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Effect of Copper Fed at Different Levels and for Different  
Lengths of Time to Growing-Finishing Pigs

Richard C. Wahlstrom, George W. Libal, Lawrence R. Dunn and Royce J. Emerick

Previous work at the South Dakota station reported in A.S. Series 71-33 has shown that pigs fed 250 parts per million (ppm) copper in the diet have an increased rate of gain with the greatest response occurring during the early growth period. Liver copper stores are elevated by feeding 250 ppm of copper. The experiment reported herein was designed to study the effectiveness of various levels of dietary copper as well as to determine the carry-over effect of copper treatments administered only during an initial 8-week treatment period. The antibiotic tylosin was included as one treatment to aid in evaluating the copper effect.

Experimental Procedure

Ninety-six crossbred pigs averaging about 41 lb. were randomly allotted to three replications of eight treatments on the basis of litter, weight and sex. Each lot consisted of four pigs, three barrows and one gilt, having access to a 6 x 8 foot concrete floored pen with a connecting 8 x 12 foot outside lot where self-feeders and waterers were located.

The eight dietary treatments were as follows:

1. Basal diet (no copper)
2. Basal diet plus 125 ppm copper to market weight
3. Basal diet plus 125 ppm copper for 8 weeks, basal diet to market weight
4. Basal diet plus 187.5 ppm copper to market weight
5. Basal diet plus 187.5 ppm copper for 8 weeks, basal diet to market weight
6. Basal diet plus 250 ppm copper to market weight
7. Basal diet plus 250 ppm copper for 8 weeks, basal diet to market weight
8. Basal diet plus 20 grams of tylosin per ton to market weight

The composition of the basal diet is shown in table 1.

The pigs were removed from their respective treatments at individual weights of approximately 210 lb. after 100 to 110 days on experiment. They were withheld from feed but allowed water for the 24 hours previous to slaughter. Liver samples were obtained at slaughter and frozen for later analysis of copper. Backfat samples were obtained from the shoulder area for determination of iodine number. After a 24-hour chill, carcasses were weighed and measured for length, backfat thickness, loin eye area and percent ham and loin.

Results

A summary of the growth performance and carcass data is presented in table 2. Average daily gains during the first 8-week period were faster when pigs received copper or tylosin in the diet. Pigs fed 250 ppm of copper gained 1.63 lb. per day or 12% faster than the 1.46 lb. per day gain of pigs fed the basal unsupplemented

diet. Pigs fed tylosin or 125 or 187.5 ppm of copper gained 1.54, 1.50 and 1.52 lb. per day, respectively, during this period. Differences in feed consumption during the first 8-week period were statistically significant ( $P < .01$ ). Pigs fed the diets containing copper or tylosin consumed more feed than pigs fed the basal diet. Feed/gain also differed significantly ( $P < .05$ ) during this period. The pigs fed copper were not as efficient in feed conversion as the control pigs.

During the finishing period of this experiment, gains and feed/gain were quite erratic. There was no consistent pattern on the effect of removing copper from the diet after 8 weeks. Gains of pigs fed 125 ppm of copper during the final growth period were essentially identical to those of pigs that had received 125 ppm of copper for the first 8 weeks only (1.67 and 1.68 lb. per day). Pigs fed 187.5 ppm of copper gained 1.86 lb. per day compared to 1.77 for those that received this level only the first 8 weeks. Pigs fed the 250 ppm level of copper gained 1.71 lb. per day during this period, while pigs receiving the high level of copper for 8 weeks gained 1.92 lb. daily during the period that they did not receive copper.

Best overall rates of gain were made by pigs fed 250 ppm of copper for 8 weeks only (1.75 lb. per day) and pigs fed 250 ppm of copper throughout the experiment (1.68 lb. per day). Gains of the other pigs averaged from 1.59 to 1.66 lb. daily. Average daily feed consumption was significantly ( $P < .01$ ) different between treatments ranging from 5.23 lb. per day for pigs fed the basal diet to 6.06 lb. daily for pigs fed 250 ppm of copper for the first 8 weeks.

Carcass length, backfat thickness and iodine number did not differ significantly between treatments. Pigs fed the copper or tylosin diets had heavier livers than pigs fed the unsupplemented diets. This is in contrast to previous data from this station indicating lighter livers in pigs fed dietary copper. Removing the copper from the diet when the pigs weighed approximately 125 lb. resulted in a liver copper level similar to that found in pigs fed the unsupplemented diet. When copper was fed during the entire growth period, liver storage increased with increasing levels of dietary copper.

#### Summary

Ninety-six crossbred pigs, 72 barrows and 24 gilts, were allotted to eight treatment groups to study the effect of feeding 125, 187.5 and 250 ppm of copper for 8 weeks or for the entire growing-finishing period. Gains were increased at all copper levels for the first 8-week period. For the entire experiment there was no benefit from feeding 125 ppm of copper. Pigs fed 187.5 and 250 ppm gained approximately 3 and 7% faster than pigs fed the basal diet. There were no consistent differences in performance of pigs fed the dietary copper for 8 weeks or the entire experiment except in liver copper storage which was increased with increasing levels of copper fed continuously to slaughter weights. Performance of pigs fed 20 grams of tylosin per ton of feed was similar to that of pigs fed the basal diet.

Table 1. Composition of Basal Diet

Ingredients	Percent
Ground yellow corn	82.8
Soybean meal (49%)	15.0
Ground limestone	0.75
Dicalcium phosphate	0.85
Salt	0.50
Trace mineral mix <sup>a</sup>	0.05
Vitamin mix <sup>b</sup>	0.05

<sup>a</sup> Provided 100 ppm zinc, 50 ppm iron, 27.5 ppm manganese, 5 ppm copper, 0.5 ppm cobalt and 0.75 ppm iodine in diet.

<sup>b</sup> Provided 1136 I.U. vitamin A, 182 I.U. vitamin D, 1.25 mg. riboflavin, 5 mg. pantothenic acid, 10 mg. niacin, 50 mg. choline and 75 mcg. vitamin B<sub>12</sub> per lb.

Table 2. Effect of Copper on Performance and Carcass Characteristics of Swine

	Basal	125 ppm copper	125 ppm copper withdrawn <sup>a</sup>	187.5 ppm copper	187.5 ppm copper withdrawn <sup>a</sup>	250 ppm copper	250 ppm copper withdrawn <sup>a</sup>	20 grams/ton tylosin
Number of pigs	12	11	12	10	12	12	12	11
Initial weight, lb.	41.3	41.3	41.3	41.1	41.3	41.3	41.2	41.2
<u>8-week summary</u>								
8-week weight, lb.	123.5	126.8	124.4	125.8	126.7	134.4	132.0	127.6
Avg. daily gain, lb.	1.46	1.52	1.48	1.51	1.52	1.65	1.61	1.54
Avg. daily feed, lb.**	3.82	4.40	4.25	3.94	4.35	4.49	4.80	4.18
Feed/gain*	2.61	2.91	2.88	2.61	2.86	2.72	2.98	2.72
<u>8 weeks to final summary</u>								
Final weight, lb.	214.2	213.0	215.6	216.4	219.1	213.4	219.8	216.5
Avg. daily gain, lb.	1.76	1.67	1.68	1.86	1.77	1.71	1.92	1.73
Avg. daily feed, lb.**	6.75	6.44	6.74	7.33	6.87	7.39	7.59	6.82
Feed/gain	3.86	3.89	4.03	3.94	3.86	4.43	3.98	3.95
<u>Overall summary</u>								
Avg. daily gain, lb.	1.60	1.60	1.59	1.66	1.64	1.68	1.75	1.62
Avg. daily feed, lb.**	5.23	5.33	5.48	5.40	5.56	5.81	6.06	5.38
Feed/gain	3.27	3.37	3.47	3.24	3.38	3.50	3.47	3.31
Carcass length, in.	29.8	29.8	29.9	29.8	29.8	29.6	29.8	29.4
Backfat thickness, in.	1.25	1.27	1.22	1.31	1.19	1.24	1.27	1.33
Backfat iodine no.	67.3	66.6	66.3	67.4	68.2	68.5	67.6	64.6
Liver weight, gram	1267	1344	1371	1426	1421	1398	1494	1403
Liver copper (dry-weight basis), ppm	17.9	21.9	18.8	38.0	17.4	77.8	21.0	15.6

<sup>a</sup>Copper fed for 8 weeks only.

\*Significant treatment differences (P<.05).

\*\*Significant treatment differences (P<.01).