

Copper Enhances Performance of Pigs

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In the last issue, the value of antibiotics and other antimicrobial agents for pigs was discussed. I would like to expand that subject a bit in this issue by discussing our research at the University of Kentucky that has involved the use of high levels of dietary copper for pigs.

Copper is a unique mineral, When it is added to pig diets at a high level (much higher than the nutritional requirement), copper stimulates growth and feed efficiency much like antibiotics do. This effect is particularly evident with young pigs. Table 1 shows results of UK studies over a 1 & year period in which high copper diets were fed to weanling pigs (from 17 to 40 lb). Copper increased growth rate by 12.3%, feed intake by 8.3% and feed efficiency by 4.8%. The same type of response occurs in growing and finishing pigs, to a lesser extent (Table 2). Today, copper is commonly used as a growth stimulant, particularly in pig starter feeds.

We have studied copper for a number of years at the University of Kentucky, Our research has focused on (1) the relative effectiveness of different levels of copper for both weanling pigs and for growing-finishing pigs, (2) the effectiveness of various sources of copper, (3) the effectiveness of combinations of copper and antibiotics, (4) methods of preventing copper buildup in tissues (especially the liver), and (5) effects of high copper diets for sows.

Levels of **copper**. Our experiments in the 1970's and early 1980's and research by others showed that the most effective level of copper in the diet was in the range of 200 to 250 parts per million (ppm). Copper supplementation in this range resulted in maximum gains, feed intakes, and feed efficiency. Some of our more recent studies with better facilities and better diets suggest that 100 to 125 ppm of copper will give almost as great of a response in young pigs as 200 to 250 ppm of copper.

Higher levels of copper (for example, 500 ppm of copper) may have negative effects, depending on the stage that it is fed. During the starter phase, it does not seem to be harmful when fed for up to 28-35 days, but there is no growth promotion. But when this level is fed to growing-finishing pigs over a longer period of time, it depresses growth and, in some instances, may be toxic and cause death. The toxicity probably results from excessive copper accumulation in the liver, which causes a breakdown in liver function.

Sources of copper. The most commonly used source of copper is copper sulfate pentahydrate. It is a bluish colored mineral salt and is sometimes called "bluestone", Copper sulfate contains about 25% copper. Many other forms of copper exist, and some are as effective as copper sulfate (examples: copper carbonate, copper chloride), while others are not (examples: copper oxide, copper

sulfide).

A new source of copper on the market is copper-lysine complex (CUPLEX-100™). This product supplies both copper (10%) and lysine (48%). We have studied this form of copper extensively, and have concluded that the copper is slightly more effective than the copper in copper sulfate. However, it is also more expensive (on an equivalent copper basis) than copper sulfate.

Combinations of copper and antibiotics. In the early 1980's. we found that a combination of copper and antibiotics for weanling pigs stimulated performance to a greater extent than did either copper or antibiotics by themselves (Figure 1). Since then, a number of universities have confirmed this finding with a wide variety of antibiotics. This response may also occur with growing-finishing pigs, but it is less well documented.

Prevention of copper accumulation. Many of our studies in the 1970's and 1980's were aimed at trying to find ways of preventing copper accumulation in the liver when high copper diets were fed. The feeding of 200 to 250 ppm copper over an extended period of time (such as the growing-finishing period) will cause a ten-fold increase in liver copper. We found that inclusion of sodium sulfide, ferrous sulfide, or elemental sulfur helped to prevent some of the accumulation of copper, and the sulfide or sulfur did not interfere with the growth promoting effects of copper.

High copper diets for sows. Recently, we have looked at the use of high copper in sow diets. The primary objective of the sow research was to see if long term feeding of high copper (250 ppm) diets would cause problems in sows. Interestingly, we found that there was actually a benefit from the feeding of copper to sows. Accumulated weight gains over six gestation-lactation cycles were increased in sows fed copper, they farrowed larger litters of pigs (10.8 vs 10.1) and the pigs were 9% heavier at birth (3.04 vs 2.81 lb) and 6% heavier at weaning (15.8 vs 14.9 lb at 28 days). We are presently conducting more research to follow up on these findings.

In summary, high copper diets are commonly fed to starter pigs in the USA as well as in many countries of the world. Copper is also included in grower and finisher diets, but to a lesser extent. Surprisingly, no one has yet to discover the mechanism of action of how copper works to improve pig performance. But it does work, without question.

If producers who mix their own feed want to add copper, they need to make sure that their supplement or base mix does not already have growth promoting levels of copper added. The addition of 1 lb of finely ground copper sulfate per ton of feed will supply 125 ppm of copper; 1.5 lb per ton supplies 185 ppm of copper and 2 lb per ton supplies 250 ppm of copper.

Table 1. High Dietary Copper as a Growth Promoter in Weanling Pigs'

Stage	Control	Copper ^b	Improvement %
Starter phase (17 to 40 lb)			
Daily gain, lb	.74	.84	12.3
Daily feed intake, lb	1.35	1.47	8.3
Feed/gain	1.88	1.79	4.8

^aSummary of 22 experiments at the University of Kentucky from 1978 to 1994 and involving 1,304 pigs weaned at 4 weeks. The test periods were 4-5 weeks.

^b200 or 250 ppm of copper as copper sulfate.

Table 2. High Dietary Copper for Growing and Finishing Pigs'

Stage	Control	Copper ^b	Improvement %
Growing phase (40 to 123 lb)			
Daily gain, lb	1.47	1.56	6.1
Feed/gain	2.80	2.70	3.6
Finishing phase (123 to 205 lb)			
Daily gain, lb	1.66	1.71	3.0
Feed/gain	3.56	3.50	1.6
Growing-finishing phase (40 to 205 lb)			
Daily gain, lb	1.56	1.63	3.1
Feed/gain	3.18	3.10	2.5

^aSummary of 18 experiments at the University of Kentucky from 1970 to 1980 and involving 672 growing-finishing pigs.

^b250 ppm of copper as copper sulfate.

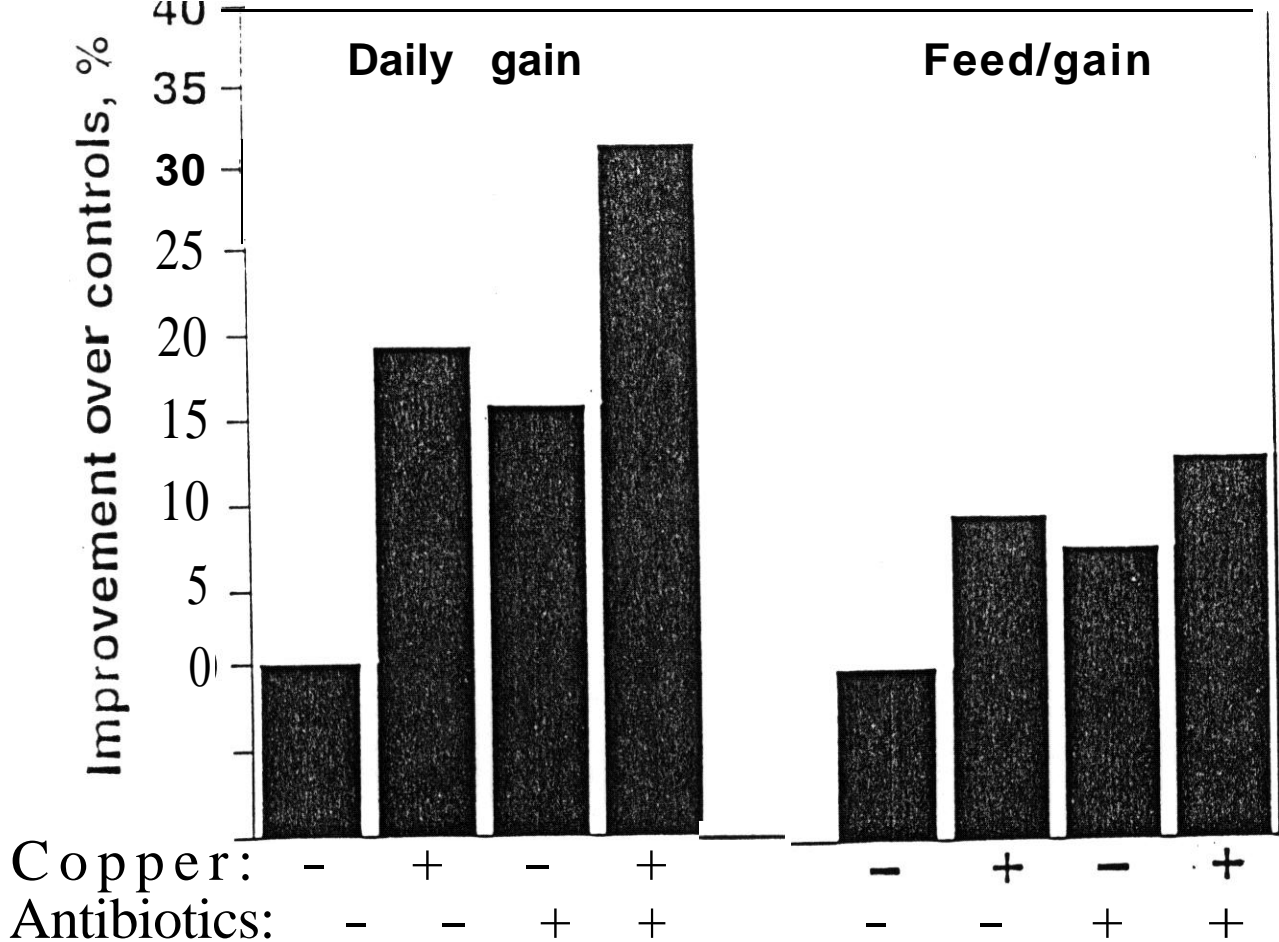


Figure Additive effects of dietary copper (250 ppm) and antibiotics in weanling pigs. Summary of 14 experiments involving 1,700 pigs at six universities.