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Effect of Dietary Addition of Denagard (Tiamulin) and CTC (Chlortetracycline) on Pig Performance Immediately after Placement in the Finishing Barn[1]

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Summary

A total of 1,313 pigs (PIC 1050 × 337; initially 49 lb) were used in a 35-d study to determine the effects of adding Denagard (Tiamulin) and CTC (chlortetracycline) to feed on pig performance immediately after placement in the finisher barn. Pigs were transported from one nursery facility and placed into the finishing barn without maintaining pen integrity. Immediately after placement in the finishing barn, pens of pigs were weighed and randomly allotted to treatments arranged in a 2 × 2 factorial with main effects of Denagard (0 and 35 g/ton; Novartis Animal Health, Greensboro, NC) and chlortetracycline (CTC; 0 and 400 g/ton). Diets were corn-soybean meal–based and contained 20% bakery and 35% dried distiller's grains with solubles (DDGS). Treatment diets were fed from d 0 to 15 with a common non-medicated diet fed from d 15 to 35.

An interaction ($P < 0.01$) was observed for ADFI from d 0 to 15 and for the overall period, with pigs fed the diet without medication and the combination of Denagard and CTC having greater ADFI than either medication alone. Adding antibiotics to the diets also improved F/G from d 0 to 15, with no differences among pigs fed Denagard, CTC, or their combination (Denagard × CTC interaction, $P < 0.01$). Adding Denagard or CTC to diets improved ($P < 0.01$) ADG and F/G from d 0 to 15; however, when the antimicrobials were removed from the diet (d 15 to 35), ADG of pigs previously fed any of the medicated diets decreased (Denadard $P < 0.01$; CTC $P < 0.06$) compared with pigs previously fed the non-medicated diet. Because the advantages in growth performance from d 0 to 15 were lost during the period from d 15 to 35, there were no differences ($P > 0.15$) in overall ADG or F/G. In conclusion, adding Denagard and/or CTC to diets immediately after pig placement in the finisher can improve growth performance, but the performance was not maintained in the subsequent period when pigs were fed non-medicated diets.

Key words: antibiotics, chlortetracycline, Denagard, finishing pig

[1] Appreciation is expressed to New Horizon Farms for use of pigs and facilities and to Richard Brobjorg, Scott Heidebrink, and Marty Heintz for technical assistance

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

Introduction

Feed medications have been widely used in the swine industry for prevention of disease and improvement of growth performance. Several trials (Steindinger et al., 2010[3]; Sotak et al., 2011[4]) have observed that nursery pigs fed diets with Denagard and CTC had greater ADG, ADFI, or improved F/G than pigs fed non-medicated diets. Movement of pigs from the nursery into the finishing facility can be a stressful period for pigs, and commingling pigs from multiple nursery pens into finishing pens may also expose pigs to new pathogens. Therefore, the advantage of feed medication might be maximized after pigs are moved from the nursery to the finisher barn. This trial was conducted to investigate the effects of dietary addition of Denagard and/or CTC on growth performance of growing pigs immediately after placement in the finisher barn.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at a commercial research-finishing barn in southwestern Minnesota. The barns were naturally ventilated and double-curtain-sided. Pens had completely slatted flooring and deep pits for manure storage. Twenty-four pens were equipped with conventional dry stainless steel feeders (STACO, Inc., Schaefferstown, PA) with 5 holes and a cup waterer in each pen for ad libitum access to feed and water. The remaining 24 pens were equipped with a double-sided wet-dry feeder (Crystal Springs, GroMaster, Inc., Omaha, NE), with the feeder as the only source of water. Daily feed additions to each pen were accomplished through a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of providing and measuring feed amounts for individual pens.

A total of 1,313 pigs (PIC 1050 × 337; initially 49 lb) were used in a 35-d study. Pigs were transported from one nursery facility and placed into the finishing barn without maintaining pen integrity. At placement into the finishing barn, a similar number of barrows and gilts were randomly placed in each pen, with 31 to 33 pigs per pen and 10 pens per treatment blocked by weight and feeder type. Treatments were arranged in a 2 × 2 factorial with main effects of Denagard (0 and 35 g/ton; Novartis Animal Health, Greensboro, NC) and chlortetracycline (CTC; 0 and 400 g/ton). Diets were corn-soybean meal–based and contained 30% bakery product and 35% dried distiller's grains with solubles (DDGS; Table 1). Treatment diets were fed from d 0 to 15, and a common, non-medicated diet was fed from d 15 to 35. Pens of pigs were weighed and feed disappearance was recorded at d 15 and 35 to determine ADG, ADFI, and F/G.

The experimental data were analyzed using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC). Treatments were arranged in a 2 × 2 factorial and data were analyzed for the main effects of Denagard and CTC, and their interaction. Pen was the experimental unit for all data analysis, and significance and tendencies were set at $P < 0.05$ and $P < 0.10$, respectively.

Results and Discussion

From d 0 to 15, pigs fed diets containing Denagard or CTC alone had decreased feed intake than pigs fed the non-medicated diet or the diet containing both Denagard and

[3] Steidinger et al., Swine Day 2009, Report of Progress 1020, pp. 122–131.

[4] Sotak et al., Swine Day 2010, Report of progress 1038, pp. 72–78.

CTC (Denagard × CTC interaction, $P < 0.01$; Table 2). Adding Denagard or CTC to the diet improved F/G with no additive response, which also led to a Denagard × CTC interaction ($P < 0.01$). The ADFI interaction from d 0 to 15 led to a similar interaction ($P = 0.05$) for ADFI for the overall period (d 0 to 35), with pigs fed non-medicated diets or the combination of Denagard and CTC having greater ADFI than pigs fed diets containing only Denagard or CTC alone. For main effects, from d 0 to 15, adding Denagard or CTC to diets improved ($P < 0.01$) ADG and F/G with an additive response in ADG.

From d 15 to 35, when a common non-medicated diet was fed, pigs previously fed Denagard ($P < 0.01$) and CTC ($P < 0.06$) had decreased ADG compared with pigs previously fed the non-medicated control diet. Feed efficiency of pigs previously fed Denagard also had poorer ($P < 0.01$) F/G from d 15 to 35. Because the growth advantage from d 0 to 15 was lost during the subsequent period from d 15 to 35, no differences ($P > 0.18$) were observed in overall (d 0 to 35) performance.

The results of this experiment are consistent with previous trials (Steidinger et al., 2010[5]; Sotak et al., 2011[6]) that found an improvement in growth rate and feed efficiency when adding antibiotics to diets; however, the benefit in growth performance was lost in the subsequent period in this trial, resulting in no benefit for the overall period. The growth rate response to Denagard and CTC also was additive, because pigs fed the combination of Denagard and CTC had greater ADG than pigs fed diets with only Denagard or CTC.

In conclusion, adding Denagard /CTC to grower diets immediately after placement in the finishing barn improved growth performance, but the performance benefit was not maintained in the subsequent period when pigs were fed non-medicated diets.

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[5] Steidinger et al., Swine Day 2009, Report of Progress 1020, pp. 122–131

[6] Sotak et al., Swine Day 2010, Report of progress 1038, pp. 72–78.

Table 1. Diet composition

Item	Treatment diet[1]	Common diet
Ingredient, %		
Corn	10.99	3.80
Soybean meal, 46.5% CP	21.52	13.54
Bakery by-product	30.00	30.00
DDGS[2]	35.00	50.00
Limestone	1.31	1.48
Salt	0.35	0.35
Vitamin-trace mineral premix	0.10	0.10
L-threonine	0.02	---
L-lysine sulfate	0.72	0.72
Phytase[3]	0.005	0.005
Denagard[4]	---	---
Chlortetracycline[5]	---	---
Total	100	100
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	1.16	1.02
Isoleucine:lysine	67	71
Leucine:lysine	164	195
Methionine:lysine	30	35
Met & Cys:lysine	61	72
Threonine:lysine	61	65
Tryptophan:lysine	17.0	17.0
Valine:lysine	77	86
Total lysine, %	1.35	1.23
ME, kcal/lb	1,541	1,547
SID lysine:ME, g/Mcal	3.41	2.99
CP, %	23.7	23.6
Ca, %	0.62	0.66
P, %	0.50	0.53
Available P, %	0.32	0.38

[1] Treatment diets were fed from d 0 to 15, then a non-medicated common diet was fed from d 15 to 35.
[2] DDGS: dried distillers grains with solubles from Valero (Aurora, SD).
[3] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN).
[4] Denagard (Tiamulin, Novartis Animal Health, Greensboro, NC) was added in place of corn at 0.175% to provide a 35 g/ton of Denagard in the treatment diet.
[5] Chlortetracycline (CTC) was added in place of corn at 0.22% to provide 400 g/ton of CTC in the treatment diet.

Table 2. Effects of Denagard (Tiamulin) and chlortetracycline (CTC) fed immediately after placement on growing pig performance[1]

						Probability, *P*<		
Item	No medication	Denagard[2] 35 g/ton	CTC 400 g/ton	Denagard 35 g/ton + CTC 400 g/ton	SEM	Denagard × CTC	Denagard	CTC
d 0 to 15[3]								
ADG, lb	1.43	1.49	1.51	1.59	0.017	0.63	0.01	0.01
ADFI, lb	2.60	2.33	2.42	2.57	0.032	0.01	0.07	0.35
F/G	1.82	1.56	1.60	1.61	0.026	0.01	0.01	0.01
d 15 to 35								
ADG, lb	2.03	1.92	1.95	1.88	0.028	0.48	0.01	0.06
ADFI, lb	4.16	4.20	4.12	4.18	0.082	0.88	0.51	0.71
F/G	2.05	2.19	2.11	2.22	0.040	0.71	0.01	0.30
d 0 to 35								
ADG, lb	1.77	1.73	1.76	1.76	0.016	0.36	0.18	0.60
ADF, lb	3.49	3.40	3.39	3.49	0.047	0.05	0.92	0.90
F/G	1.97	1.96	1.92	1.98	0.024	0.15	0.28	0.61
BW, lb								
d 0	48.9	48.9	48.9	48.9	0.867	0.96	0.98	0.99
d 15	70.3	71.2	71.6	72.9	0.874	0.81	0.20	0.10
d 35	111.1	109.6	110.6	110.8	1.041	0.44	0.52	0.72

[1] A total of 1,313 pigs (initial BW 49 lb) were used in a 35-d trial. Pigs were randomly allotted to 1 of 4 dietary treatments with 31 to 33 pigs/pen and 10 pens per treatment.
[2] Denagard (0 and 35 g/ton; Novartis Animal Health, Greensboro, NC).
[3] Treatment diets were fed from d 0 to 15, then a non-medicated common diet was fed from d 15 to 35.

Effects of Source and Level of Added Zinc on Growth Performance and Carcass Characteristics of Finishing Pigs Fed Ractopamine HCl[1]

C. B. Paulk, M. D. Tokach, J. L. Nelssen, J. M. Gonzalez, J. M. DeRouchey, R. D. Goodband, and S. S. Dritz[2]

Summary

A total of 312 pigs (PIC 327 × 1050; initially 206.1 lb) were used in a 27-d study to determine the effects of increasing added Zn from zinc oxide (ZnO; Zinc Nacional S.A., Monterrey, Mexico) or Availa-Zn (Zinpro, Eden Prairie, MN) on growth performance and carcass characteristics of finishing pigs fed Ractopamine HCL (RAC; Paylean; Elanco Animal Health, Greenfield, IN). Pigs were allotted to 1 of 6 dietary treatments in a completely randomized design with 2 pigs per pen and 26 pens per treatment completed over 2 consecutive groups of finishing pigs (13 pens per treatment per group). Dietary treatments consisted of (1) a corn-soybean meal–based negative control diet (0.66% standardized ileal digestible [SID] lysine); (2) a positive control diet (0.92% SID lysine) containing 10 ppm RAC; (3), (4), and (5) RAC plus 50, 100, and 150 ppm added Zn from ZnO, respectively; and (6) RAC plus 50 ppm added Zn from Availa-Zn. The trace mineral premix provided a basal level of 83 ppm Zn from Zn Sulfate ($ZnSO_4$) in all diets.

Overall, pigs fed the positive control RAC diet had improved ($P < 0.05$) ADG, F/G, income over feed cost (IOFC), final BW, HCW, carcass ADG, carcass F/G, carcass IOFC, carcass yield, boneless loin weight, and a tendency for reduced ($P < 0.08$) ADFI compared with pigs fed the negative control diet. Pigs fed RAC with up to 150 ppm added Zn from ZnO had numerically improved (linear, $P < 0.09$) F/G, IOFC, caloric efficiency on an ME and NE basis, and a tendency toward increased (quadratic, $P < 0.06$) boneless loin weights. In addition, carcass ADG tended to increase (quadratic, $P < 0.09$) with increasing ZnO, with little improvement beyond feeding 50 ppm added Zn. Overall, pigs fed diets with 50 ppm added Zn from Availa-Zn had increased ($P < 0.05$) IOFC, carcass ADG, and a tendency for increased ($P < 0.06$) ADG compared with pigs fed positive control, RAC diet. No differences were observed in performance ($P > 0.10$) among pigs fed diets with 50 ppm added Zn from ZnO or Availa-Zn.

These data indicate that adding up to 150 ppm Zn from ZnO or 50 ppm Zn from Availa-Zn in finishing pig diets containing RAC can improve performance and IOFC; however, more research is needed to better define the response and understand the mechanism responsible for the improved performance from added Zn.

Key words: Ractopamine HCl, zinc, finishing pig

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[1] Appreciation is expressed to Farmland Foods Inc., Roger Johnson, and Cory Rains for carcass data collection.

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

Introduction

Ractopamine HCl (RAC; Paylean; Elanco Animal Health, Greenfield, IN) is frequently added to finishing pig diets to improve growth performance and carcass leanness. When adding RAC to finishing diets, amino acid concentrations are generally increased approximately 30% to maximize growth and carcass lean based on growth modeling results and several research trial datasets. Little research has been conducted to determine the effects of trace mineral concentrations on the response to RAC, but recent studies have observed that added Zn can increase the response to RAC (Akey, 2011[3], Patience, 2011[4]). We designed an experiment to determine the effects of adding various concentrations of added Zn from zinc oxide (50, 100, or 150 ppm ZnO or 50 ppm added Zn from Availa-Zn on growth performance and carcass characteristics of finishing pigs fed RAC.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The project was conducted at the K-State Swine Teaching and Research Center. Pigs were housed in an environmentally controlled finishing building with pens that were 5 ft × 5 ft with totally slatted flooring. Each pen was equipped with a dry self-feeder and a nipple waterer to provide ad libitum access to feed and water.

A total of 312 finishing pigs (PIC 327 × 1050, two consecutive groups of 156 pigs) with an initial BW of 206.1 lb were used in this study. Pens of pigs were allotted to 1 of 6 dietary treatments, with either 2 barrows or 2 gilts per pen and 26 pens per treatment. Dietary treatments consisted of: (1) a corn-soybean meal–based negative control diet formulated to 0.66% SID lysine; (2) a positive control diet formulated to contain 0.92% SID lysine and 10 ppm RAC; (3), (4), and (5) the RAC diet plus 50, 100, and 150 ppm added Zn from ZnO, respectively; and (6) RAC plus 50 ppm added Zn from Availa-Zn (Table 1). Basal diets contained 83 ppm Zn from $ZnSO_4$ provided by the trace mineral premix. Experimental diets were fed in meal form, and ZnO or Availa-Zn was added to the RAC diet at the expense of corn. Pigs and feeders were weighed on d 0, 14, and 27 to determine ADG, ADFI, F/G, IOFC, and caloric efficiency on an ME and NE basis.

Caloric efficiency is a measurement of the efficiency of energy usage, or the ME or NE required per pound of gain. Metabolizable energy values of the feed ingredients were derived from NRC (1998[5]), and NE values of the feed ingredients were derived from INRA (2004[6]). Income over feed cost, a method to measure an economic value, was also calculated and assumed that other costs, such as utility and labor, were equal and the only variables were ADG and feed usage for the experimental period. Corn was valued

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[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. IA St. Univ. Anim. Ind. Rep.

[5] NRC. 1998. Nutrient Requirements of Swine, 10th ed. Natl. Acad. Press, Washington DC.

[6] INRA (Institut National de la Recherche Agronomique). 2004. Tables of composition and nutritional value of feed materials, Sauvant, D., J-M. Perez and G. Tran, Eds. Wageningen Academic Publishers, The Netherlands and INRA, Paris, France.

at $225/ton, soybean meal at $316/ton, L-lysine at $1.10/lb, DL-methionine at $2.70/lb, L-threonine at $1.25/lb, RAC at $35.26/lb, zinc oxide at $0.86/lb, Availa-Zn at $1.50/lb, and pig price at $0.61/lb live weight.

On d 27, both groups of pigs were weighed, tattooed, and shipped to a commercial packing plant (Farmland Foods Inc., Crete, NE) for calculation of HCW and percentage carcass yield. For the second group of pigs, last-rib ruler backfat measurements, percentage lean, and boneless loin weights were collected. Percentage carcass yield was calculated by dividing HCW by live weight obtained at the farm before transport to the packing plant. Percentage lean was calculated by dividing the standardized fat-free lean (SFFL) by HCW. The following equation was used for calculation of SFFL (NPPC, 2001[7]):

Lb. SFFL= 23.568 + 0.503 × (HCW, lb) – 21.348 × (last-rib backfat thickness, in.)

To calculate carcass ADG and F/G, an initial carcass weight was estimated by multiplying initial live weight by a 75% yield value. Carcass-based IOFC was calculated using the same ingredient prices and carcass was priced at $0.87/lb.

All data were analyzed as a completely randomized design using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. In addition to treatment, the effects of gender and group were included as fixed effects. Hot carcass weight was used as a covariate for analyses of backfat thickness and boneless loin weight. Contrast statements consisted of: (1) negative control vs. positive control RAC diet, (2) increasing ZnO linear and quadratic polynomials, (3) positive control RAC diet vs. Availa-Zn, and (4) 50 ppm added Zn from ZnO vs Availa-Zn. Statistical significance was determined at $P < 0.05$ and trends at $P < 0.10$.

Results and Discussion

From d 0 to 14, pigs fed the positive control RAC diet had improved ($P < 0.01$) ADG, F/G, IOFC, and caloric efficiencies on both a ME and NE basis compared with pigs fed the negative control diet (Table 2). Pigs fed RAC with up to 150 ppm added Zn from ZnO had numerically improved (linear, $P < 0.09$) IOFC. Pigs fed RAC plus Availa-Zn had increased ($P < 0.05$) ADG, IOFC, caloric efficiency on a ME basis and a tendency for improved ($P < 0.06$) F/G and caloric efficiency on a NE basis compared with pigs fed only RAC. No differences in performance ($P > 0.12$) were found between pigs fed diets containing 50 ppm added Zn from ZnO vs. Availa-Zn.

From d 14 to 27, pigs fed the positive control RAC diet had reduced ($P < 0.02$) ADFI, F/G, and caloric efficiency on an ME and NE basis and a tendency for increased ($P < 0.06$) ADG compared with the negative control diet. No differences were observed in performance ($P > 0.24$) between pigs fed RAC and diets containing added Zn from ZnO or Availa-Zn. Performance did not differ ($P > 0.60$) in pigs fed diets with 50 ppm added Zn from ZnO vs. Availa-Zn.

[7] NPPC 2001. Procedures for Estimating Pork Carcass Composition. Natl. Pork Prod. Counc., Des Moines, IA.

Overall (d 0 to 27), pigs fed RAC had improved ($P < 0.05$) ADG, F/G, IOFC, final BW, HCW, carcass ADG, carcass F/G, carcass IOFC, percentage carcass yield, and boneless loin weight and a tendency for reduced ($P < 0.08$) ADFI compared with those fed the negative control diet (Table 3). Pigs fed RAC with up to 150 ppm added Zn from ZnO had numerically improved (linear, $P < 0.09$) F/G, IOFC, caloric efficiencies on a ME and NE basis, and a tendency for increased (quadratic, $P < 0.06$) boneless loin weights. In addition, carcass ADG tended to increase (quadratic, $P < 0.09$) with increasing ZnO, with little improvement beyond feeding 50 ppm added Zn. Pigs fed diets with 50 ppm added Zn from Availa-Zn also had a tendency for increased ($P < 0.06$) ADG, and had increased ($P < 0.05$) IOFC and carcass ADG compared with pigs fed the positive control RAC diet. No differences were observed in performance ($P > 0.38$) between pigs fed diets with 50 ppm added Zn from ZnO vs. Availa-Zn.

The addition of RAC to the diet of finishing pigs improved ADG, F/G, IOFC, and carcass-based IOFC by 16%, 18%, \$2.85, and \$5.09, respectively, compared with pigs fed the negative control diet. The addition of 150 ppm Zn from ZnO to the RAC diet numerically improved F/G by 3.4% and IFOC by \$1.50 compared with the RAC-only diet. The addition of 50 ppm Zn from Availa-Zn to the RAC diet numerically improved ADG by 4.6%, resulting in increased IOFC of \$1.62 per pig compared with the RAC-only diet. These data indicate that adding up to 150 ppm Zn from ZnO or 50 ppm Zn from Availa-Zn in finishing pig diets containing RAC can improve performance and IOFC; however, more research is needed to better define the response and understand the mechanism of action for the added Zn.

Table 1. Diet composition (as-fed basis)[1,2]

Item	Control	RAC
Ingredient, %		
Corn	84.29	73.91
Soybean meal, (46.5% CP)	13.65	24.00
Monocalcium P, (21% P)	0.50	0.45
Limestone	0.90	0.90
Salt	0.35	0.35
Vitamin premix	0.075	0.075
Trace mineral premix[3]	0.075	0.075
L-lysine HCl	0.15	0.15
DL-methionine	---	0.015
L-threonine	---	0.025
Ractopamine HCl[4]	---	0.05
Total	100	100
Calculated analysis, %		
Standardized ileal digestible (SID) amino acids, %		
Lysine	0.66	0.92
Isoleucine:lysine	71	70
Leucine:lysine	184	158
Methionine:lysine	32	30
Met & Cys:lysine	66	60
Threonine:lysine	64	64
Tryptophan:lines	19	19
Valine:lysine	85	79
Total lysine, %	0.75	1.03
CP, %	13.70	17.60
ME, kcal/lb[5]	1,520	1,518
NE, kcal/lb[6]	1,139	1,109
SID lysine: ME/Mcal	1.97	2.75
Ca, %	0.51	0.53
P, %	0.44	0.47
Available P, %	0.16	0.16

[1] Diets were fed in meal form from d 0 to 27 of the experiment.
[2] Dietary treatments were obtained by replacing corn in the RAC diet to achieve 50, 100, and 150 ppm added Zn from ZnO (Zinc Nacional S.A., Monterrey, Mexico) and 50 ppm added Zn from Availa-Zn (Zinpro, Eden Prairie, MN).
[3] Provided 83 ppm Zn from $ZnSO_4$.
[4] Provided 9 g/lb of Ractopamine HCl (Paylean; Elanco Animal Health, Greenfield, IN).
[5] ME values for ingredients were derived from NRC (1998).
[6] NE values for all ingredients were derived from INRA (2004).

Table 2. Effects of added zinc and Ractopamine HCl (RAC) on growth performance of finishing pigs[1]

			ZnO, ppm Zn			Availa-Zn, ppm Zn		Probability, *P*<				
									ZnO		Availa-Zn vs.	
	Control	RAC	50	100	150	50	SEM	Control vs RAC	Linear	Quadratic	RAC	50 ppm Zn (ZnO)
d 0 to 14												
ADG, lb	2.39	2.93	2.98	2.97	3.06	3.14	0.07	0.01	0.24	0.81	0.04	0.12
ADFI, lb	7.39	7.24	7.20	7.12	7.19	7.34	0.14	0.44	0.71	0.67	0.62	0.47
F/G	3.14	2.48	2.44	2.42	2.38	2.34	0.05	0.01	0.16	0.94	0.06	0.19
IOFC, $/pig[2]	7.19	9.78	10.31	10.38	10.95	11.28	0.47	0.01	0.09	0.96	0.03	0.15
Caloric efficiency[3]												
ME	4,767	3,770	3,701	3,670	3,613	3,549	79	0.01	0.16	0.94	0.05	0.18
NE	3,272	2,547	2,501	2,480	2,441	2,398	54	0.01	0.16	0.94	0.06	0.19
d 14 to 27												
ADG, lb	2.18	2.36	2.46	2.42	2.37	2.41	0.07	0.06	0.99	0.26	0.57	0.66
ADFI, lb	7.21	6.71	6.88	6.75	6.57	6.84	0.14	0.02	0.39	0.24	0.55	0.85
F/G	3.38	2.89	2.83	2.83	2.80	2.85	0.07	0.01	0.39	0.87	0.68	0.88
IOFC, $/pig[2]	5.35	5.60	6.04	6.04	5.94	5.73	0.42	0.67	0.60	0.52	0.83	0.60
Caloric efficiency[3]												
ME	5,137	4,382	4,297	4,299	4,247	4317	104	0.01	0.39	0.87	0.66	0.89
NE	3,525	2,961	2,903	2,905	2,869	2917	70	0.01	0.39	0.87	0.67	0.89

continued

Table 2. Effects of added zinc and Ractopamine HCl (RAC) on growth performance of finishing pigs[1]

			ZnO, ppm Zn			Availa-Zn, ppm Zn		Probability, *P*<				
									ZnO		Availa-Zn vs.	
	Control	RAC	50	100	150	50	SEM	Control vs RAC	Linear	Quadratic	RAC	50 ppm Zn (ZnO)
d 0 to 27												
ADG, lb	2.28	2.66	2.73	2.71	2.72	2.79	0.05	0.01	0.38	0.57	0.06	0.38
ADFI, lb	7.30	6.99	7.04	6.94	6.89	7.10	0.12	0.08	0.49	0.68	0.53	0.76
F/G	3.21	2.63	2.59	2.57	2.54	2.55	0.04	0.01	0.09	0.91	0.12	0.46
IOFC, $/pig[2]	12.54	15.39	16.35	16.42	16.89	17.01	0.59	0.01	0.08	0.68	0.05	0.43
Caloric efficiency[3]												
ME	4,881	3,996	3,927	3,905	3,850	3861	60	0.01	0.09	0.91	0.12	0.44
NE	3,350	2,700	2,653	2,638	2,601	2609	40	0.01	0.09	0.91	0.12	0.45
Weight, lb												
d 0	206.0	206.1	205.8	204.9	206.5	206.5	1.50	0.96	0.98	0.54	0.85	0.75
d 14	239.4	247.1	247.6	246.5	249.3	250.4	1.88	0.01	0.52	0.54	0.22	0.29
d 27	267.4	277.8	279.5	278.0	280.1	281.8	2.12	0.01	0.58	0.93	0.19	0.44

[1] A total of 312 pigs (PIC 327 × 1050; two consecutive groups of 156 pigs) were used in a 27-d study with 2 pigs per pen and 26 pens per treatment.
[2] IOFC: income over feed cost. Corn was valued at $225/ton, soybean meal at $316/ton, L-lysine at $1.10/lb, DL-methionine at $2.70/lb, L-threonine at $1.25/lb, RAC at $35.26/lb, zinc oxide at $0.86/lb, Availa-Zn at $1.50/lb, and pig price at $0.61/lb.
[3] Caloric efficiency is expressed as kcal/lb gain.

Table 3. Effects of added zinc and ractopamine HCl (RAC) on carcass characteristics of finishing pigs[1]

			ZnO, ppm Zn			Availa-Zn, ppm Zn		Probability, $P<$				
									ZnO		Availa-Zn	
Item	Control	RAC	50	100	150	50 ppm Zn	SEM	Control vs. RAC	Linear	Quadratic	RAC	50 ppm Zn (ZnO)
Final wt, lb	267.4	277.8	279.5	278.0	280.1	281.8	2.12	0.01	0.58	0.93	0.19	0.44
HCW, lb	197.3	206.8	209.3	207.3	207.8	210.2	1.54	0.01	0.88	0.49	0.12	0.69
Carcass ADG, lb[2]	1.59	1.93	2.03	1.99	1.96	2.05	0.04	0.01	0.84	0.09	0.03	0.80
Carcass F/G, lb[2]	4.62	3.63	3.48	3.51	3.55	3.47	0.07	0.01	0.52	0.21	0.13	0.90
Carcass yield, %[3]	73.9	74.4	74.8	74.5	74.4	74.65	0.18	0.05	0.76	0.18	0.36	0.50
Back fat depth, in.[4,5]	0.97	0.93	0.93	0.92	0.88	0.90	0.04	0.43	0.26	0.52	0.50	0.47
Loin wt, lb[4,5]	8.52	8.92	8.74	8.88	9.10	8.81	0.12	0.02	0.17	0.06	0.46	0.68
Lean, %[4,5,6]	51.74	52.15	52.12	52.25	52.63	52.48	0.37	0.43	0.30	0.55	0.49	0.46
Carcass IOFC, $/pig[7]	147.22	152.31	154.31	152.97	153.54	154.74	1.17	0.01	0.65	0.54	0.15	0.79

[1] A total of 312 pigs (PIC 327 × 1050; two consecutive groups of 156 pigs) were used in a 27-d study with 2 pigs per pen and 26 pens per treatment.
[2] Initial carcass weight was calculated using a 75% yield value.
[3] Percentage yield was calculated by dividing HCW by live weight obtained at the farm before transport to the packing plant.
[4] Data were collected on the second group of pigs (13 pens per treatment).
[5] Adjusted using HCW as a covariate.
[6] Percentage lean was calculated by dividing the standardized fat-free lean (SFFL) by HCW. The equation used for calculation of SFFL was derived from NPPC (2001).
[7] Carcass IOFC: carcass-based income over feed cost. Corn was valued at $225/ton, soybean meal at $316/ton, L-lysine at $1.10/lb, DL-methionine at $2.70/lb, L-threonine at $1.25/lb, RAC at $35.26/lb, zinc oxide at $0.86/lb, Availa-Zn at $1.50/lb, and carcass price at $0.87/lb.