Effects of Feeding Copper and Feed-Grade Antimicrobials on the Growth Performance of Weanling Pigs

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Summary

A total of 240 weanling pigs (34 d of age with an average body weight of 17.1 lb) were used in a 35-d growth trial to compare the growth performance effects of copper (Cu) and feed-grade antimicrobials. The 6 dietary treatments were arranged in a 2 × 3 factorial with 2 added Cu levels (basal level of 16.5 ppm or basal + 125 ppm from copper sulfate) and 3 antimicrobial treatments including a control, chlortetracycline (CTC; Alpharma, Fort Lee, NJ) at 500 g/ton (10 mg/kg BW), and tylosin (Tylan; Elanco Animal Health, Greenfield, IN) at 100 g/ton. Each treatment had 8 pens with 5 pigs per pen. Treatments were allotted to pen in a randomized complete block design, with location within the barn serving as the blocking factor. Following the brief acclimatization period prior to starting the experiment (13 d), pigs were fed dietary treatments for 21 d followed by another 14 d on the control diet to examine any carryover effects. No significant copper × antimicrobial interactions were observed ($P > 0.07$) for any pig performance response. From d 0 to 21, pharmacological Cu tended to increase ($P < 0.07$) both ADG and ADFI compared with pigs provided basal levels of Cu. Dietary CTC inclusion increased ($P < 0.01$) ADG and tended to improve ($P < 0.09$) ADFI and F/G over pigs not fed diets with CTC. Dietary Tylan did not alter ($P > 0.19$) ADG, ADFI, or F/G compared with pigs provided the control diets. From d 21 to 35, pigs that previously had received pharmacological Cu tended to have lower ($P < 0.06$) ADG compared with those never receiving pharmacological Cu. Also, pigs previously receiving Tylan had lower ($P < 0.01$) ADG than those never receiving Tylan.

For the overall trial (d 0 to 35), adding Cu for the first 21 d had no impact ($P > 0.32$) on ADG, ADFI, or F/G. Similarly, Tylan did not influence ($P > 0.30$) pig performance. The benefits of CTC during the first 21 d led to a tendency for increased ($P < 0.06$) ADG and ADFI compared with those not receiving CTC. Overall, pharmacological Cu and antimicrobials may offer performance advantages when incorporated in nursery pig diets; however, that advantage will not increase and may be lost after Cu and/or antimicrobials are removed from diet.

Key words: antimicrobials, copper, growth promoters, nursery pig

Introduction

Pharmacological concentrations of Cu, fed as copper sulfate, are often used to enhance the growth performance in both weanling and growing pigs. Copper is often supple-

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mented at pharmacological levels of 125 to 250 ppm to increase growth and feed intake in weanling pigs. The growth promotional effects of Cu are similar to that of antibiotics in that it alters the gut microbial flora, thereby reducing the fermentation loss of nutrients and suppressing pathogens. Studies done by Stahly et al. (1980)[2] showed additive responses to subtherapeutic levels of Cu and antimicrobials; however, recent studies on the role of Cu and feed-grade antimicrobials on the growth performance of piglets are sparse. Therefore, the present study was conducted to evaluate the effects of Cu, chlortetracycline (CTC), and tylosin (Tylan) on the growth performance of weanling piglets.

Procedures

The protocol used in this experiment was approved by the Kansas State University Institutional Animal Care and Use Committee. The study was conducted at the K-State Segregated Early Weaning Research Facility in Manhattan, KS.

A total of 240 weanling pigs (34 d of age with an average body weight of 17.1 lb) were used in a 35-d growth trial to compare the growth performance effects of Cu and feed-grade antimicrobials. The 6 dietary treatments were arranged in a 2 × 3 factorial with 2 added Cu levels (basal level of 16.5 ppm or basal + 125 ppm from copper sulfate) and 3 antimicrobial treatments including a control, CTC at 500 g/ton (10 mg/kg BW), and Tylan at 100 g/ton. There were 8 pens per treatment with 5 pigs per pen. Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. All the pens had metal tri-bar flooring and provided approximately 3 ft^2/pig. Pig weights and feed disappearance were recorded every week to calculate ADG, ADFI, and F/G. Treatments were allotted to pens in a randomized complete block design with location within the barn serving as the blocking factor, thereby ensuring that adjacent pens alternated among the treatment groups.

All pigs were placed on common starter diets for 13 d upon arrival to the nursery facility. The common diets did not contain any antimicrobials or pharmacological levels of Cu or Zn. After feeding a prestarter diet for the first 7 d of the 13-d pretest period, pigs were fed the phase 1 control diet for 6 d prior to the start of the experiment to become accustomed to the nutrient profile and create a constant environment for the enteric bacteria prior to starting the experiment. Treatment diets were then assigned for 21 d. The Phase 1 diet was utilized for 14 d, and the Phase 2 diet was used for the remaining 7 d of the 21-d antimicrobial portion (Table 1). To generate treatment diets, corn was replaced in the control diet with copper sulfate, Tylan, and/or CTC. After 21 d, all pigs were placed on the control diet from Phase 2 for 14 d to examine for any carryover effects from providing pharmacological Cu or antimicrobials.

Experimental data were analyzed as a 2 × 3 factorial using the PROC MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Contrast statements were used to test the main effects of Cu addition and antimicrobial effects as well as the interactions. Additional contrast statements were used to compare the effects of CTC and Tylan compared with the controls. Random effects were used for barn as well as location

[2] Stahly, T. S., G. L. Cromwell, and H. J. Monegue. 1980. Effects of dietary inclusions of copper and (or) antibiotics on the performance of weanling pigs. J. Anim. Sci. 51:1347-1351.

within barn. Pen was the experimental unit for all data analysis. Statistics were considered significant at $P < 0.05$ and were considered tendencies at $P < 0.10$.

Results and Discussion

No significant copper × antimicrobial interactions were observed ($P > 0.07$) for any pig performance response in this study (Table 2). From d 0 to 21, adding pharmacological Cu to the diet tended to increase ($P < 0.07$) both ADG and ADFI compared with pigs provided basal levels of Cu. Dietary CTC inclusion increased ($P < 0.02$) ADG and d-21 BW. Adding CTC also tended to improve ($P < 0.09$) ADFI and F:G over pigs not provided diets with CTC. Dietary Tylan inclusion did not alter ($P > 0.19$) ADG, ADFI, or F/G compared with pigs provided the control diets.

As pigs were switched to the control diet (d 21 to 35), pigs that previously had received pharmacological Cu tended to have lower ($P < 0.06$) ADG compared with those never receiving pharmacological Cu. Also, pigs previously receiving Tylan had lower ($P < 0.01$) ADG compared with their control counterparts.

Throughout the entire 35-d study, Cu supplementation for the first 21 d had no impact ($P > 0.32$) on ADG, ADFI, or F/G. Similarly, addition of Tylan did not affect ($P > 0.30$) pig performance; however, the benefits of including CTC in the diet observed during the first 21 d led to a tendency for increased ($P < 0.09$) ADG, ADFI, and final BW compared with those not receiving CTC.

Overall, this study showed advantages to inclusion of 500 g/ton (10 mg/kg BW) of CTC in the diets of weanling pigs. After CTC was withdrawn from the feed, growth rate returned to control levels; however, the added gain achieved when CTC was fed was not lost. No advantages were observed for inclusion of Tylan. Several previous studies performed by K-State researchers have shown growth and feed intake advantages with pharmacological Cu. The current study showed a marginal pig performance response to Cu that was limited to the period when it was fed, followed by a lag in performance when pigs were switched back to basal Cu levels. Pharmacological Cu and antimicrobials may offer performance advantages when incorporated in nursery pig diets; however, that advantage will not increase and may be lost after Cu and/or antimicrobials are removed from diet.

Table 1. Diet composition (as-fed basis)

Item	Phase 1[1]	Phase 2[2]
Ingredient, %		
Corn[3]	57.33	65.80
Soybean meal (46.5% CP)	25.88	30.67
Spray-dried whey	10.00	---
Select menhaden fish meal	4.50	---
Monocalcium P (21% P)	0.38	1.03
Limestone	0.58	0.98
Salt	0.30	0.35
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
Lysine HCl	0.25	0.36
DL-Methionine	0.125	0.130
L-Threonine	0.105	0.130
Phytase[4]	0.165	0.165
Total	100	100
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	1.30	1.25
Isoleucine:lysine	61	60
Leucine:lysine	127	128
Methionine:lysine	35	33
Met & Cys:lysine	59	58
Threonine:lysine	63	62
Tryptophan:lysine	17	17
Valine:lysine	68	67
Total lysine, %	1.43	1.38
ME, kcal/lb	1,509	1,503
SID lysine:ME ratio, g/Mcal	3.94	3.81
CP, %	21.3	20.4
Ca, %	0.70	0.68
P, %	0.63	0.61
Available P, %	0.47	0.42
Avail P:calorie, g/Mcal	1.41	1.27

[1] Pigs were fed Phase 1 from d 0 to 14.
[2] Pigs were fed Phase 2 from d 14 to 35.
[3] Corn was replaced with chlortetracycline (CTC 50; Alpharma, Fort Lee, NJ) at 10 lb/ton, Tylan 100 (Elanco Animal Health, Greenfield, IN) at 1 lb/ton, and/or $CuSO_4$ at 1 lb/ton to create treatment diets.
[4] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 450 FTU/lb, with a release of 0.13% available P.

Table 2. Effects of dietary antimicrobials and copper sulfate on weanling pig growth performance[1]

	Antimicrobial regiment[2]							Probability, P <				
											Control vs.	
Item	Control	Tylan[3]	CTC[4]	Cu[5]	Cu[5] + Tylan[3]	Cu[5] + CTC[4]	SEM	Copper × antimicrobial	Copper	Antimicrobial	Tylan	CTC
Initial wt, lb	17.1	17.0	17.1	17.0	17.1	17.1	0.52	0.96	0.96	0.99	0.90	0.88
d 0 to 21												
ADG, lb	1.04	1.09	1.14	1.11	1.11	1.24	0.039	0.52	0.07	0.02	0.55	0.01
ADFI, lb	1.51	1.50	1.60	1.59	1.56	1.68	0.049	0.95	0.07	0.07	0.74	0.07
F/G	1.45	1.37	1.41	1.43	1.42	1.36	0.032	0.31	0.87	0.20	0.20	0.09
wt on d 21, lb	38.9	39.8	41.1	40.4	40.4	43.1	0.99	0.79	0.11	0.05	0.63	0.02
d 21 to 35												
ADG, lb	1.79	1.66	1.74	1.70	1.62	1.69	0.082	0.83	0.06	0.02	0.01	0.44
ADFI, lb	2.89	2.75	2.97	2.84	2.80	2.90	0.076	0.50	0.57	0.02	0.09	0.16
F/G	1.62	1.67	1.70	1.67	1.74	1.72	0.053	0.75	0.13	0.15	0.13	0.08
d 0 to 35												
ADG, lb	1.33	1.31	1.37	1.34	1.30	1.41	0.038	0.72	0.58	0.03	0.40	0.06
ADFI, lb	2.03	1.98	2.12	2.07	2.03	2.15	0.046	0.98	0.33	0.02	0.31	0.06
F/G	1.53	1.51	1.55	1.54	1.57	1.53	0.027	0.30	0.47	0.99	0.99	0.90
Final wt, lb	62.1	61.4	63.8	62.5	61.5	65.0	1.67	0.89	0.55	0.06	0.48	0.09

[1] A total of 240 nursery pigs (PIC 1050 barrows, initially 17.1 lb) were used in a 35-d experiment with 8 pens per treatment.
[2] Antimicrobial regiments were applied from d 0 to 21. All pigs received the control diet from d 21 to 35.
[3] Tylan (Elanco Animal Health, Greenfield, IN) was fed at 100 g/ton.
[4] Chlortetracycline (Alpharma, Fort Lee, NJ) was fed at 500 g/ton or approximately 10 mg/kg of body weight.
[5] Copper was supplemented at 125 ppm above the basal level (16.5 ppm) from copper sulfate.