Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 1198

2013

Effects of added zinc and copper on growth performance and carcass characteristics of finishing pigs fed ractopamine HCl (2013)

Kyle F. Coble

Chad B. Paulk

Joel M. DeRouchey

See next page for additional authors

Effects of added zinc and copper on growth performance and carcass characteristics of finishing pigs fed ractopamine HCl (2013)

Authors

Kyle F. Coble, Chad B. Paulk, Joel M. DeRouchey, Michael D. Tokach, Robert D. Goodband, and Steven S. Dritz

Effects of Added Zinc and Copper on Growth Performance and Carcass Characteristics of Finishing Pigs fed Ractopamine HCl[1]

K.F. Coble, C.B. Paulk, J.M. DeRouchey, M.D. Tokach, R.D. Goodband, and S.S. Dritz[2]

Summary

A total of 253 finishing pigs (PIC 327 × 1050; initial BW 204 lb) were used in a 28-d study to determine the effects of added Zn (Availa-Zn; Zinpro Corp., Eden Prairie, MN), Cu (Availa-Cu; Zinpro Corp.), or both to diets containing ractopamine HCl (RAC; Paylean; Elanco Animal Health, Greenfield, IN) on growth performance and carcass characteristics. Pens of pigs were randomly assigned to 1 of 5 treatments and balanced on average pig weight with 7 to 8 pigs per pen. Treatments included a control diet without RAC (negative control) and 4 diets containing 9 g/ton RAC with or without added Zn (50 ppm) or Cu (125 ppm) in a 2 × 2 factorial.

Overall, pigs fed RAC had increased ($P < 0.01$) ADG and improved F/G, which resulted in approximately a 15.5-lb heavier ($P < 0.01$) pig compared with those fed the negative control diet. Pigs fed added Zn had decreased ($P < 0.05$) ADG and tended to have decreased ($P < 0.09$) ADFI. Pigs fed added Cu also tended ($P < 0.10$) to have decreased ADG. No differences were observed in F/G when Zn or Cu was added to the diet.

Hot carcass weight, carcass yield, loin depth, and percentage lean increased ($P < 0.01$) in pigs fed the positive control diet containing RAC compared with those fed the negative control diet, whereas backfat was unaffected. Carcass characteristics were not affected by added Zn or Cu.

Feed cost and revenue increased ($P < 0.01$) for pigs fed the positive control diet containing RAC by approximately \$9.63 and \$10.08, respectively, compared with pigs fed the negative control diet; however, no difference was observed in feed cost per lb of gain. Income over feed cost (IOFC) did not differ in pigs fed the negative or positive control diet. Adding Zn decreased ($P < 0.05$) revenue per pig, and adding Cu tended to increase ($P < 0.06$) feed cost per lb of gain and reduce ($P < 0.10$) revenue per pig. There were no differences in IOFC between diets containing added Zn and no added Zn. Added Cu reduced ($P < 0.05$) IOFC.

In summary, growth and carcass characteristics improved in pigs fed dietary RAC as expected, but adding Zn, Cu, or both to diets containing RAC did not improve growth performance, carcass characteristics, or IOFC. Adding copper actually reduced IOFC due to the added expense.

---

[1] The authors would like to express thanks to Triumph Foods, Inc., St. Joseph, MO, for their help and cooperation in carcass data collection.

[2] Department of Diagnostic Medicine/Pathology, College of Veterinary Medicine, Kansas State University.

Key words: finishing pigs, zinc, copper, ractopamine HCl

Introduction

Ractopamine HCl (RAC; Paylean; Elanco Animal Health, Greenfield, IN) is commonly added to finishing diets just before marketing to improve growth performance and carcass leanness. Research associated with RAC has predominately focused on amino acids and the higher protein accretion generally observed in pigs fed RAC; however, limited data exists evaluating the effects of mineral supplementation in conjunction with feeding RAC.

Previous research (Akey, 2011[3]; Patience, 2011[4]) has observed improvements in growth performance when adding Zn to diets containing RAC. Paulk et al. (2012[5]) also observed a tendency for increased ADG when adding 50 ppm Zn to diets containing RAC. This approach resulted in a $0.47 increase in IOFC per pig. Copper is another important trace mineral that is commonly added to nursery pig diets, but recent data evaluating the growth performance of pigs fed added Cu during the finishing period are limited, specifically during the last phase where diets may contain RAC. Therefore, the objective of this study was to evaluate the effects of added Zn, Cu, or both in diets containing RAC on growth performance, carcass characteristics, and economics.

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.

The barn was mechanically ventilated with completely slatted flooring over a deep pit. Each pen (10 ft × 10 ft) was equipped with a 2-hole stainless steel feeder and cup waterer for ad libitum access to feed and water. Feed deliveries were made and recorded by a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) for each individual pen.

A total of 253 mixed sex pigs (PIC 327 × 1050, initially 204 lb) were used in a 28-day study. Pens of pigs were randomly allotted to 1 of 5 dietary treatments in a completely randomized design with 7 or 8 pigs per pen and 7 replications per treatment. Pigs were fed a negative control diet that did not contain RAC (negative control; 0.72% standardized ileal digestible [SID] lysine) or diets containing 9 g/ton RAC (positive control; 0.92% SID Lys; Table 1). Additional treatments included the positive control with or without added Zn (50 ppm from Availa-Zn; Zinpro Corp., Eden Prairie, MN) or Cu (125 ppm from Availa-Cu; Zinpro Corp., Eden Prairie, MN) arranged in a 2 × 2 factorial. All diets contained 55 ppm Zn and 8 ppm Cu from the trace mineral premix. Zinc and Cu were added at the expense of corn. All diets were analyzed for Zn and Cu and were found to be similar to calculated values (Table 2).

[3] Akey. 2011. Effects of Zinc Source and Level in Paylean Diets on Pig Performance and Carcass Characteristics. Akey Swine Newsletter.
[4] Patience, J.P. 2011. Impact of Zinc Source and Timing of Implementation on Grow-finish Performance, Carcass Composition, and Locomotion Score. Iowa St. Univ. Anim. Ind. Rep.
[5] Paulk, C.B. et al., Swine Day. 2012, Report of Progress 1074, pp. 356–364.

Pens of pigs and feeders were weighed on d 0, 14, and 28 of the experiment to determine ADG, ADFI, and F/G. Prior to d 28, pigs were individually tattooed for plant identification. On day 28, the pigs were individually weighed and transported to a commercial packing plant (Triumph Foods Inc., St. Joseph, MO) for processing and data collection. Carcass measurements included HCW, loin depth, and backfat depth. These measurements were used to determine the percentage carcass yield and percentage lean for each pig.

At the conclusion of the study, total feed cost per pig was determined by multiplying ADFI by the respective diet cost and the number of days on feed. Cost per lb of gain was calculated by dividing the total feed cost by the total weight gained during the 28-d period. Revenue was determined by multiplying ADG by 28 and a live price of $65.00 per cwt. Income over feed cost was calculated by subtracting total feed cost from revenue. Ingredient prices used were: corn = $7.84 per bushel; soybean meal = $478 per ton; L-lysine = $1.16 per lb; ractopamine HCl = $36.31 per lb; Availa-Zn = $1.50 per lb, and Availa-Cu = $2.15 per lb.

The experimental data were analyzed as a 2 × 2 + 1 factorial with main effects of added Zn or Cu, plus a contrast comparing pigs fed the negative control diet with those fed the diet containing RAC. The MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) was used with pen as the experimental unit. Hot carcass weight served as a covariate for the analysis of loin depth, backfat, and percentage lean. Data presented as least square means and results were considered significant at $P \leq 0.05$ and considered a tendency between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

No Zn × Cu interactions ($P > 0.10$) were observed for any of the response criteria throughout the study. From d 0 to 14, pigs fed the positive control diet containing RAC had increased ($P < 0.01$) ADG, BW, and improved F/G compared with those fed the negative control diet (Table 3). There were no differences in ADFI. Adding either Zn or Cu to the positive control during this period did not influence growth performance (Table 4).

From d 14 to 28, pigs fed the positive control diet again had increased ($P < 0.01$) ADG, BW, and improved F/G compared with those fed the negative control diet. Adding Zn, Cu, or both decreased ($P < 0.02$) ADG compared with the negative control; however, the reduction in ADG combined with no change in ADFI during this period resulted in pigs fed added Cu having poorer ($P < 0.04$) F/G compared with those not fed added Cu.

Overall, pigs fed the positive control diet had increased ($P < 0.01$) ADG and improved F/G compared with pigs fed the negative control diet. These pigs were approximately 15.5 lb lighter ($P < 0.01$) than pigs fed the positive control diet containing RAC. Pigs fed added Zn had decreased ($P < 0.05$) ADG and a tendency ($P < 0.09$) for decreased ADFI. Pigs fed added Cu had a tendency ($P < 0.10$) for decreased ADG. There were no differences in F/G when Zn or Cu was added to the positive control diet.

Pigs fed the positive control diet had increased ($P < 0.01$) HCW, loin depth, percentage lean, and carcass yield compared with pigs fed the negative control, but there were no differences in backfat. Added Zn or Cu to diets containing RAC had no effect on any of the carcass characteristics.

Feed cost and revenue increased ($P < 0.01$) for pigs fed the positive control diet containing RAC by approximately $9.63 and $10.08, respectively, compared with the negative control, but feed cost per lb of gain did not differ. Therefore, IOFC did not differ in pigs fed the negative and positive control diets. Added Zn decreased ($P < 0.05$) revenue per pig, and added Cu tended to increase ($P < 0.06$) feed cost per lb of gain and reduce ($P < 0.10$) revenue per pig, due in part to the expense of the adding both Zn and Cu to the diet. There were no differences in IOFC among pigs fed diets containing added Zn vs. no added Zn, but adding Cu reduced ($P < 0.05$) IOFC, again due in part to the expense of adding both Zn and Cu to the diet.

In conclusion, adding Zn or Cu to diets containing RAC did not improve growth, carcass characteristics, or IOFC.

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

Item	Negative control	Positive control
Ingredient, %		
Corn	82.77	74.03
Soybean meal, 46.5% CP	15.24	23.99
Limestone	1.00	0.95
Monocalcium P, 21%	0.25	0.20
Salt	0.35	0.35
Vitamin premix	0.075	0.075
Trace mineral premix[2]	0.075	0.075
L-lysine HCl	0.150	0.150
DL-methionine	---	0.025
L-threonine	0.010	0.035
Phytase[3]	0.075	0.075
Ractopamine HCl[4]	---	0.05
Availa-Zn[5]	---	---
Availa-Cu[6]	---	---
Total	100	100
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	0.70	0.92
Isoleucine:lysine	71	70
Leucine:lysine	179	158
Methionine:lysine	31	31
Met & Cys:lysine	65	61
Threonine:lysine	65	65
Tryptophan:lysine	18.7	19.3
Valine:lysine	84	79
Total lysine, %	0.79	1.03
ME, kcal/lb	1,521	1,520
SID lysine:ME, g/Mcal	2.09	2.75
CP, %	14.3	17.6
Ca, %	0.50	0.50
P, %	0.39	0.41
Available P, %	0.21	0.21

[1] Treatment diets fed for 28 d.
[2] Trace mineral premix provided 55 ppm Zn from $ZnSO_4$ and 8 ppm Cu from $CuSO_4$ in the complete diet.
[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] Provided 9 g/ton of ractopamine HCl (Elanco Animal Health, Inc., Greenfield, IN).
[5] Zinpro Corp. (Eden Prairie, MN); added 50 ppm Zn at the expense of corn to the positive control diet.
[6] Zinpro Corp, (Eden Prairie, MN); added 125 ppm Cu at the expense of corn to the positive control diet.

Table 2. Analyzed zinc and copper concentrations of complete diets[1,2]

Concentration, ppm	Negative control	Positive control	50 ppm Zn	125 ppm Cu	50 ppm Zn + 125 ppm Cu
Zinc	98.7	106.3	143.8	95.2	134.7
Copper	12.3	14.6	15.2	114.8	108.2

[1] Values represent means from one composite sample, analyzed in triplicate.
[2] Trace mineral premix provided 55 ppm Zn from $ZnSO_4$ and 8 ppm Cu from $CuSO_4$ in the complete diet.

Table 3. The effects of added zinc and copper on finishing pig growth performance, carcass characteristics, and economics[1]

							Probability, $P <$		
Item	Negative control	Positive control	50 ppm Zn	125 ppm Cu	50 ppm Zn + 125 ppm Cu	SEM[2]	Neg. control vs. pos. control	Zn	Cu
BW, lb									
d 0	204.5	204.5	202.3	204.3	204.6	2.48	1.00	0.76	0.73
d 14	228.6	238.7	237.1	239.1	239.1	2.33	0.01	0.73	0.63
d 28	259.5	275.0	272.1	273.7	270.6	2.37	0.01	0.23	0.57
d 0 to d 14									
ADG, lb	1.72	2.44	2.43	2.48	2.46	0.086	0.01	0.83	0.69
ADFI, lb	6.20	6.33	6.18	6.52	6.29	0.130	0.49	0.17	0.26
F/G	3.61	2.62	2.56	2.63	2.58	0.082	0.01	0.51	0.86
d 14 to d 28									
ADG, lb	2.21	2.59	2.50	2.47	2.26	0.058	0.01	0.02	0.01
ADFI, lb	7.46	7.56	7.34	7.37	7.21	0.137	0.60	0.19	0.25
F/G	3.38	2.92	2.94	2.99	3.21	0.080	0.01	0.15	0.04
d 0 to d 28									
ADG, lb	1.96	2.52	2.47	2.48	2.36	0.042	0.01	0.05	0.10
ADFI, lb	6.83	6.94	6.76	6.94	6.75	0.106	0.44	0.09	0.96
F/G	3.48	2.76	2.74	2.80	2.86	0.048	0.01	0.67	0.11
Carcass characteristics									
HCW, lb	194.5	208.3	205.9	208.2	206.1	2.55	0.01	0.36	0.99
Yield, %	72.21	73.33	73.16	73.52	73.54	0.201	0.01	0.68	0.13
Backfat, in.[3]	0.85	0.80	0.77	0.76	0.76	0.025	0.09	0.59	0.31
Loin depth, in.[3]	2.39	2.56	2.50	2.55	2.56	0.041	0.01	0.57	0.49
Lean, %[3]	51.97	53.37	53.31	53.66	53.72	0.313	0.01	0.99	0.24
Economics									
Feed cost, $/pig	33.30	42.93	41.90	43.90	42.03	0.593	0.01	0.12	0.83
Feed cost, $/lb gain	0.606	0.610	0.608	0.621	0.637	0.009	0.78	0.53	0.06
Revenue, $ / pig[4]	35.75	45.83	44.87	45.10	42.93	0.759	0.01	0.05	0.10
IOFC, $/pig[5]	2.45	2.90	2.96	2.01	0.89	0.725	0.66	0.48	0.05

[1] A total of 253 (PIC 327 × 1050) were used in a 28-d finishing trial with 7 to 8 pigs per pen and 7 replications per treatment.
[2] No Zn × Cu interactions ($P > 0.10$).
[3] HCW was used as a covariate.
[4] Revenue based on $65.00/cwt live price.
[5] Income over feed cost = total revenue/pig – feed cost/pig.

Table 4. Main effects of added zinc and copper on finishing pig growth performance, carcass characteristics, and economics[1]

	Zn		Cu			Probability, $P <$	
Item	-	+	-	+	SEM	Zn	Cu
BW, lb							
d 0	204.4	203.6	203.6	204.5	1.82	0.76	0.73
d 14	238.9	238.1	237.9	239.1	1.72	0.73	0.63
d 28	274.4	271.36	273.6	272.16	1.74	0.23	0.57
d 0 to d 14							
ADG, lb	2.46	2.44	2.44	2.47	0.635	0.83	0.69
ADFI, lb	6.42	6.23	6.25	6.40	0.095	0.17	0.26
F/G	2.62	2.66	2.59	2.60	0.604	0.51	0.86
d 14 to d 28							
ADG, lb	2.53	2.38	2.55	2.36	0.043	0.02	0.01
ADFI, lb	7.46	7.28	7.45	7.29	0.101	0.19	0.25
F/G	2.96	3.08	2.93	3.10	0.059	0.15	0.04
d 0 to d 28							
ADG, lb	2.50	2.41	2.49	2.42	0.031	0.05	0.10
ADFI, lb	6.94	6.75	6.85	6.85	0.078	0.09	0.96
F/G	2.78	2.80	2.75	2.83	0.035	0.67	0.11
Carcass characteristics							
HCW, lb	208.2	206.0	207.1	207.1	1.75	0.36	0.99
Yield, %	73.43	73.34	73.24	73.53	0.137	0.68	0.13
Backfat, in.[2]	0.78	0.77	0.79	0.76	0.163	0.59	0.31
Loin depth, in.[2]	2.55	2.53	2.53	2.56	0.031	0.57	0.49
Lean, %[2]	53.51	53.51	53.34	53.69	0.215	0.99	0.24
Economics							
Feed cost, $/pig	43.01	41.97	42.42	42.56	0.474	0.12	0.83
Feed cost, $/lb gain	0.616	0.622	0.609	0.629	0.008	0.53	0.06
Revenue, $/pig[3]	45.47	43.90	45.35	44.02	0.559	0.05	0.10
IOFC, $/pig[4]	2.46	1.93	2.93	1.45	0.533	0.48	0.05

[1] A total of 253 (PIC 327 × 1050) were used in a 28-day finishing trial with 7 to 8 pigs per pen and 7 replications per treatment.
[2] HCW was used as a covariate.
[3] Revenue based on $65.00/cwt live price.
[4] Income over feed cost = total revenue/pig – feed cost/pig.