietary Cu, Se and E had no effect on immunity and no evidence of tissue lesions or symptoms typical of Se and E deficiency were found.

Introduction

Addition of Cu to pig diets has been shown by a number of researchers to increase growth rate and improve feed efficiency. It has become common practice to add 125 to 250 ppm Cu to starter and growing pig diets for improvement in performance. Selenium is also added to starter diets at .3 ppm, and along with the addition of E, has been shown to reduce incidence of skeletal and cardiac muscle necrosis associated with pigs fed Se-E deficient diets.

However, studies in chicks have shown biological interactions between Se and Cu that render Se much less toxic than when it is present alone at toxic levels in the diet. These data suggest that there may be an interaction between Cu and Se in which high levels of Cu in the diet may render dietary Se less biologically active. Therefore, this study was conducted to evaluate possible interactions of Cu, Se, and E on growth performance and immunological response in weanling swine.

Procedures

One-hundred and sixty pigs with an averge initial weight of 12.3 lb were employed in a 2 x 2 x 2 factorial experiment in which pigs were fed a 1.25% lysine, corn-soybean meal 20% whey diet (table 1). Added to the basal diet was 0 or 10 g of Vitamin E per ton as alpha-tocopheryl acetate; 0 or .3 ppm Se as sodium selenite; and 10 or 260 ppm Cu as copper sulfate.

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Pigs were weighed at weaning (28 days) and placed in an environmentally regulated room with wire floors over a Y-flush gutter. Each 4 ft x 5 ft pen was equipped with a self-feeder and a nipple waterer. Temperature in the nursery was 90° F for the first week post-weaning and gradually decreased throughout the 6-wk trial. Pigs were housed five pigs per pen, four pens per treatment, with weight and feed consumption determined bi-weekly.

Phytohemagglutinin (PHA) was injected into the flank as an indicator of in-vivo cell-mediated immunity. Double-fold skin thickness was measured initially on both rear flanks of two pigs in each pen by a constant tension micrometer. After measurements were made, 1 ml saline was injected into one flank as a placebo while 1 ml saline containing 250 µg of PHA was injected in the other flank. Twenty-four hours later the flank double-fold skin thickness was re-measured and the change in skin-fold thickness was recorded.

At the conclusion of the trial, one pig in each pen was selected randomly and sacrificed. Necropsy was performed with close examination of tissue samples to determine if typical deficiency symptoms were present.

Results and Discussion

There were no treatment interactions for the performance traits, therefore, only the main effects are discussed. The effect of dietary Cu addition on pig performance is presented in table 2. There was a 13% improvement in ADG during the first 2 wk for pigs fed the 260 ppm Cu diet. However, this advantage was not consistant during the entire trial.

Feed intake was stimulated by 9% for those pigs fed the higher level of Cu for the first 2 wk. However, FI was reduced ($P<.05$) after 4 wk for pigs fed the 260 ppm Cu diet. Although there was a numerical improvement in feed efficiency after 2 wk at the higher Cu level, there were no differences ($P<.05$) for feed utilization.

In table 3, effects of Se on pig performance are shown. While FI was not different ($P<.05$) for pigs fed 0 or .3 ppm Se in the diet, there was an improvement in both gain and feed utilization. Average daily gains were increased overall by 7%, while FE was improved by 5% during the trial for those pigs fed .3 ppm of Se in the diet.

The effect of E on growth traits is presented in table 4. Although some research has shown improvement in growth and efficiency of gain due to the addition of E to starter pig diets, our data suggest no beneficial response from adding 10 g per ton of E.

There was no effect of dietary Cu, Se, or E on the immunological response to PHA (table 5). Likewise, there were no indications of Mulberry Heart, liver, or skeletal necrosis typical of Se and/or E deficiency symptoms.

In conclusion, the addition of 260 ppm of Cu to starter pig diets enhanced ADG and FI for the first 2 wk postweaning. These data indicate that .3 ppm of Se added to starter pig diets resulted in 5% improvement in FE, with a 7% improvement in ADG. The corn and soybeans used in these diets were grown locally, indicating that, although Kansas is typically thought of as an area adequate in Se, there is merit to adding .3 ppm Se to premixes for starter pig diets. Vitamin E had no effect on growth performance, while none of the treatments had any influence on *in vivo* cell-mediated immunity as measured by the PHA assay.

Table 1. Composition of Basal Diet

Ingredients	%
Corn	44.57
Soybean meal, 44%	32.38
Dried whey	20.00
Monocalcium phosphate	1.01
Limestone	.98
Salt	.20
Trace minerals	.10
Vitamin premix	.50
ASP 250	.25
	100.00
Calculated Analyses	
ME, kcal/lb	1418.41
Crude protein, %	20.90
Lysine, %	1.25
Calcium, %	.85
Phosphorus, %	.70

Table 2. Effect of Dietary Copper on Pig Performance[a]

Criteria	Week 2	Week 4	Week 6	Overall
ADG, (lb)				
10 ppm Cu	.40[b]	1.05	1.34	.93
260 ppm Cu	.45[b]	1.00	1.32	.93
SE	.02	.03	.03	.02
ADFI, (lb)				
10 ppm Cu	.55[c]	1.52[c]	2.32	1.46
260 ppm Cu	.60[c]	1.43[c]	2.27	1.43
SE	.02	.02	.06	.02
F/G				
10 ppm Cu	1.42	1.46	1.73	1.58
260 ppm Cu	1.34	1.45	1.74	1.56
SE	.06	.04	.05	.02

[a] Total of 160 pigs (5/pen with 4 pens/treatment), average initial wt = 12.3 lb, and trial length was 6 wk.
[b] Copper effect ($P=.13$)
[c] Copper effect ($P<.05$)

Table 3. Effect of Dietary Selenium on Pig Performance[a]

Criteria	Week 2	Week 4	Week 6	Overall
ADG, (lb)				
0 ppm Se	.41	.98[b]	1.30	.90[b]
.3 ppm Se	.45	1.08[b]	1.36	.96[b]
SE	.02	.03	.03	.02
ADFI, (lb)				
0 ppm Se	.58	1.44[b]	2.28	1.43
.3 ppm Se	.57	1.51[b]	2.31	1.46
SE	.02	.02	.06	.02
F/G				
0 ppm Se	1.46[c]	1.49	1.76	1.61[b]
.3 ppm Se	1.30[c]	1.41	1.71	1.53[b]
SE	.06	.04	.05	.02

[a] Total of 160 pigs (5/pen with 4 pens/treatment), average initial wt = 12.3 lb, and trial length was 6 wk.
[b] Selenium effect ($P<.05$)
[c] Selenium effect ($P=.07$)

Table 4. Effect of Dietary Vitamin E on Pig Performance[a]

Criteria	Week 2	Week 4	Week 6	Overall
ADG, (lb)				
0 g Vit E	.43	1.04	1.31	.93
10 g Vit E	.42	1.01	1.35	.93
SE	.02	.03	.03	.02
ADFI, (lb)				
0 g Vit E	.58	1.49	2.30	1.46
10 g Vit E	.57	1.46	2.29	1.44
SE	.02	.02	.06	.02
F/G				
0 g Vit E	1.39	1.44	1.76	1.57
10 g Vit E	1.37	1.46	1.71	1.56
SE	.06	.04	.05	.02

[a]Total of 160 pigs (5/pen with 4 pens/treatment), average initial wt = 12.3 lb, and trial length was 6 wk.

Table 5. Effect of Dietary Copper, Selenium and vitamin E on Response to PHA[ab]

Period	Cu, ppm		Se, ppm		Vit. E, IU/kg		SE[c]
	10	260	0	.3	0	11	
Initial	.15	.16	.15	.15	.15	.15	.008
14-day	.19	.18	.19	.19	.18	.19	.009
28-day	.16	.16	.16	.16	.15	.16	.009
42-day	.17	.16	.17	.16	.16	.16	.008

[a]Each mean represents eight pigs.
[b]Flank thickness = change in inches during 24 hr.
[c]Standard error.