

FEED ADDITIVES FOR SWINE 2.
Copper and Iron Additions for Grower Rations

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Copper when added to swine rations at levels of 150 to 200 ppm has been reported to stimulate growth and improve feed efficiency similar to that obtained with low-level antibiotics (Braude, 1965; Wallace, 1967; Kornegay and Thomas, 1971). Although the exactly correct levels of iron to use with high levels of copper are not known, it has been suggested that substantial amounts of iron (150-200 ppm) in the ration are necessary as a protection against copper toxicity.

The objectives of these trials were to evaluate copper as a growth stimulant for growing swine and to determine if supplemental iron is beneficial.

Experimental Procedure

Three trials, using crossbred pigs, were conducted to compare copper addition (none and 150 ppm) and iron additions (none, 40, and 80 ppm) with grower rations. Trials 2 and 3 consisted only of no addition and 80 ppm of iron.

In trial 1, 222 pigs, averaging 16.5 lb. initially were used in an 84-day trial. In trials 2 and 3, 64 pigs averaging 64.1 lb and 40 pigs averaging 64.4 lb, respectively, were used in 56-day trials.

The pigs were self-fed and housed in totally enclosed buildings with either concrete floors (trials 1 and 2) or partially slotted floors (trial 3). Average daily gains and feed intakes, feed/gain ratios, and hemoglobin levels (only trials 1 and 3) were measured. Pigs were assigned to rations from outcome groups based on body weight, sex and letters. The crude protein level of the rations was lowered by changing the proportions of corn and soybean meal (table 1).

The data (individual values for average daily gain and hemoglobin and pen averages for feed intake and feed/gain) were statistically analyzed, using analyses of variance and Duncan's (1955) multiple range test.

Results and Discussion

Iron added at a level of 40 or 80 ppm to the basal ration had no effect upon the feedlot performance of pigs in trials 1 through 3 (table

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2). This lack of a response was not unexpected, in view of the fact that rations similar to the basal ration used in this study have been found to contain approximately 200 ppm iron, with a significant amount of this coming from defluorinated phosphate. In two of the three trials, gain was significantly improved by the addition of 150 ppm copper and feed/gain was significantly decreased in 1 of 3 trials. Gain was improved about 8%, and feed efficiency was only improved about 3%, which is in agreement with the report by Wallace (1967). Hemoglobin levels were similar for all treatments, with a small but significant ($P < .05$) increase due to copper in trial 1 which is the reverse of what is normally reported. Feed costs were in general less for pigs that were fed the rations with added copper.

Summary

Dietary copper, when added at 150-200 ppm, acted as a growth stimulant. Supplemental iron was of no benefit either in the presence or absence of copper. The greatest effect of copper was on average daily gain which was a result of increased feed intake with only a small increase in feed efficiency. It would appear, based on hemoglobin levels, that the amounts of copper fed in these treatments was well below the toxic level. Lowered hemoglobin values are normally reported where copper is fed at a level to produce chronic toxicity. Feed costs per gain were, in general, less for pigs fed the rations with copper added.

Literature Cited

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- Duncan, D. B. 1955. Multiple range and multiple F test. *Biometrics* 11:1.
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- Wallace, H. D. 1967. High level copper in swine feeding. A review of research in the United States. Pub. by International Copper Research Ass'n., Inc., New York, N. Y.

TABLE 1. PERCENTAGE COMPOSITION OF BASAL RATIIONS
(16% crude protein)¹

Ingredients ²	Percent
Corn	79.20
Soybean meal (48.5%)	17.75
Defluorinated phosphate	2.20
Swine trace mineral salt ³	0.50
Vitamin premix ⁴	0.35

¹The crude protein level was lowered by changing the proportions of corn and soybean meal according to the following schedule: 18% - 15 to 40 lb; 16% - 40 to 75 lb; 14% - 75 to 150 lb; 12% - 150 to 220 lb. The amount of defluorinated phosphate and vitamin premix was also lowered at each step-down of protein.

²Copper (in the form of copper sulfate) was added to 150 ppm to the appropriate ration. In trials 1, 2, and 3, iron sulfate was added to supply the appropriate level of iron. Zinc was added at a level of 80 ppm in the form of zinc sulfate.

³Contained (%): 0.8 Mn, 0.4Fe, 0.08 Cu, 0.01 Co, 0.01 I, 1.0 Zn and 95.9 NaCl.

⁴Supplied (per lb of ration): 2.1 mg riboflavin, 10.9 mg pantothenic acid, 10.9 mg niacin, 16.8 mg vitamin B₁₂, 350 mg choline chloride, 2100 I.U. vitamin A, 350 I.U. vitamin D.

TABLE 2. AVERAGE DAILY GAIN, FEED INTAKE, FEED PER GAIN, HEMOBLOBIN AND FEED COSTS OF GROWING PIGS FED RATIONS WITH ADDED COPPER AND IRON

Trials ¹ & Treatments	Daily ²	Feed	Feed ²	Hemoglobin	Feed cost ³
	Gain	Intake	per Gain		per Gain
	lb	lb	lb/lb	gm/100 ml	¢/lb
Trial 1					
Basal ration	1.21(0)	3.09	2.52(0)	11.7	7.9
40 ppm Fe	1.14(-5)	2.94	2.62(4)	11.5	8.2
80 ppm Fe	1.18(-3)	2.98	2.50(-1)	11.9	7.9
150 ppm Cu	1.22(2)	3.11	2.55(1)	11.8	8.1
150 ppm Cu & 40 ppm Fe	1.33(11)	3.40	2.46(-2)	12.2	7.8
150 ppm Cu & 80 ppm Fe	1.22(11)	3.05	2.51(0)	12.0	7.9
Trial 2					
Basal ration	1.47(0) ⁴	5.20	3.34(0) ⁵	--	10.5
80 ppm Fe	1.36(-7)	5.02	3.48(4)	--	10.9
150 ppm Cu	1.57(7)	5.26	3.23(-3)	--	10.2
150 ppm Cu & 80 ppm Fe	1.62(10)	5.25	3.20(-4)	--	10.1
Trial 3					
Basal ration	1.65(0)	4.26	2.58(0)	15.0	8.1
80 ppm Fe	1.76(7)	4.39	2.50(-3)	14.7	7.9
150 ppm Cu	1.75(6)	4.36	2.49(-3)	14.8	7.9
150 ppm Cu & 80 ppm Fe	1.77(7)	4.25	2.39(-7)	14.9	7.6

¹Length of test (days), pigs per treatment (number), and average initial weight (lb) were 84, 37 and 16.5, respectively, for trial 1; 56, 16, and 64.1 for trial 2; 56, 10, and 64.4 for trial 3.

²Values in parentheses are the percentage changes from the basal ration.

³Based on the following ingredient cost (¢/lb): corn, 2.41; soybean meal, 6.25; defluorinated phosphate, 5.35; swine trace mineral salt, 3.10; vitamin premix, 30.00; ferrous sulfate, 6.50; bluestone (Cu), 29.70.

⁴Significant (P<.01) effect of copper.

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