Influence of Copper Sulfate and Tribasic Copper Chloride on Feed Intake Preference in Finishing Pigs[1]

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Summary

A total of 150 pigs (PIC 327 × 1050; initially 191 lb BW) were used in a 15-d study to determine if pigs have a preference for diets that contain added Cu from either copper sulfate ($CuSO_4$) or tribasic copper chloride (TBCC). Pens of pigs were randomly allotted to 1 of 3 dietary preference comparisons with 10 replications per comparison. Treatment diets used were a corn-soybean meal control with no supplemental Cu, or the control diet with 150 ppm of added Cu from either $CuSO_4$ or TBCC. Pens contained two feeders, each with 1 of 2 treatment diets with feeders rotated once daily within each pen. The comparisons tested were: (1) control vs. $CuSO_4$, (2) control vs. TBCC, and (3) $CuSO_4$ vs. TBCC.

For comparison 1, pigs consumed more ($P < 0.01$) of the control diet than the added $CuSO_4$ diet (3.68 vs. 2.02 lb/d), which translated into pigs eating 66% of their daily intake from the control diet and 34% from the $CuSO_4$ diet. For comparison 2, pigs consumed more ($P < 0.03$) of the control diet than the TBCC diet (3.30 vs. 2.49 lb/d), which equated to 57% of their daily intake from the control diet and 43% from the TBCC diet. For comparison 3, pigs consumed more ($P < 0.01$) of the diet containing TBBC than that with the added $CuSO_4$ (3.50 vs. 1.96 lb/d), which was equivalent to 65% vs. 35% of daily intake, respectively.

In summary, when given a choice, pigs preferred to consume a diet without high levels of added Cu; however, when given the choice between diets containing either Cu source, pigs preferred diets containing TBCC.

Key words: finishing pig, copper, feed intake, preference

Introduction

Producers frequently utilize supplemental copper for growth promotion in the nursery and early finishing periods. Recent research, however, suggests that the ADFI and ADG response may continue longer through the finishing phase. Coble et al. demonstrated that when TBCC was included in finishing diets, a linear increase ($P < 0.01$) in overall ADG and ADFI was observed when pigs were fed diets with increased levels up to 150 ppm of Cu from TBCC (see "Effects of Copper Source (Intellibond C or Copper Sulfate) on Growth Performance, Carcass Characteristics, Pen Cleanliness,

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and Economics in Finishing Pigs," page 168). Pigs fed Cu from copper sulfate ($CuSO_4$) had a tendency for increased (linear; $P < 0.08$) ADG with increased ($P < 0.02$) ADFI. Due to the added growth rate, pigs fed diets with the TBCC had an 8.3-lb heavier ($P < 0.01$) HCW than control pigs fed no supplemental Cu, which translated into an improvement in income over feed and facilities cost (IOFFC) of approximately $1.34 per head when data were adjusted to the same closeout weight of 275 lb. This difference in HCW was not demonstrated to this degree by pigs fed Cu from $CuSO_4$.

The exact mode of action through which TBCC affects feed intake is unknown, but it could be a reflection of either an up-regulation of the metabolic pathways influencing feed intake or that pigs simply prefer diets containing TBCC. Recent research completed by Yang et al. (2012[4]) observed that an increased dietary concentration of Cu offered to pigs was associated with increased Ghrelin mRNA expression in the fundic region of the stomach and increased serum growth hormone (GH) concentrations. Although increases in these hormones are known to be associated with increased feed intake, it is not known if pigs prefer to consume diets containing copper when given a choice. Therefore, the objective of this study was to determine if finishing pigs have a preference for diets containing no additional Cu or 150 ppm of added Cu from either TBCC or $CuSO_4$.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in the experiment. The study was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS.

A total of 150 pigs (PIC 327 × 1050; initially 191 lb BW) were used in a 15-d study. Pigs were housed in a mechanically ventilated, slatted-floor facility, with 2 nipple waters and 2 identical 2-hole stainless steel feeders in each pen (10 ft × 5 ft). Pigs were placed into pens by sex, with each sex accounting for 15 pens (30 pens total). On d 0, pens of pigs were individually weighed and pens were randomly allotted to 1 of 3 dietary comparisons, balancing on the average BW of the pen and sex across comparisons. Basal diets were corn-soybean meal–based, fed in meal form, and contained 8 ppm of Cu from $CuSO_4$ from the trace mineral premix. The 3 experimental diets consisted of a control diet with no additional Cu or diets with 150 ppm added Cu from either $CuSO_4$ or TBCC (Table 1).

The comparisons tested were: (1) control vs. $CuSO_4$, (2) control vs. TBCC, and (3) $CuSO_4$ vs. TBCC. The 3 dietary comparisons were assigned to pens with 10 replicate pens per comparison. Within each pen, each comparison diet was assigned to 1 of 2 separate feeders that were located on opposite sides of the pen. Daily, at approximately 8:00 a.m., feeders were moved from one side of the pen to the other to prevent location bias in feeding behaviors of the pigs. Feeders were weighed every 3 d at the same time feeders were moved to determine ADFI. At the end of the study, individual pigs were weighed to ensure performance was typical for pigs in this environment. Individual

[4] Yang, W., J. Wang, X. Zhu, Y. Gao, Z. Liu, L. Zhang, H. Chen, X. Shi, L. Yang, and G. Liu. 2012. High level of dietary copper promote ghrelin gene expression in the fundic gland of growing pigs. Biol. Trace Elem. Res. 150:154–157.

diets were sampled from multiple feeders during the trial, combined into a composite sample, then analyzed for Cu concentration in duplicate (Table 2).

Experimental data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC). The LSMEANS procedure was used to determine the mean difference of ADFI as measured and as a percentage of the total consumed for the following contrasts: (1) control vs. $CuSO_4$, (2) control vs. TBCC, and (3) $CuSO_4$ vs. TBCC. Results from the experiment were considered significant at $P \leq 0.05$.

Results and Discussion

Analyzed dietary Cu concentrations were 18 ppm in the control diet, 196 ppm in the add $CuSO_4$ diet, and 243 ppm in the added TBCC diet. Although differences occurred between analyzed and calculated Cu concentrations, all final Cu concentrations were within the acceptable analytical variation for Cu analysis.

For comparison 1, pigs consumed more ($P < 0.01$) of the control diet compared with the added $CuSO_4$ diet (3.68 vs. 2.02 lb/d), which translated into pigs eating 66% of their daily intake from the control diet and only 34% from the $CuSO_4$ diet. For comparison 2, pigs consumed more ($P < 0.03$) of the control diet compared to the added TBCC diet (3.30 vs. 2.49 lb/d), which equated to 57% of their daily intake from the control diet whereas 43% came from the TBCC diet. For comparison 3, pigs consumed more ($P < 0.01$) of the diet containing TBCC than that with added $CuSO_4$ (3.50 vs. 1.96 lb/d), which was equivalent to 65% vs. 35% of total daily intake, respectively (Table 3).

In summary, when given a choice, pigs preferred to consume the control diet with no added Cu over diets that contained 150 ppm of Cu from added $CuSO_4$ or TBCC. However, when pigs were given the choice between diets containing added Cu, they preferred to consume diets with TBCC. These data do not explain the increase in feed intake in finishing pigs fed 150 ppm Cu from TBCC reported by Coble et al. (see page 168); in fact, supplemental copper appears to have a negative impact, suggesting that the increase in feed intake is not because of an increase in palatability. Therefore, further research efforts should be focused on determining the metabolic mechanisms behind the previously reported increased ADFI of pigs fed supplemental TBCC.

Table 1. Diet composition (as-fed basis)[1]

Item	Control
Ingredient, %	
Corn	81.09
Soybean meal , 46.5% CP	16.77
Monocalcium P, 21%	0.33
Limestone	1.05
Salt	0.35
L-lysine	0.15
L-threonine	0.02
Trace mineral premix[2]	0.08
Vitamin premix	0.08
Phytase[3]	0.10
Copper[4]	---
Total	100.00
Calculated analysis	
Standardized ileal digestible (SID) amino acids, %	
Lysine	0.71
Isoleucine:lysine	71
Leucine:lysine	171
Methionine:lysine	31
Met & Cys:lysine	62
Threonine:lysine	64
Tryptophan:lysine	20
Valine:lysine	81
SID lysine:ME, g/Mcal	2.14
ME, kcal/lb	1,503
Total lysine, %	0.82
CP, %	14.8
Ca, %	0.50
P, %	0.40
Available P, %	0.24
Copper added, ppm	8

[1]Treatment diets were fed for 15 d.
[2]Trace mineral premix provided 8 ppm Cu from $CuSO_4$.
[3]Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 204.3 phytase units (FTU)/lb, with a release of 0.10% available P.
[4]150 ppm added Cu from either $CuSO_4$ or TBCC was added to the control diet at the expense of corn.

Table 2. Analyzed copper concentrations of complete diets (as-fed basis)[1,2]

	Control	$CuSO_4$	TBCC
Copper, ppm	18	196	243

[1]Values represent means from one composite sample, analyzed in duplicate.
[2]All diets contained a trace mineral premix that provided 8 ppm Cu from $CuSO_4$.

Table 3. Effects of $CuSO_4$ and TBCC on feed intake preference of finishing pigs[1]

Item	ADFI, lb	ADFI, %
Comparison 1		
Control	3.68	65.7
$CuSO_4$	2.02	34.4
SE	0.341	5.69
Probability, *P* <	0.01	0.01
Comparison 2		
Control	3.30	57.0
TBCC	2.49	43.0
SE	0.247	3.71
Probability, *P* <	0.03	0.02
Comparison 3		
$CuSO_4$	1.96	35.0
TBCC	3.50	65.0
SE	0.286	5.257
Probability, *P* <	0.01	0.01

[1]A total of 150 pigs (PIC 327 × 1050; initially 190 lb) were used in a 15 d study with 10 replications per comparison.